THE LONGITUDINAL EFFECT OF PROGRESSIVE OVERLOAD ON SPEED AND ACCURACY IN BASEBALL PITCHING

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THE LONGITUDINAL EFFECT OF PROGRESSIVE OVERLOAD ON SPEED AND ACCURACY IN BASEBALL PITCHING

By

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M.G.S.

DEDICATION

This thesis is respectfully dedicated to my mother and father, Mr. and Mrs. Robert Sinks.

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CHAPTER I

INTRODUCTION

Statement of the Problem

The purpose of this study was (1) to determine if "progressive overload" increases the velocity of a thrown baseball; (2) to determine the effect of "progressive overload" on the accuracy of a thrown baseball.

It is the belief of many coaches that if a pitcher can throw a good fast ball he has a better chance of being an effective pitcher.[1,2,3,4] This ability has generally been regarded as innate, since some people have fast contracting muscles and some slow. There are a few studies

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[1]George Sisler, Sisler on Baseball (New York: David McKay Company, Inc., 1954), p. 130.

[2]John J. McGraw, How to Play Baseball (New York: Harper and Bros. Publishers, 1914), p. 39.

[3]Christy Mathewson, Pitching in a Pinch (New York: G. P. Putnam's Sons, 1912), p. 5.

[4]William T. Lai, Championship Baseball (New York: Prentice-Hall, Inc. 1954), p. 60.

on this subject, but they are mostly of short duration and seem to have conflicting statements in regards to accuracy determination.[5,6,7,8]

The relationship between strength and throwing a baseball involves muscle power and speed of movement. Wilkens,[9] conducted an investigation in speed of movement of the arms with and without weight training. It was concluded that speed of movement in the arm of experienced weightlifters is as great as that of inexperienced weight trainees and that improvement is constantly related to training. In Wilkens' experiment he found no ill effects or slowing action in the arms speed.

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[5]Randall L. Hagerman, "The Effect of 'Overload Warm-up' on the Speed of Throwing" (unpublished Master's thesis, Michigan State University, East Lansing, 1956), p. 18.

[6]Robert C. Lummer, "The Effect of 'Overload Warm-up' on Speed and Accuracy in Baseball Throwing" (unpublished Master's thesis, Michigan State University, East Lansing, 1957), p. 3.

[7]Leroy Albrecht, "The Effect of 'Overload Warm-up' on Speed and Accuracy" (Published Master's thesis, Michigan State University, East Lansing, 1958), p. 12.

[8]Richard Lewis Severance, "The Effect of Weighted Baseballs on Speed and Accuracy in Baseball Throwing" (unpublished Master's thesis, Michigan State University, East Lansing, 1959), p. 17.

[9]Bruce M. Wilkens, "The Effect of Weight Training on Speed of Movement," Research Quarterly, 23:361-370, October, 1952.

Capen,[10] studied the effects of overload in specific athletic events. In this study he proved that the training will improve scores. An example of this type of training in baseball would be the swinging of a leaded bat just before hitting. Similarly, it has been thought by many professionals that the use of a weighted baseball during their warm-up period helped them throw the regulation ball faster.[11]

Need for the Study

Experiments have been performed in which a weighted baseball was used in the warm-up period to determine the effect of overload on the velocity of the thrown baseball.[12,13,14,15] The first two studies found no statistical difference in velocity although in both experiments the subjects increased in speed.[16,17] Albrecht's study on overload

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[10]Edward K. Capen, "The Effect of Systematic Weight Training on Power, Strength and Endurance," Research Quarterly 21:83-93, May, 1950.

[11]Hagerman, op. cit., p. 1.

[12]Ibid.

[13]Lummer, op. cit., p. 1.

[14]Albrecht, op. cit.

[15]Severance, op. cit.

[16]Hagerman, op. cit., p. 14.

[17]Lummer, op. cit., p. 18.

warm-up had a statistical difference at the 1% level.[18] The longitudinal study by Severance found an increase in velocity at the 5% level of confidence.[19] All of the studies seem to have conflicting statements in regard to accuracy. By completing a longitudinal study the author desired to determine the effects on accuracy and velocity in more highly skilled subjects. The results of Severance were favorable but not statistically significant in accuracy.

It was also an important factor that this study was synonymous with its justification in that it might lend further credence to coaching techniques concerning overload and weight training. Baseball has been plagued for some time with antiquated methods in the development and improvement of young players. The findings from this study could help speed that development.

