THE EFFECTS OF DIFFERING TRAINING PROGRAMS UPON THE ENDURANCE OF MALE RATS

Thesis for the Degree of M. A.
MICHIGAN STATE UNIVERSITY

Jerome Charles Weber

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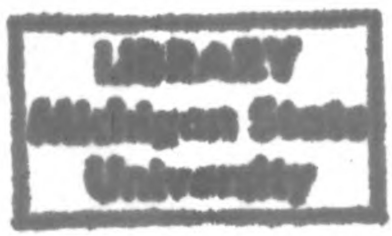

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by

Jerome Charles Weber

A THESIS

Submitted to
Michigan State University
in partial fulfillment of the requirements
for the degree of

MASTER OF ARTS

Approved _____

Department of Health, Physical Education, and Recreation

1961

ABSTRACT

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by Jerome C. Weber

The purpose of this study has been to compare two different methods of training for endurance and to evaluate their relative effectiveness. This was accomplished using a treatment by level experimental design which included a group of animals which trained by an underdistance method, a second group which trained by an overdistance method, and a third group which was sedentary.

Twelve animals in each group were kept in individual cages. The animals in the underdistance group trained each weekday, except testing days, by swimming for one minute and then resting for one minute. This was done with a high percentage of their body weight attached by means of lead sinkers, strung on wire, and held in place with waterproof adhesive tape. This was done to a maximum of twenty repetitions. The animals in the overdistance group were trained the same number of days by constant swimming with a small percentage of their body weight attached for a maximum of sixty minutes. The sedentary group received no exercise. Each group was handled equally and the sedentary group was placed in the water for approximately one minute once each week with no weights in order to accustom the animals to the water.

On Friday of every third week, three animals from each group were chosen to be tested. These animals were shaved and washed in a detergent solution in order to negate any unfair advantages of excessive hair growth or body oils which would add to an animal's buoyancy. These animals were then placed in a deep can lined with plexiglass and their total elapsed swimming time with four percent of their body weight added in the usual manner was timed to the nearest second.

Swimming times were recorded and averages for each group at each of the four levels of testing were calculated. Analysis of variance results indicated no statistically significant results between groups. Recommendation is made that this study be repeated using larger numbers of animals in each group so that any unusually high or low performance by an individual subject would not have so great an effect upon the group average.

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DEDICATION

This paper is dedicated to my parents, Morris and Ethel Weber, who imbued me with the desire to secure an education and were a constant source of inspiration and encouragement to me.

ACKNOWLEDGEMENTS

The author wishes to acknowledge the aid and encouragement given him by the members of the department. These include Dr. Henry J. Montoye and Dr. Wayne D. VanHuss who gave unstintingly of their time and efforts, and Janos Nevai and David Anderson who were a constant help in setting up and carrying out this experiment.

The author also wishes to express his gratitude to his wife Barbara who was a great help in the preparation of this paper and without whose patience and understanding this work would not have been possible.

CHAPTER I

INTRODUCTION AND STATEMENT OF THE PROBLEM

Introduction

For many years, trainers and managers of athletic personnel have attempted to discover a single best method of training an athlete to compete in the most effective manner. This has been especially true in sports in which endurance is a major factor in the calibre of an athlete's performance. Much has been reported in athletic journals to the effect that one system of training or another will accomplish the best results. However, in few of these reports has there been any attempt to scientifically validate these theories.

Statement of the Problem

The purpose of this study was to compare overdistance and underdistance methods of training for endurance and to estimate their relative effectiveness.

Importance of the Problem

Endurance is an extremely important asset for athletes in many sports. In some sports, such as long distance running and swimming, it is the most important single factor relative to an athlete's success. In some team games, such as hockey, soccer, football, and basketball, it is almost as important as the athlete's special skill in the sport.

Many different methods of endurance training have been used over the years and their popularity has often been based

on the success obtained by a single team or athlete which has used this particular method. Too often these training methods are expected to bring about the same results in the mediocre athlete that they have brought about in the superior athlete. It should be realized that there is no single method of training which will act as a panacea for an athlete's lack of ability in other facets of playing ability.

Most of the studies done in this area have been studies of a specific rather than a general nature. They have attempted to show how an athlete would best prepare for a distance swimming event or a cross-country event or how endurance training could be incorporated into a football conditioning program. The studies are primarily concerned with specific sports or parts of the body. The problem under investigation in this study however, is to try to determine the most effective method of training for endurance in general.

Limitations of the Study

The present study was performed using male albino rats. Many people may feel that a training method which produces results, no matter how significant, in lower animals cannot be considered applicable to human training.

This study was concerned mainly with the effects of training upon performance of an endurance event. The results have been interpreted upon the basis of performance only.

DEFINITIONS OF TERMS USED

Endurance

Endurance is interpreted as the capacity or ability to

continue, without interruption, a physical act for an extended period of time.

Training

Training denotes any process or method used to prepare a subject to be capable of performing a specific act.

Control Group

Control group is used to denote that group of subjects which were given no specific method of training designed to increase their endurance and which were incorporated into the study for the purpose of serving as a standard or basis of comparison.

Experimental Group

Experimental group is used to denote those groups of subjects which were subjected to specific methods of endurance training and which were incorporated into the study for the purpose of demonstrating their effects upon endurance.

CHAPTER II

REVIEW OF THE LITERATURE

There has been a great deal of literature in the past twenty years describing specific methods of training for endurance. In almost all of these studies, the subjects have been humans and the type of training described was oriented towards a specific athletic event. There has been no previous literature dealing with the exact topic involved in this study. The purpose of this chapter will be to briefly describe the training methods currently in use as described in the literature.

Most of the literature to be found on various methods of training for endurance has been published in athletic journals since 1940. Methods of training have become more scientific and successful methods have been widely copied. One of the most successful methods which Americans have copied from Europe is the Swedish system of training for distance track events called "fartlek". The success of the Swedish runners in the distance events of the 1940 Olympics was the event which gave impetus to waves of emulation of this method of training. This is a rather unique method of training in the sense that the individual runner is left almost to his own devices in deciding just how much work he will do each day and at what rate he will work. Lacey (11) describes this method of training as alternate walking, jogging, striding, and sprinting. A day's workout in the fartlek system is not

considered successful unless the runner feels better at the completion of the workout than he did at the outset. The runner is supposed to set his pace so that he is never fully tired and never fully rested. The objective of this system of training is to have the athlete build up his body during training rather than have him tear it down by extremely strenuous workouts and then having to build it up again. Most of the previous systems of training were aimed at building speed or endurance in a runner. This was one of the first methods advanced which attempted to improve both. This is typical of the systems used by athletes of a high calibre which might very well be unsuccessful if tried by runners of a lower calibre. The success of this method of training depends almost entirely upon the judgement and maturity of the athlete. This method is particularly suited for European runners who are not considered to be in prime until the age of twenty-five or later.

The underlying principle behind this type of training is also used now in other methods of training. Rankin (13) describes training methods for middle and long distance runners in which the attempt is made to have the runner adjust to stresses placed upon him and also to think in terms of the body repair needed after a particularly strenuous workout. He states that speed is an outgrowth of strength and endurance and that the distance runner must train for these qualities initially rather than to first train for speed when he is concerned with a distance event. He suggests the use of both

overdistance and underdistance running and also suggests that both these methods be done only at 2/3 speed at first.