Limitations of the Study

1. Psychological factor. All subjects are instructed to throw all of their test throws as hard as possible. It is difficult to obtain maximum performance from all players. The players were motivated verbally as much as possible.

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[18] Albrecht, op. cit., p. 18.

[19] Severance, op. cit., p. 20.

2. The players missed the target too frequently for a precise accuracy recording.

3. The small number of subjects.

Definitions

1. "Progressive Overload"--Additional weight added to the baseball internally every two weeks throughout the experimental period.

2. "Warm-up Period"--Time it takes each individual to prepare himself, according to individual differences for the throwing of the weighted ball.

CHAPTER II

RELATED LITERATURE

This chapter contains literature which is related to the weight training of baseball players both directly and indirectly. Since relatively little research has been completed on baseball most of the findings are indirect but pertinent to the study.

There have been a few studies which show the velocity of a thrown pitch may be increased by use of weight training.[20,21,22] Many coaches, however are still skeptical of using such a program. The reason that even the positive results have been contradicting and these remained a question. Most research on the subject has had a positive trend but because of the limitations involved with equipment and the motivational problems the evidence is minimumal.

It is known that many athletes have there own unique methods of weight training. Almost all baseball players when in the on deck circle, waiting to hit, swing a lead

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[20] Lummer, op. cit., p. 14.

[21] Albrecht, op. cit., p. 18.

[22] Severance, op. cit., p. 20.

bat, or if not a lead bat, maybe two or three regulation bats giving them the same affect. This indicates that they believe by swinging the heavier bat the regulation bat seems lighter and easier to handle. Track men do the same by using weights on their ankles when running in practice. Some swimmers have been known to practice with weights tied to their legs. Many athleties will not expose their own personal secrets because they feel it is to their advantage. More and more research is now being carried on so that we will not stand still in the rapidly changing society. There is seldom a day passes that some record is not broken in the field of athletics. The records are being broken because of high intensity training and not because we are satisfied to stand where we are.

Hagerman[23] studied the effect of an overload warm-up at Michigan State University. He used a weighted ball (11 ounces) in a warm-up period to evaluate the effect on velocity of a thrown baseball. In his study eight subjects were used as a sample. Each subject was his own control as related to warm-up. The entire test covered a period of one day. Each subject chosen participated in two separate tests. The first test was given in the morning and was

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[23]Hagerman, op. cit.

preceded by a warm-up period with the regulation baseball. Each subject threw fifteen pitches at a target, which was a simulated strike zone, for score. The throws were timed using an electric clock. The clock would start upon release of the ball from the fingers and the circuit was closed upon impact of the ball on the target. The same procedure was followed after the subjects had used a weighted baseball (11 ounces) for their warm-up period. The regulation pitching distance of sixty feet-six inches was used in both tests. Hagerman's results were not statistically significant. However, the data were sufficiently promising to warrant further research.

Lummer[24] in a similar study, examined the effect of "overload warm-up" on speed and accuracy in baseball throwing. The subjects were sixteen volunteers from the Physical Education service courses at Michigan State University. The testing with the different weight baseballs was conducted in the Latin square order. Record cards were made up prior to selecting the subjects at which time the order of warm-up with the four weighted balls was set. Subjects 1-4 threw ball A at the first session, subjects 5-8, ball A at the second session, subjects 9-12, ball A at the fourth session

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[24]Lummer, op. cit.

and subjects 13-16, ball A at the third session. The remainder of the orders of throw evolved around this plan. When the subjects reported for the experiment their names were affixed to a card by alphabetical order starting at one and working through sixteen. The subjects were divided into four groups determined by the order in which they threw the weighted warm-up balls. Each subject acted as his own control in that he daily threw both after the regular warm-up and the "overload warm-up" with each of the four weighted baseballs. The testing was divided into four sections with each subject warming-up with the regulation ball for ten practice throws to a gloved catcher and then after three orientation throws with the normal weight ball to become familiar with the wiring to his throwing arm and the target, ten throws for score were recorded on the electric clock. He then was given one of the weighted balls, according to the category he was placed in before the start of the testing, and threw the heavier ball for twenty-five times to a gloved catcher before proceeding with his recorded scores. This process was followed at each of the testing sessions with a different weight baseball being used by each group of subjects for the "overload warm-up."

The results showed that "overload warm-up" had no effect on the speed of throwing although an increase was found in the mean velocity scores for all four weighted balls. The warming-up with an overweight baseball had no

harmful effects on the speed of throwing. However, warming-up with the nine ounce ball resulted in increase in accuracy regardless of the effects on velocity.

Following up studies by Hagerman and Lummer, Albrecht[25] investigated the effect of an "overload warm-up" period on the speed and accuracy of the baseball throw. Fifty baseball players from the 1958 freshman baseball team of Michigan State University acted as subjects. All were accomplished baseball players in high school. Each subject acted as his own control in both the regulation and "overload warm-up" tests.

All players were allowed to warm-up using normal baseball procedure with a regulation baseball. After a complete warm-up, each subject recorded ten throws for speed and accuracy during the regulation phase. After a ten minute rest the subjects continued in a controlled warm-up period using the weighted baseball. This consisted of fifteen normal throws and ten throws at maximum speed for a total of twenty-five throws in the "overload warm-up" period. Immediately following this period the subject recorded ten additional throws for speed and accuracy with a regulation baseball.

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[26] Albrecht, op. cit.

Ten subjects were randomly selected from the original fifty and retested in velocity. This test consisted of two phases. The first phase was a duplication of the original test. The second phase was another duplication eliminating the "overload warm-up." The second phase of testing was conducted as a control.

Conclusions were based on a mean velocity of .340 seconds found for regular warm-up as compared to .316 seconds for the "overload warm-up." The mean difference was .024 seconds, indication the subjects threw faster after the "overload warm'up." This mean difference was statistically significant at the 1% level. Accuracy was not changed.

Severance[26] studied overload throwing in high school baseball players. Eight volunteers from the baseball team at Potterville High School, Michigan, served as subjects. The subjects were tested prior to the experiment and matched into pairs according to velocity, at which each subject could throw the ball from thirty feet-three inches. Following the pre-test the subjects were divided into two groups of four subjects each. All this time one group was designated as the experimental group and the other as the control group. The subjects ranged in age from fifteen to

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[26]Severance, op. cit.

nineteen years of age. All subjects had played on the high school team and had played one or two games a week for ten weeks prior to the beginning of the experiment.

A program using weighted baseballs was set up for each of the four subjects in the experimental group. Each subject in the experimental group, after sufficient warm-up with the weighted baseball, threw the weighted baseball ten times maximally each day Monday through Thursday. On Friday of each week the subjects warmed-up with the weighted baseball, then threw the regulation baseball for ten maximal throws which were recorded for velocity and accuracy. A seven ounce ball was used the first week, a nine ounce ball the second week, an eleven ounce ball the third week, and a thirteen ounce ball the fourth and fifth week.

The control group did not throw the weighted baseball but followed the same outline and procedure as the experimental group, only with the regulation ball.

The results of the data for the two groups showed that the experimental group increased in speed more than the control group. An analysis of variance was used to prove that the value of ($F=7.55$) was statistically significant at the 5% level of confidence. The data also indicated that experimental group showed more improvement in accuracy of throwing than the control group. When analysis of variance was applied to this difference, the value ($F=26.83$) was significant at the 1% level.

Petroff[27] investigated the immediate affect of throwing an eleven ounce ball on the speed and accuracy following impairment in throwing velocity.

Twelve baseball pitchers from the 1959 Michigan State University varsity baseball team served as subjects. Each individual acted as his own control in the warm-up period and the "overload warm-up" period.

Each subject was instructed to warm-up with a regulation five ounce baseball using his own customary warm-up procedure. After the subjects' warm-up period, a wire was taped on at wrist, forearm, biceps, back of his shoulder, and around the thigh. The wire was connected to a chronoscope, which was started by the breaking of the circuit of two wires at the fingers as described by Albrecht.[28] Each subject was allowed two pitches at the target to accustom himself to the wires. The subject was then instructed to throw as fast as possible at a target thirty feet-three inches from the pitching rubber. A recorder registered the velocity of each of the ten throws. Another observer acted as the judge to determine the accuracy of each pitch at the target.

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[27]Thomas A. Petroff, "The Effect of 'Overload Warm-up' on Speed and Accuracy in Baseball Pitching following Muscular Fatique" (unpublished Master's thesis, Michigan State University, East Lansing, 1960).

[28]Albrecht, op. cit., p. 15.