Gobleman, (19) in a study done at the University of Oregon, attempted to determine how various physical education activities would rank in terms of their contribution to physical fitness. He found that those activities which were conducted for general body conditioning and were trained for by endurance techniques contributed the most.

This is typical of a great many studies which have attempted to incorporate endurance training into training for general fitness or training for power and strength. Capen (7) has reported the effects of weight training upon strength and endurance. In this study the principle which was involved was the overload principle for specified periods of time with an increasing overload.

Definitions of endurance have been incorporated into most of the other studies on endurance. Karpovich (10) defines endurance in terms of how long an exercise can be continued. He states that fatigue limits a person's endurance. Any factor which delays the onset of fatigue will increase endurance. Endurance depends upon the ability of a person to counteract the accumulation of fatigue products.

Steinhaus (14) discusses the effects of training on animals in great detail. He stated that the literature in this area shows a great increase in heart weight due to training and also an increase in the ratio of heart weight to body weight. Training serves the purpose of allowing the person

to perform a given task with less expenditure of internal work as measured by the subject's oxygen requirement. He stated that "endurance, or the postponement of fatigue, is the ability of an organism to balance anabolic and catabolic processes. This means a sufficent oxygen supply and food supply" He goes on to state the following as the most probable causes of fatigue:

> "1, depletion of the phosphocreatine store by loss of one or both of its breakdown products; 2, failure of the resynthesis process due to some limitation being set on the production of lactic acid which most commonly is probably due to the accumulation of lactic acid and therefore due to 3, inability to oxidize lactic acid promptly, due to a shortage of oxygen. The lactic acid accumulated enters the circulation and causes 4, disturbances in carbon dioxide carrying power of the blood, in the respiratory center, and in the vasomotor regulation which an increased circulation can only temporarily compensate; 5, failure of the circulatory and respiratory systems to meet these demands."

He stated that training increase endurance by meeting these problems in reverse order. An increased return of the venous blood fills the heart more completely and produces stronger systoles. This causes cardiac hypertrophy with greater volume per stroke, resting volume, and a slower pulse. This faster circulation causes fragmentation of older corpuscles and stimulation of the production of new ones. The greater resting volume carries more oxygen to the tissues and helps to remove lactic acid before it enters the circulation in large quantities. Since in the presence of enough oxygen, phosphocreatine may be directly resynthesized without the formation of lactic acid, there is a strong possibility that

the increased oxygen transport of the trained person may provide the conditions necessary for this direct resynthesis and therefore reduce the burden of the lactic acid formation.

Ackerman (17) in a study on the relationship of exercise to electrocardiograms in rats indicated to the author the method for training which will be discussed later and also the proper method of housing and correct water temperature. He also defined the procedure for an all-out testing session which was incorporated into this study. His conditioned animals showed slower pulse rates than the sedentary animals and he felt that training might even retard the aging process of the heart.

Wilbur (16), in a study conducted with guinea pigs also aided the author in the procedure for the all-out testing session. He found that if weighted guinea pigs were forced to swim in a group rather than individually, 70% of the animals showed a decrease of 50% in swimming time.

CHAPTER III

EXPERIMENTAL METHOD

Design of the Experiment

The object of this study was to compare the relative effectiveness of two commonly accepted methods of training for endurance. These methods were the underdistance and overdistance methods. The animals which were assigned to Group I were to train by the underdistance method. Those which were assigned to group II were to train by the overdistance method. In addition, an overload principle was to be applied to both groups.

Those animals which were assigned to Group II would train for endurance by swimming for an extended period of time with a small percentage of their body weight added for overload. This weight was added by means of lead sinkers strung on a piece of wire and held in place by waterproof adhesive tape wrapped around the animal's tail. (see figure 1) The weight which was added would be three percent of the animal's body weight at the beginning of the experiment and would increase in gradations of one-half percent of the body weight when, and if, the animal managed to swim for sixty minutes with the preceding weight. The animals in this group were placed in the sink and were timed by means of a Kodak timer. The maximum swimming time, for reasons of practicality, was limited to one hour. If an animal was

Figure I Tail Weighting Technique

unable to swim for the full sixty minutes, he would be removed from the water and his total swimming time would be noted on the data sheets. Whether an animal was able to continue or not was determined by the author's subjective decision. When the animals were removed from the water they were placed in towels and were dried off and returned to their cages.

The animals which were assigned to Group I trained for endurance by swimming for a shorter period of time with a large percentage of their body weight added for overload. This weight was added by the same method used for Group II. The weight which was added was three percent of the animal's body weight at the beginning of the experiment and was increased in gradations of one-half percent of the body weight when, and if, the animal managed to swim for twenty repetitions with the preceding weight. The animals in this group did not swim constantly but instead swam twenty repititions of one minute each. Between each repitition the animals were allowed one minute to rest.

In order to be sure that each animal in this group was in the water swimming for exactly one minute and was resting for one minute, a basket was built which snugly fitted the inner dimensions of the sink in which the animals swam. This basket was constructed of one quarter inch wire mesh which sunk immediately when placed in the water and was easily raised to the surface. (see figure ?) When each of the animals in this group had been weighted at the tail, they

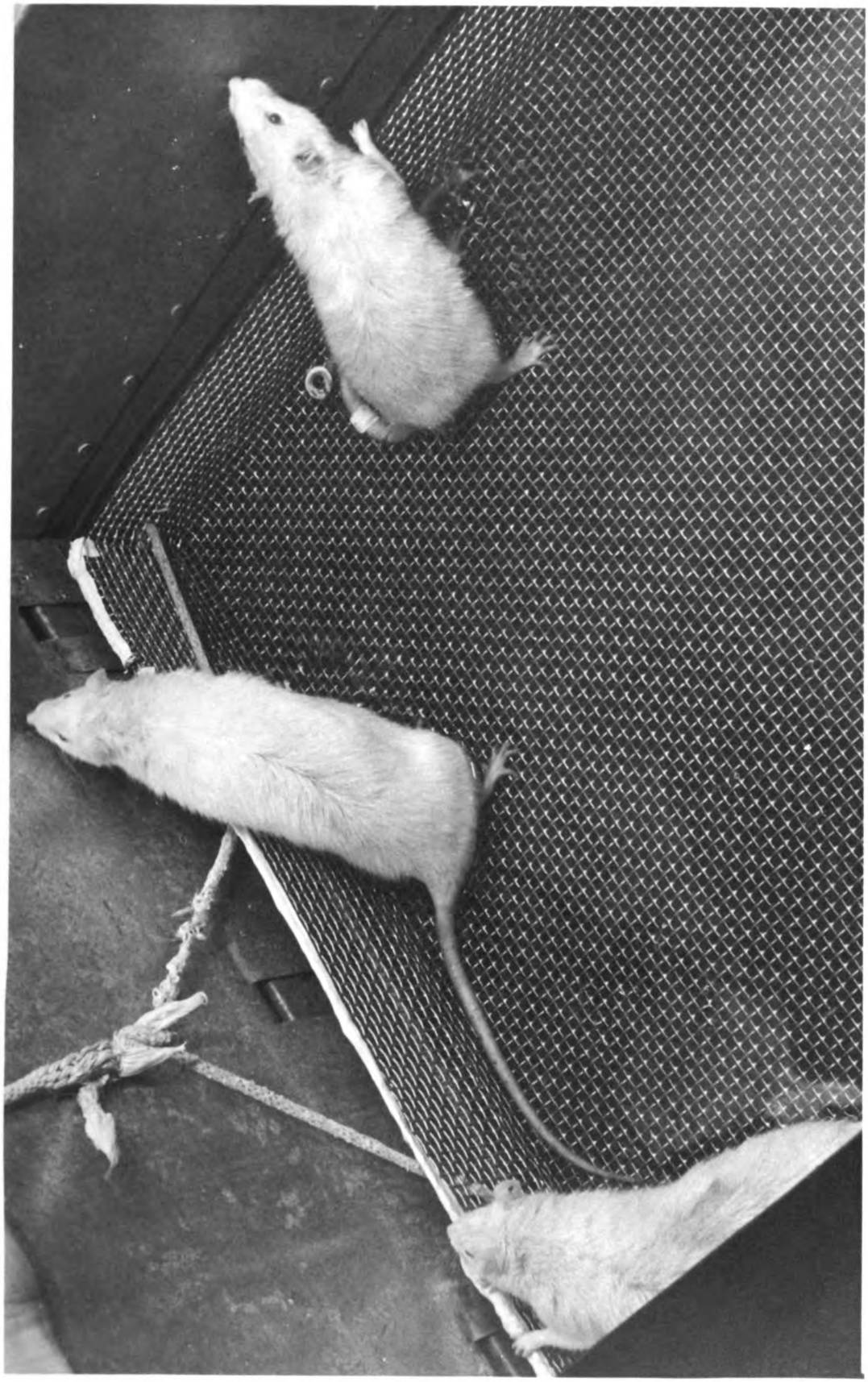


Figure II Under-Distance Basket

were placed in the wire basket and placed in the sink. As the basket entered the water it sunk, and the animals were free to swim. At the end of one minute, which was determined on a Kodak timer, the basket was brought to the surface of the water. Since the basket fitted the sides of the sink snugly, the animals in the sink were raised also. During the minute of rest the basket was held at the surface of the water and the animals were able to simply stand or lie in the basket and rest.

If an animal was unable to continue for the full twenty repetitions, he was removed from the water, his time was recorded, he was dried off, and then returned to his cage. The author again had to make a subjective decision as to whether or not the animal was able to continue.

The times for Group II were recorded to the nearest whole minute until which the animal swam. The number of repetitions for Group I were recorded as the number of complete repetitions which the animal swam unless it was within ten seconds of completing another when it was removed from the water.

The animals which were assigned to Group III were used as the control group. These animals were kept sedentary. A particular point was made to handle these animals as much as those in the two exercise groups so that a difference in the amount of handling would not become a factor in the experiment. The exercise which these animals received was limited to the movement they could get while confined to their cages.

In addition, once a week they were taken out of their cages and placed in the water so that the water would not be completely strange to them when they were placed in it for the testing sessions.

Subjects and Equipment

The animals used in the experiment were male albino rats of the Sprague-Dawley strain. The animals were fifteen weeks old when they arrived at the laboratory. All the animals were born on the same day but were not litter mates. Before the actual experimental work was begun, the animals were kept in the laboratory for three weeks. During this time, the animals were assigned to groups on the basis of a random selection. The animals were housed in individual cages measuring approximately 10 inches long, 8 inches wide, and 7 inches high. Each animal had its own food and water supply. Water was supplied to the animal by means of an inverted bottle hung outside the cage and leading into the cage through a piece of bent metal tubing. Throughout the experiment the animals were fed Wayne Lab Blox manufactured by Allied Mills of Chicago. Care was taken to be sure that the animals were never short of food or water.

After the animals had been assigned to their respective groups, each animal was marked for purposes of identification. This was done by a series of coded round and triangular cuts made in the ears. (see figure 3) The round holes were made with a paper punch and the triangular cuts were made with a

FIGURE III- IDENTIFYING EAR MARKINGS

pair of scissors. There was almost no bleeding and no infection at all due to this procedure. The groups were further identified by means of a small stain mark placed on various positions of the tail for each group. In addition, each cage was marked with the individual and group number of the animal in it.

During the three week period preceding the beginning of the experiment, the animals were handled each day so that they would become accustomed to being picked up. They were also placed in the water during this time, without weights, so they might become accustomed to being placed in the water, to being lifted out of the water, and to being dried off. The temperature in the laboratory was constantly kept at 80±3 degrees Farenheit. It was deemed adviseable to keep the room this warm in order to negate any possibility of the animals developing colds and pneumonia after swimming and thus losing subjects.

The animals swam in a sink which measured approximately 24 inches wide, 24 inches long, and 18 inches high. It was soon discovered that the height of the sink was not great enough to keep the animals from clambering out of the sink so sheet metal inserts were obtained which raised the height of the swimming area to 27 inches. This was the area used for the daily training of the animals. The water in this sink was always between 35 and 37 degrees Centigrade.

The Testing Session

The entire experimental period lasted for twelve weeks.

The animals in the two experimental groups were trained each weekday for this period with the exception of the testing days. There were four testing sessions and these were on the Friday of weeks 3, 6, 9, and 12. On these days, three animals from each group were selected randomly to be tested. These animals were first shaved with an electric animal clipper. The hair on the animal's body holds air which contributes to his buoyancy. Since the amount of hair on each animal is not the same, this factor was eliminated by shaving each of the animals. In addition, before being tested, the animal was washed off in a detergent solution. This was done to remove as much of the body oils as possible. These oils also contribute to the animal's buoyancy and are not equal in each animal and this factor was also eliminated.

Since the test was to be a measure of all-out swimming, it was decided not to use the sinks. These were shallow enough to afford the animal the opportunity of going to the bottom and then pushing off and coming to the top again. A common ten gallon garbage can was used for the testing session. This was lined with a sheet of plexiglass so that the animal could neither go to the bottom of the can and push off, or cling to any support on the sides of the can. With the plexiglass in place, the can measured 17 inches in diameter and was 25 inches deep. The length of the swim was recorded on a Cenco electric timer. As the animal was placed in the water the timer was started and as he was removed from the water it was stopped. This time was recorded to the nearest

whole second.

The animals were tested with a weight attached to their bodies in the same manner as previously described. The animal was weighed to the nearest half gram with 15 3 hours before he was tested. The weight used for each animal was 4 percent of his body weight at this final weighing. This weight was constructed to the nearest half gram.

After being tested, the animal was dried off and returned to his cage. On the day following his testing period, the animal was sacrificed in conjunction with another study which was being done concurrently.