The accuracy and velocity of each pitch was recorded. After each serves of ten throws, the subject was given a rest period of approximately five minutes. Following each series of ten throws, the subject was asked if he felt any signs of arm weariness. If the subject in the initial throw of a series of ten throws indicated that his arm was getting tired, he was encouraged to complete the remainder of the ten throws in that particular set.

If there was a decrease of .040 seconds or more between the mean score of the initial set of ten throws and the set in which the subject expressed fatique, an additional set was thrown. This terminated the first phase of the experiment.

Following a five minute rest the same subject took part in the "overload warm-up" period. This period consisted of fifteen pitches with an eleven ounce ball thrown as fast as possible at a distance of fifteen feet. The eleven ounce ball was selected because Lummer[29] had obtained the best results with this weighted ball.

Following another five minute rest period, the second phase of the experiment was conducted with the subject throwing a regulation baseball at his maximum ability for two sets of ten pitches at the target. The velocity and accuracy was recorded again for each pitch. This concluded the testing routine.

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[29]Lummer, op. cit., p. 25.

Petroff concluded by the use of analysis of variance that there was statistical significance at the 1% level of confidence in velocity and the accuracy scores after the "overload warm-up" did not decrease significantly.

Chui,[30] in an experiment to ascertain some of the pertinent facts concerning the effects of systematic weight training on athletic power found that weight training seemed to increase the amount of potential power in the subjects tested. Data was secured from body weight, Sargent jump, standing broad jump, eight pound shot, twelve pound shot, and sixty-yard dash of twenty-three subjects performing weight training exercises and twenty-two controls before and after the experimental period. In the shot put events the trained group showed overall improvement and training seemed to have a positive effect on power. The probability of increasing speed in sprint events through training with systematic weight exercises seemed likely since seventeen of the weight training group did show improvement. Chui concluded that the subjects engaged in weight training improved over the control group and that the results indicated the probability of increasing speed through systematic weight training, even though statistical significance was not shown.

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[30]Edward Chui, "The Effect of Systematic Weight Training on Athletic Power," Research Quarterly, 23:361-369, October, 1950.

Capen,[31] in a similar experiment studied the effects of systematic weight training on strength, athletic power, and muscular and circulatory-respiratory endurance. He found that training with weights improved scores in power events significantly even though a control group scored higher on the pre-test and practiced them during the testing period. The experimental group of forty-two sophomores trained using barbells and dumbbells, while the control group for the study consisted of twenty-nine freshmen in a physical education conditioning course. The weight training group showed greater general improvement in muscular strength and also excelled in all final scores in muscular and circulatory-respiratory scores though not significantly.

Jack F. Davis,[32] studying the effects of weight training on swimmers, found that as a result of weight training all swimmers tested increased their speed in both the 25 yard and 50 yard dash. The investigator tested for ten weeks devoting the first and last to time trials in the 25 and 50 yard dashes and the second through ninth week to intensive weight training with just one hour of swimming per week. The crawl stroke was used to determine what effect weight training might have on swimming.

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[31]Capen, op. cit.

[32]Jack F. Davis, "The Effect of Weight Training on Speed in Swimming," The Physical Educator, 12:28-29, March, 1955.

Masley, Hairabedian and Donaldson[33] proposed to determine whether increased strength gained through weight training was accompanied by an increase in muscular co-ordination and speed of movement. The experimental group was composed of twenty-four subjects who had selected a beginning weight lifting class as their required physical education activity for an eight week period. All students who had any previous weight lifting experience were excluded from the study. There were two control groups selected, of which, the first consisted of twenty-four volunteers from a beginning volleyball class. The second control group was made up of fifteen volunteers from among those men who were required to attend a sports lecture course in lieu of any required physical education activity. The only restriction placed on the control group, as related to extracurricular activity, was that they were not permitted to participate in any weight training. McCloys' revision of the Rogers' Strength Index[34] was used to measure increased strength. Speed of movement was measured in terms of elapsed time required to complete twenty-four rotary movements of the arm in a frontal plane.

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[33]John W. Masley, Ara Hairabedian, and Donald N. Donaldson, "Weight Training in Relation to Strength, Speed, and Coordination," Research Quarterly, 24:308-315, October, 1953.

[34]C. H. McCloy, "A New Method of Scoring Chinning and Dipping," Research Quarterly, 2:132-143, December, 1931.

The weight training group was given a weight program to build the body. Groups of related exercises were used with a moderate amount of weight and repetitions. Each subject was encouraged to increase the number of repetitions on each work period. There was no attempt to increase the weight amount to the maximum. The program lasted for six weeks and each group met three times a week for 35 minute periods of work.

The experimental group showed the only significant increase in speed which was at the 2% level of confidence. However, the evidence to test the hypothesis that an increase in strength was associated with an increase in speed was inconclusive since a signigicant increase in strength by the experimental group was associated with a significant increase in speed, but a similar increase in strength by the volleyball group was not accompanied by a similar increase in speed. It was concluded that the weight training had no deleterious effect on any of the subjects.

Wilkens[35] tested the speed of movement of the arm action with nineteen university students before and after a semester of an elementary weight training class. Wilkens concluded that the weight training had no slowing effect on the speed of the arm movement as measured in this study. It was also concluded that the chronic weight lifter is not

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[35] Wilkens, op.cit.

"muscle-bound" as far as his speed of movement is impaired. There was however no increase in speed of movement during this one semester of training although it is believed as training increases, improvement is constantly gained.

Hooks[36] explains that throwing a baseball is not purely a matter of strength and that the best arms are those that are able to explode with speed and strength at precisely the right instant, simulating the action of a buggy whip. Therefore, the specific throwing muscles should be trained through resistive exercises, but the greater part of a lifting program should be devoted to exercises that require a combined movement of many muscles used in throwing.

Hooks suggests boring a small hole halfway through an old baseball and pour an ounce of hot lead into it, allowing it to solidify before using. He believes that up to ten ounces of lead may be added without deleterious affects.

He suggested to start out slow by throwing the lightest (6 oz.) ball and work until it can be thrown as hard as possible without soreness. This may take one or several weeks. Graduate to the next heaviest ball and proceed in the same manner. A very important portion of the exercise is to throw the ball properly, getting a full wrist snap in to each throw.

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[36]Gene Hooks, Application of Weight Training to Athletics (Englewood Cliff, New Jersey: Prentice-Hall, Inc., 1962).

Ouellete[37] studied the effect of quadriceps development on sprint running time. The subjects were three freshmen track candidates and five members of a track and field class. The experimental group consisted of two freshmen track candidates and two members of the track and field class. This group participated in a progressive resistance exercise program, which consisted of meeting four days a week and performing a knee extension exercise for both right and left legs. At the end of each week a one R.M. was determined and recorded.

The control group consisted of one freshman track candidate and three members of the track and field class who did not take part in the resistence overload program. All subjects participated in daily track training and were tested twice each week for seven weeks. A two week lay off was brought about because of a between term school vacation and took place between the fourth and fifth week.

Thigh girth development and tension strength was measured each Wednesday. Friday was set aside for testing seventy-five yard dash times and also determining and recording of one R.M. for the experimental group only.

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[37]Richard C. Ouelette, "The Effect of Quadriceps Development on Sprint Running Time" (unpublished Master's thesis, Michigan State University, East Lansing, 1955).

The results of this study showed that progressive resistence exercise even above the weight loads used in knee exercise had no deleterious effect on sprint running times and the trends were toward faster times although not significantly so. There was a significant increase (F=12.1 and 32.5 at the one per cent level of confidence) in one R.M. values, from the initial to final test, in the experimental group. However, no conclusions could be drawn as to whether this significant increase was due to weight training or running.

CHAPTER III

METHODOLOGY

The purpose of this study was (1) to determine if "progressive overload" increases the velocity of a thrown baseball; (2) to determine the effect of "progressive overload" on the accuracy of a thrown baseball. In this study as in previous studies the experimental method was elected as a type of research.[38] The following discussion will describe the methods and procedures which were used in calculating velocity and in recording the accuracy of the subjects throws. As mentioned in the first chapter continuous encouragement and motivation was given to each individual subject to get him performing at his optimal.

I SUBJECTS

Sample

Fourteen volunteers were selected from the Michigan State University 1964 freshmen team to serve as subjects. The subjects were tested at the beginning of the experiment and matched into pairs according to the speed at which each

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[38] Research Methods Applied to Health, Physical Education and Recreation (revised edition; Washington, D. C.: American Association for Health, Physical Education and Recreation, 1952), pp. 301-314.

subject could throw the ball forty feet. The subjects were then divided into two groups of seven subjects each. One group was designated as the experimental group and the other group was designated as the control group. The subjects were all between the age of nineteen and twenty-one. All of the subjects had played high school baseball plus participating in a summer program prior to the beginning of this experiment.