CHAPTER IV

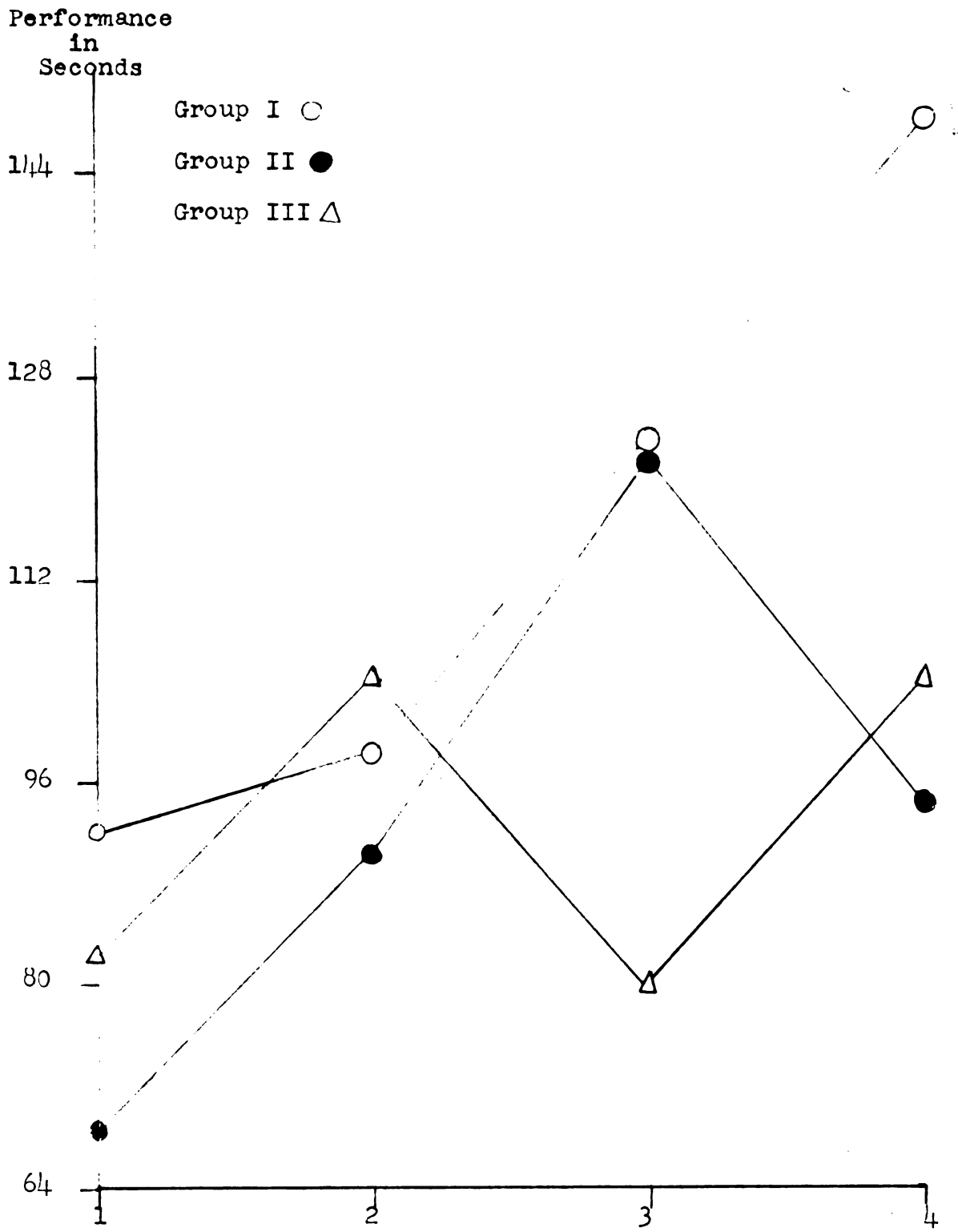
RESULTS

When all of the data from the experimental period had been compiled, there were twelve measures of all-out swimming for each of the three treatments or exercise groups. These twelve measures were obtained over the twelve week experimental period by testing three animals from each group at each of four levels. These four levels were at the end of the third, sixth, ninth, and twelfth weeks. Test results are shown in Chart I. With the exception of the second testing period, the animals in group I scored higher than those in the other groups on each of the testing days. This was the group which trained by the underdistance method with the heavy overload. The performance of this group improved steadily from one testing session to the next.

The animals in group II, which trained by the overdistance method with a light overload, scored lowest in each of the testing sessions with the exception of testing session number three. The animals in group III, which was the sedentary group, scored highest in the second testing session, lowest in the third testing session, and in the middle in testing sessions one and four.

The highest single achievement was recorded by group I. The greatest achievement of group II was higher than the greatest achievement of group III but group II also recorded the lowest achievement of any of the groups in any testing

CHART I- AVERAGE TESTING PERFORMANCES



session. The difference between highest and lowest achievement between testing sessions was greatest for group I, next for group II, and lowest for group III.

The two most surprising points on the chart are indicated by the best performance of group III in the second testing session and the drop in performance recorded by group II in the final testing session. Both of these may be explained by analyzing the raw data to be found in the appendix. (see tables 1 and 3) The reader will note that animal number eight in group III recorded a swimming time of 162 seconds in testing session two. It may be further noted that animal number nine in group II recorded a swimming time of only 49 seconds in the final testing session. The time recorded by animal number eight in group III was the highest time recorded by any animal in any of the testing sessions with the exception of one animal in group I during the final test. The time recorded by animal number nine in group II was the lowest time recorded by any animal in any of the testing sessions. The effect of any outstandingly high or low performance by any individual subject upon the average of three subjects is obviously great. This will be discussed further in the final chapter.

Charts 2 and 3 graphically represent the weekly average swimming time recorded by groups I and II, and the weekly average percentage of body weight which each of the groups carried. Since the study was concerned with the effects of overdistance versus underdistance training in increasing

CHART II- AVERAGE DAILY SWIMMING TIME AND PERCENTAGE OF BODY WEIGHT CARRIED- GROUP I

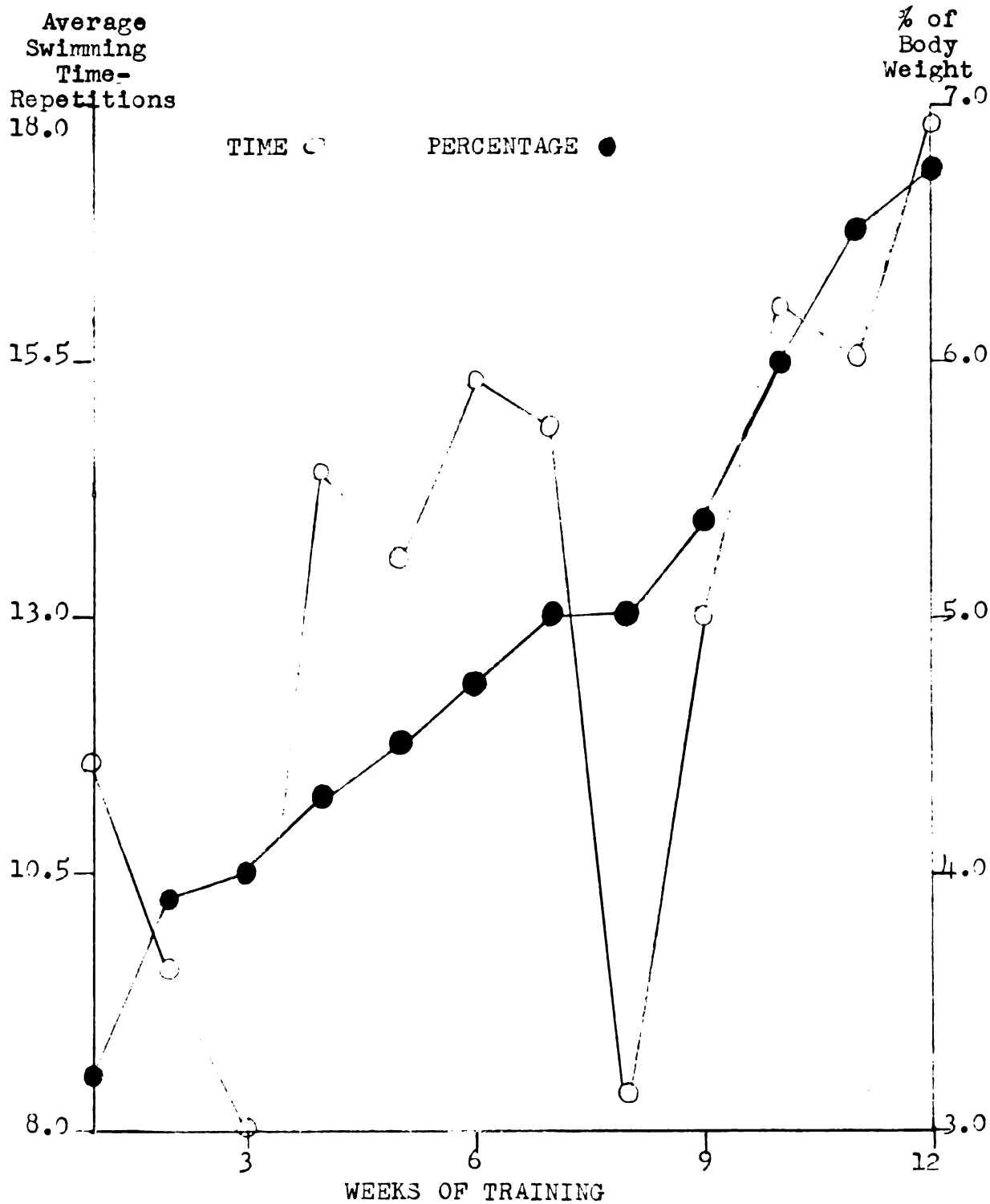
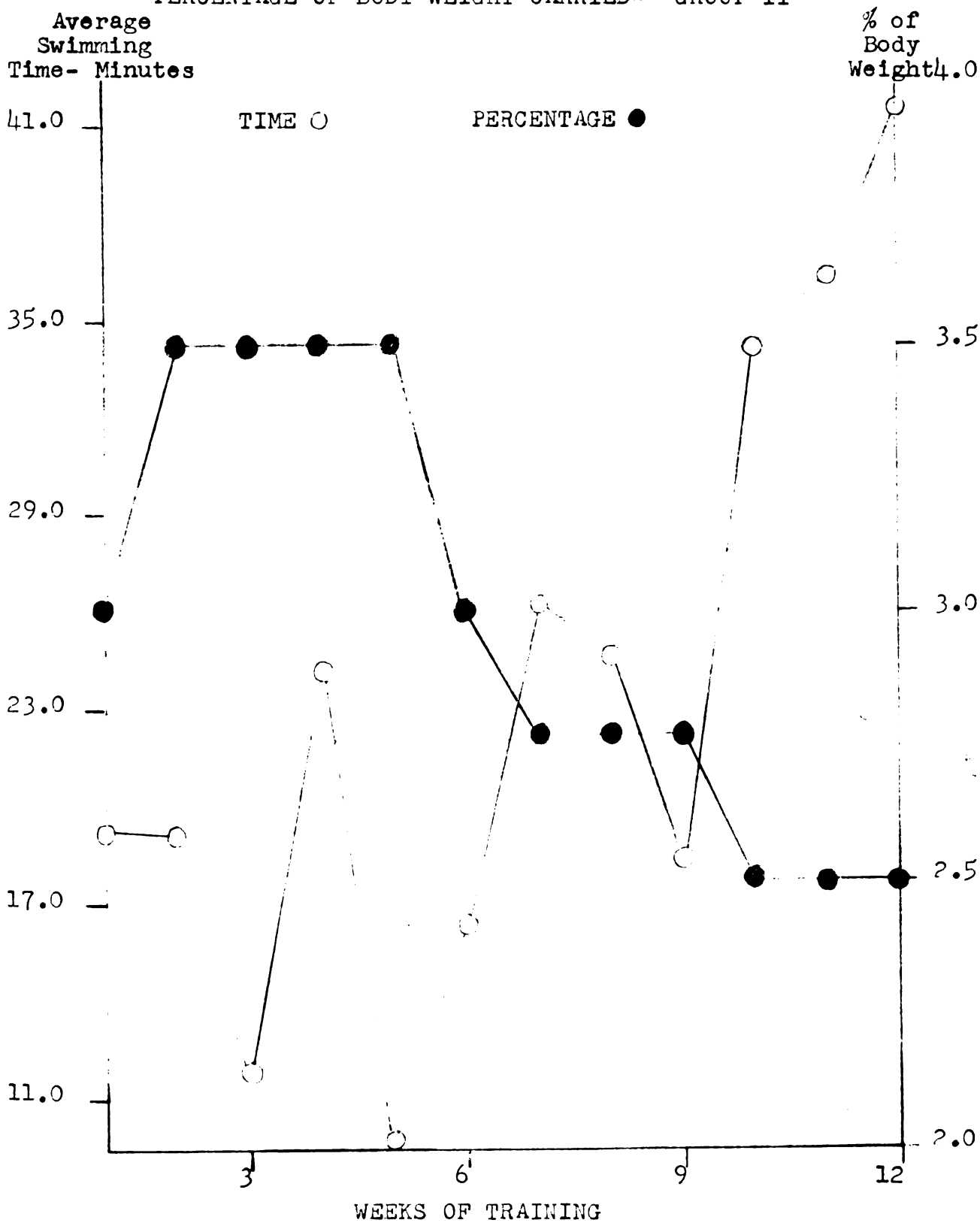


CHART III- AVERAGE DAILY SWIMMING TIME AND PERCENTAGE OF BODY WEIGHT CARRIED- GROUP II

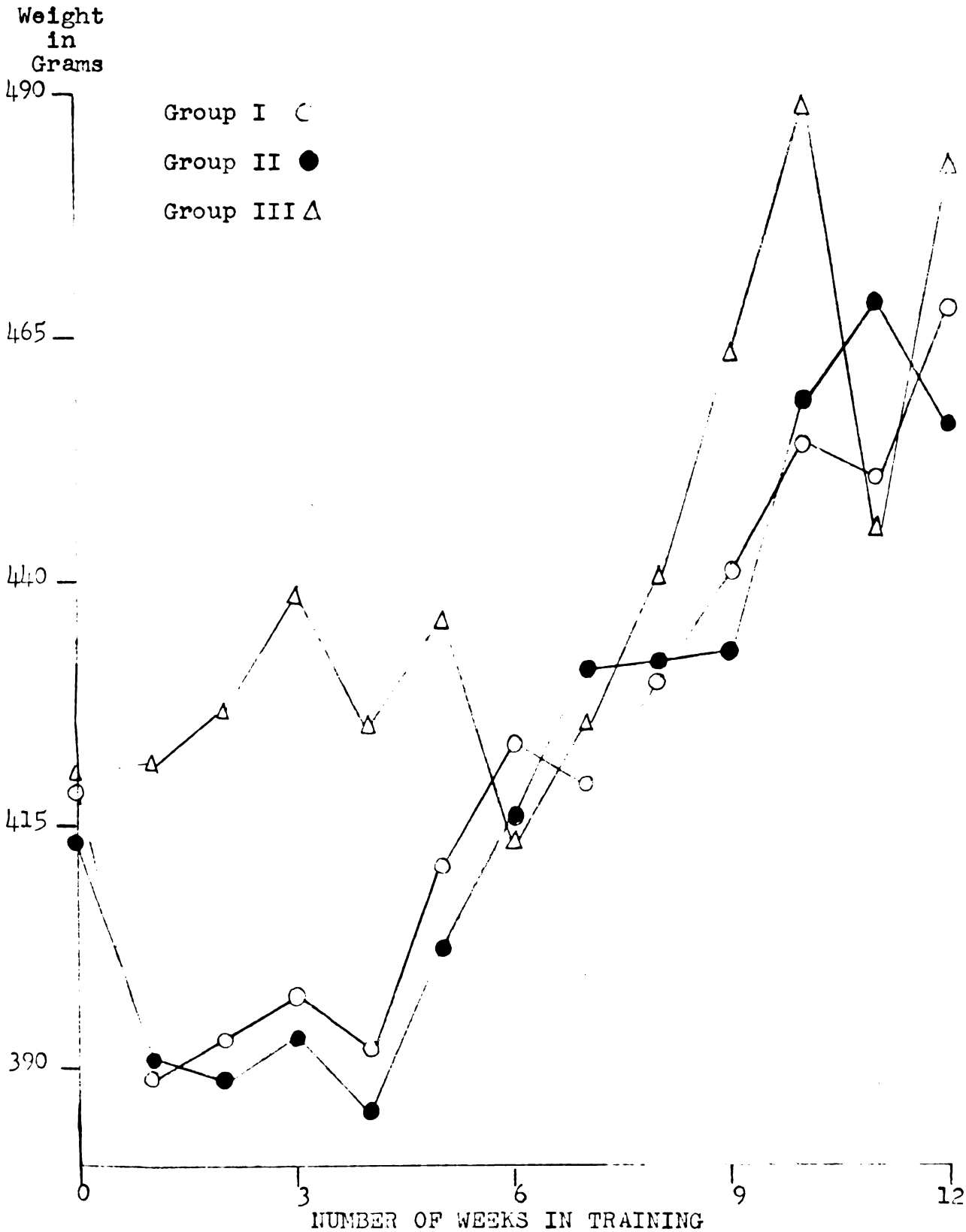


endurance, at the conclusion of weeks 5, 6, and 9 it was deemed adviseable to decrease the percentage of weight attached to the animals in group II. When this was done there was an increase in the amount of minutes which this group was able to swim.

The weights attached to the animals in group I were gradually increased over the twelve week period from 3 percent of body weight to an average of 6.8 percent at the end of the twelfth week. The sharpest drop in performance came at the end of the eighth week when the animals in this group were carrying 5 percent of their body weight. However, the recovery was rapid following this drop and by the end of the ninth week the animals were carrying an average of 5.375 percent of their body weight during the swimming periods.

During the experimental period the animals were weighed every Thursday evening. The results of these measures are shown in Chart IV. The average weight of group III was the highest of the three groups during nine of the twelve weeks. This was as expected. It is interesting to note that the underdistance method of training brought about the greatest immediate weight loss when the training was initiated. However, it should not be inferred that this is always the case since the object of this paper was not to determine weight loss and the food intake was no regulated or measured. It may also be noted that at the end of the experiment, the average body weights of the three groups were in the same relative position as at the beginning of the experiment.

CHART IV- WEEKLY CHANGES IN AVERAGE BODY WEIGHT



The data which were obtained from the all-out testing sessions of the three groups of animals were statistically analyzed by means of an analysis of variance. The results of this analysis are presented below in figure 4.

FIGURE IV- STATISTICAL ANALYSIS

	df	Sum of Squares	Mean Squared	F
Treatment	2	3,869.48	1,934.74	2.16
Level	3	6,336.22	2,112.07	2.36
Interaction	6	5,937.19	989.53	1.10
Error	24	21,501.67	895.90	
Total	35	37,644.56		

The F ratios which were obtained were not statistically significant. No interpretations of the data are warranted.

CHAPTER V

SUMMARY, CONCLUSIONS, AND RECOMMENDATIONS

Summary

The objective of this study has been to compare two different methods of training for endurance and to evaluate their relative effectiveness. This was accomplished using a treatment by level experimental design which included a group of animals training by an underdistance method, a second group which trained by an overdistance method, and a third group which was sedentary.

Twelve animals in each group were kept in individual cages. The animals in the underdistance group trained each weekday, except testing days, by swimming for one minute and then resting for one minute with a high percentage of their body weight attached. This was done to a maximum of twenty repetitions. The animals in the overdistance group trained the same number of days by swimming constantly with a small percentage of their body weight attached to a maximum of sixty minutes. The sedentary group received no special exercise. Each group was handled equally and the sedentary group was exposed to the water for approximately one minute once each week in order to accustom them to it.

On Friday of every third week, three animals from each group were chosen to be tested. These animals were shaved and washed in a detergent solution to negate any unfair advantages of excessive hair growth or body oils. These

animals were then tested and their total elapsed swimming time with four percent of their body weight added was measured to the nearest second.

These times were recorded and averages for each group at each of the four levels of testing were determined. These twelve averages were then tested for statistical significance by means of an analysis of variance.

Conclusions

1. No statistically significant differences were found between the two training methods or between the trained and untrained groups.

Recommendations

1. Experimental work related to the nature and cause of physical changes such as endurance is of extreme importance to the field of physical education.
2. Although the evidence presented in this study did not indicate that different training methods caused a significant difference in performance as measured on an all-out endurance test, it is recommended that a study such as this one be repeated using larger numbers of animals in each group.
3. In a similar study using larger numbers of animals, the average performance for each group would not be as greatly affected by any single unusually high or low performance.
4. It is recommended that the experimental period either be extended to fifteen weeks or that the animals in

each of the experimental groups be subjected to training twice each day.

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APPENDIX

TABLE I- RESULTS OF ALL-OUT TESTS

GROUP I

Testing Period One (March 24)

Number	Time for Swim (seconds)
7	103
8	77
11	96

Testing Period Two (April 14)

Number	Time for Swim (seconds)
5	141
6	77
9	77

Testing Period Three (May 6)

Number	Time for Swim (seconds)
1	134
12	122
16	115

Testing Period Four (May 27)

Number	Time for Swim (seconds)
13	167
15	95
17	185

TABLE II- RESULTS OF ALL-OUT TESTS

GROUP II

Testing Period One (March 24)

Number	Time for Swim (seconds)
14	70
15	61
16	75

Testing Period Two (April 14)

Number	Time for Swim (seconds)
4	100
11	82
12	90

Testing Period Three (May 6)

Number	Time for Swim (seconds)
5	112
6	162
17	96

Testing Period Four (May 27)

Number	Time for Swim (seconds)
9	49
10	98
13	139

TABLE III- RESULTS OF ALL-OUT TESTS

GROUP III

Testing Period One (March 24)

Number	Time for Swim (seconds)
5	100
10	70
14	79

Testing Period Two (April 14)

Number	Time for Swim (seconds)
1	64
2	87
8	162

Testing Period Three (May 6)

Number	Time for Swim (seconds)
3	77
4	84
6	79

Testing Period Four (May 27)

Number	Time for Swim (seconds)
9	130
11	80
12	105

TABLE IV- INDIVIDUAL DAILY SWIMMING TIMES- GROUP I

	ANIMAL NUMBER								
Week	1	2	3	4	5	6	7	8	9
	4	3	4	5	5	5	4	4	4
	11	9	8		12	8	12	12	8
I	20	20	20		20	20	20	20	20
	20	20	11		20	20	20	20	20
	6	9	3		5	7	13	5	4
	20	20	7		20	20	20	8	5
	4	4	11		6	3	5	12	10
II	13	6	0		13	8	14	4	3
	12	5			12	7	9	6	9
	15	5			12	4	7	5	4
	17	8			14	7	10	9	7
	5	0			4	0	3	0	1
III	8	3			7	4	9	2	4
	16				7	4	17	3	1
	T**				T	T	(T)*	(T)	T
	8				10	1			3
	20				20	20			20
IV	17				16	17			19
	18				13	16			16
	20				20	4			3
	16				19	8			6
	18				15	13			10
V	13				16	17			13
	12				14	11			9
	9				11	13			11
	13				19	15			14
	20				15	20			20
VI	13				16	12			8
	11				14	15			9
	T				(T)	(T)			(T)

T** Friday of every third week was devoted to testing. On these days, those animals which were not tested were not exercised either.

(T)* Denotes those animals which were tested on that particular day.

(continued)

INDIVIDUAL DAILY SWIMMING TIMES- GROUP I

ANIMAL NUMBER

Week	1	2	3	4	5	6	7	8	9
VII	10								
	14								
	12								
	15								
	17								
VIII	13								
	14								
	10								
	7								
	11								
IX	13								
	19								
	20								
	17								
	(T)*								
X									
XI									
XII									

(continued)

INDIVIDUAL DAILY SWIMMING TIMES- GROUP I

	ANIMAL NUMBER							
Week	10	11	12	13	14	15	16	17
	4	2	3	3	3	4	3	5
	13	13	6	8	8	7	16	16
I	20	20	10	20	10	20	20	20
	4	20	20	20	20	20	20	20
		4	7	7	6	6	5	15
		9	11	13	17	11	20	20
		13	16	18	17	15	4	5
II		3	5	8	4	6	7	16
		5	14	10	4	11	13	13
		5	11	6	7	14	4	13
		8	13	11	9	16	8	14
		2	5	4	1	3	5	6
III		6	11	9	5	10	10	9
		4	3	3	2	10	3	11
		(T)	T	T	T	T	T	T
			6	20	1	20	3	5
			20	20	5	20	20	20
IV			18	18	11	17	19	16
			13	18	16	19	17	19
			9	20	7	20	5	20
			14	16	11	18	7	14
			12	16	13	19	12	18
V			9	14	15	14	14	11
			13	18	12	17	17	13
			16	15	17	14	12	16
			12	17	13	18	20	11
			20	20	20	20	20	20
VI			14	11	16	15	13	14
			12	16	16	13	9	17
			T	T	T	T	T	T

(continued)

INDIVIDUAL DAILY SWIMMING TIMES- GROUP I

ANIMAL NUMBER

Week	10	11	12	13	14	15	16	17
			14	13	16	14	12	15
			17	17	18	16	15	18
VII			11	14	13	15	13	16
			13	12	16	17	16	15
			16	15	15	14	18	17
			10	12	10	9	10	11
			11	9	6	7	11	12
VIII			8	10	7	4	7	14
			3	9	3	3	3	16
			4	5	3	5	3	13
			5	9	6	11	7	12
			10	20	5	20	6	20
IX			11	17	8	20	7	20
			14	18	8	15	7	20
			(T)	T	T	T	(T)	T
				20	8	20		20
				17	9	11		18
X				18	18	20		20
				18	9	20		15
				17	10	16		18
				15	10	19		20
				15	9	15		17
XI				16	9	18		20
				17	10	16		20
				17	12	17		20
				19	14	20		20
				16	12	19		20
XII				17	15	18		20
				20	15	20		20
				(T)	T	(T)		(T)

TABLE V- INDIVIDUAL DAILY SWIMMING TIMES- GROUP II

	ANIMAL NUMBER								
Week	1	2	3	4	5	6	7	8	9
	5	5	18	9	9	7	7	6	6
	4		17	9	15	5	9	5	5
I	15		60	49	60	53	60	38	37
	4			6	5	6	12	5	5
	5			19	6	5	9	6	7
	24			51	19	40	29	42	13
	36			57	30	46	42	51	28
II	4			55	3	5	3	2	1
	3			45	3	3	5	2	2
	3			28	3	4	7	1	2
	8			34	6	11	18		6
	3			28	5	4	5		4
III	5			30	7	6	9		7
				35	3	2	14		8
				T**	T	T	T		T
				60	4	4	60		5
				17	7	9	27		7
IV				23	13	17	34		16
				32	17	15	22		19
				7	18	15	20		11
				8	4	5			6
				12	6	6			10
V				5	2	4			4
				6	6	4			5
				8	5	5			7
				8	11	7			5
				12	13	10			8
VI				27	18	16			5
				45	17	15			9
				(T)*	T	T			T

T** Friday of every third week was devoted to testing. On these days, those animals which were not tested were not exercised either.

(T)* Denotes those animals which were tested on that particular day.

(continued)

INDIVIDUAL DAILY SWIMMING TIMES- GROUP II

	ANIMAL NUMBER								
Week	1	2	3	4	5	6	7	8	9
VII					25 20 22 24 17	21 30 23 21 36			7 7 6 7 22
VIII					22 21 22 18 20	27 28 17 17 18			5 7 10 4 6
IX					19 20 12 15 (T)	15 18 9 17 (T)			5 7 7 7 T
X									51 20 32 16 19
XI									15 13 16 29 32
XII									37 30 36 9 (T)

(continued)

INDIVIDUAL DAILY SWIMMING TIMES- GROUP II

	ANIMAL NUMBER							
Week	10	11	12	13	14	15	16	17
	2	3	2	9	3	3	5	4
	7	41	5	60	6	8	23	59
I	60	59	11	60	34	39	53	60
	10	6	5	40	7	23	41	27
	7	7	6	11	9	17	45	18
	37	22	35	16	38	50	55	29
	43	32	37	20	43	52	55	36
II	2	2	2	4	2	3	5	7
	6	4	3	7	6	4	8	9
	5	4	2	12	5	7	7	30
	14	13	9	21	12	11	16	28
	3	4	2	5	4	5	5	44
III	8	11	7	16	9	7	10	52
	6	3	3	9	5	7	6	48
	T	T	T	T	(T)	(T)	(T)	T
	5	4	3	12				60
	32	10	5	48				41
IV	41	27	19	53				49
	47	33	24	46				47
	26	34	20	31				10
	10	4	3	41				10
	8	11	5	48				15
V	4	6	2	36				6
	5	6	2	30				6
	6	6	3	34				10
	7	8	4	25				6
	9	14	8	28				12
VI	10	25	26	25				16
	10	21	34	52				22
	T	(T)	(T)	T				T

(continued)

INDIVIDUAL DAILY SWIMMING TIMES- GROUP II

	ANIMAL NUMBER							
Week	10	11	12	13	14	15	16	17
	23			56				32
	26			55				29
VII	23			54				30
	20			57				33
	12			60				15
	23			57				28
	20			58				29
VIII	23			57				27
	10			42				26
	18			52				28
	12			52				29
	18			54				28
IX	9			26				17
	13			30				12
	T			T				(T)
	60			60				
	25			40				
X	47			41				
	16			31				
	22			30				
	29			60				
	32			56				
XI	30			60				
	36			54				
	39			52				
	43			60				
	32			60				
XII	41			54				
	32			60				
	(T)			(T)				

TABLE VI- INDIVIDUAL AND AVERAGE WEEKLY BODY WEIGHTS- GROUP I

Animal Number	DATE OF WEIGHING 3/2	3/9	3/16	3/23	3/30	4/6	4/13
1	468.5	428.0	431.5	447.5	462.0	450.0	440.0
2	446.0	416.0	407.5				
3	402.5	329.5					
4	435.5						
5	394.0	377.0	380.0	385.5	388.0	415.0	422.0
6	421.0	393.5	394.5	398.0	355.5	432.0	415.0
7	453.0	423.5	416.5	403.0			
8	421.0	392.5	390.0	383.5			
9	414.0	387.5	361.0	357.5	370.5	409.0	418.0
10	449.5	407.5					
11	400.5	367.0	369.5	379.0			
12	394.0	386.0	390.0	395.5	412.5	420.0	410.0
13	432.5	413.5	403.0	382.5	393.0	423.5	439.0
14	365.0	360.0	377.5	401.0	384.5	375.0	385.5
15	406.5	373.0	376.0	383.5	379.0	372.5	385.5
16	413.5	414.0	416.5	421.5	383.5	390.0	424.0
17	400.5	371.0	392.5	432.0	424.0	425.0	476.5
Average	418.7	389.9	393.3	397.5	392.1	411.7	423.6

(continued)

INDIVIDUAL AND AVERAGE WEEKLY BODY WEIGHTS- GROUP I

Animal Number	DATE OF WEIGHING 4/20	4/27	5/4	5/11	5/18	5/25
1	449.0	457.0	471.5			
2						
3						
4						
5						
6						
7						
8						
9						
10						
11						
12	413.5	418.0				
13	429.0	434.0	448.5	462.0	443.5	464.5
14	389.0	401.5	412.0	436.0	419.5	442.0
15	386.5	400.5	411.0	428.0	436.5	451.5
16	414.5	429.0	445.5			
17	461.0	473.5	487.0	492.0	501.5	513.5
Average	419.9	429.9	441.9	454.5	450.3	467.9

TABLE VII-INDIVIDUAL AND AVERAGE WEEKLY BODY WEIGHTS-GROUP II

Animal Number	DATE OF WEIGHING 3/2	3/9	3/16	3/23	3/30	4/6	4/13
1	403.0	385.0	373.5				
2	445.5						
3	419.0						
4	421.0	402.0	400.5	403.0	412.0	425.5	400.0
5	423.5	395.5	390.0	379.5	355.5	374.5	399.5
6	389.5	375.0	381.5	393.0	373.5	375.0	403.0
7	429.0	395.0	397.0	407.5	356.0		
8	415.0	400.0	387.0				
9	416.0	398.0	376.5	370.0	381.5	408.5	408.5
10	417.0	393.5	395.0	398.0	406.5	386.5	410.0
11	438.5	400.5	404.5	402.0	400.0	418.0	440.0
12	467.0	388.0	382.0	378.5	380.0	385.5	397.0
13	448.5	409.5	411.0	422.5	408.0	422.5	451.0
14	329.0	341.0	347.5	357.0			
15	454.0	426.0	424.5	417.0			
16	360.5	394.5	398.0	407.0			
17	362.0	353.5	371.5	385.0	391.0	417.5	414.0
Average	414.0	390.7	389.1	393.6	385.5	402.2	416.6

(continued)

INDIVIDUAL AND AVERAGE WEEKLY BODY WEIGHTS- GROUP II

Animal Number	DATE OF WEIGHING 4/20	4/27	5/4	5/11	5/18	5/25
1						
2						
3						
4						
5	435.5	426.0	421.5			
6	414.0	408.5	402.5			
7						
8						
9	440.5	441.0	442.5	451.0	454.5	458.0
10	410.5	416.0	419.0	442.5	453.0	458.5
11						
12						
13	447.5	458.0	474.5	482.5	497.5	451.0
14						
15						
16						
17	437.0	438.0	438.5			
Average	430.8	431.3	433.1	458.7	468.3	455.8

TABLE VIII-INDIVIDUAL AND AVERAGE WEEKLY BODY WEIGHTS-GROUP III

Animal Number	DATE OF WEIGHING 3/2	3/9	3/16	3/23	3/30	4/6	4/13
1	450.0	447.5	448.0	452.0	416.0	396.0	417.0
2	252.5	319.0	337.5	368.0	355.5	369.5	369.5
3	446.0	457.5	451.0	457.5	422.5	436.0	393.5
4	451.0	460.0	461.0	464.5	425.0	416.5	399.0
5	443.0	424.5	429.0	446.5			
6	407.0	399.0	403.0	424.5	409.5	430.5	392.5
7	414.5	401.5	411.0	426.5	433.5	442.5	405.0
8	423.0	398.5	417.5	436.0	433.5	442.5	405.0
9	453.5	425.5	431.0	444.5	410.5	448.5	406.5
10	421.5	423.5	420.5	422.0			
11	459.0	446.0	450.0	467.0	465.5	478.0	454.0
12	441.0	450.0	457.5	461.5	462.5	481.5	456.0
13	435.0	435.0	434.0	427.5	429.5	452.5	437.5
14	450.0	434.0	447.0	460.0			
15	412.0	432.0	437.0	448.0	455.0	473.0	442.0
16	374.5	392.0	397.5	411.0	418.5	436.5	411.5
Average	420.8	421.6	427.0	438.6	425.9	436.3	414.5

(continued)

INDIVIDUAL AND AVERAGE WEEKLY BODY WEIGHTS- GROUP III

Animal Number	DATE OF WEIGHING 4/20	4/27	5/4	5/11	5/18	5/25
1						
2						
3	390.0	419.0	451.5			
4	379.0	393.5	455.5			
5						
6	395.5	430.5	452.5			
7	426.5	440.0	462.5	464.0	421.5	458.5
8						
9	415.0	437.0	451.5	463.0	401.5	466.0
10						
11	478.0	483.0	499.5	518.0	466.0	465.5
12	485.0	492.5	512.0	522.0	467.0	517.5
13	426.5	441.5	476.0	480.5	461.5	496.5
14						
15	443.0	427.5	387.0			
16	414.5	437.0	476.0	490.0	453.5	491.0
Average	425.3	440.2	463.4	489.6	445.2	482.5

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