II EQUIPMENT

Timing Device

An electric timing clock, the Athletic Performance Analyzer,[39] scaled to 1/100's of a second was employed to record the speed of each throw. Estimation of the thousandth place was relatively simple. Activation of the clock began with the release of a peg attached to a 20 pound nylon test line which was in turn attached to the ball. The line was adjusted to each individual so that at the moment of ball release the release peg would "break" the circuit. When the ball in flight made contact with the target, the area of which simulated the strike zone, the circuit was opened and stopped the clock enabling a reading to be taken.

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[39]Athletic Performance Analyzer (Dekan Timing Device Co., P.O. Box 712 Glen Ellyn, Illinois).

Target

The target[40,41] proper was constructed of a 17 x 36 inch piece of five-ply plywood covered with rubber matting and set off from the 30 x 56 inch frame. The clock stopping device was an electrical vibrator which upon any vibration would stop the clock. There was sufficient vibration when the target was struck that the clock stopped instantly and without difficulty. The face of the target was painted with equidistant squares from the sides and given the value of five, four, three, and two starting at the center and working toward the outside. The scoring area for five measured 7 1/2 x 11 inches, area for measured 22 x 15 inches on its outside border, area three measured 44 x 30 inches.

Wiring Device

A wire extended from the target to a jack plug in the clock. A second release button was used to place the release peg between. Upon release of the peg the clock would start. A sufficient length of nylon test line was used to allow for flexibility in throwing and maneuvering.

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[40]Lummer, op. cit., p. 14.

[41]Severance, op. cit., p. 15.

Baseballs

In choosing the weighted balls to be used in this study it was decided to increase the regulation baseball, which as stated in the Official Baseball Rules, must weigh not less than five nor more than five and one-quarter ounces,[42] by two ounce increments. Weights for the three balls selected were set at seven, nine and eleven ounces. The added weight was accomplished by drilling a hole in a regulation baseball, filling it with lead to the desired weight and replacing the baseball cover.

Throwing Area

The pitching distance was reduced to forty feet three inches in an effort to cut down on the number of wasted pitches encountered in some of the previous studies by Hagerman,[43] and Lummer[44] when balls missed the target area and did not produce a score. Even though the subjects are trained pitchers they lack the ability often to hit the target consistently. Therefore in shortening the regulation pitching distance it was felt that this would add to the value of the study in not discouraging the subjects when their throws were not recorded by the clock on complete misses.

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[42] Baseball Almanac (New York: A. S. Barnes and Company, Inc., 1963).

[43] Hagerman, op. cit.

[44] Lummer, op. cit.

III PROCEDURE

The Experimental Factor

A program using weighted baseballs was set up for each of the seven subjects in the experimental group. Each subject in the experimental group would warm-up his own individual way. When the subjects had warmed-up thoroughly physically with the regulation baseballs, for about eight minutes, they would then begin to toss the weighted baseball. It was very important that the technique of throwing of the weighted ball be emphasized. They were told to use the same motion that they would use pitching a regular ball and also to be sure and follow through. This not only prevented injuries but also the weight training was then specific to the motion of throwing used in throwing the regulation weight baseball. After warming up thoroughly with the weighted baseball for eight minutes each subject threw the weighted ball five times maximally twice a week, Monday and and Wednesday. After throwing the weighted baseball for eight minutes the subjects would return to the regulation baseball for four minutes. Each subject in the experimental group, therefore, received twenty minutes of throwing and all conditions were the same. It was decided that I would test every Friday but in two different methods on every other Friday. On the first Friday the warm-up was conducted with the regulation ball for eight minutes, then the weighted ball for five minutes and finally the regulation

ball for two minutes before they threw the regulation baseball for ten maximal throws which were recorded for speed and accuracy. Every two weeks this method was used for testing. On the other in-between Fridays the testing was handled in the following manner. The subjects would not pick up a weighted ball at all but would warm-up as usual to their individual differences for a period of fifteen minutes with the regulation baseball at which time they were prepared to be tested. Ten pitches at maximal speed were recorded for velocity and accuracy. The seven ounce ball was used the first two weeks, the nine ounce ball the second two weeks, and the eleven ounce ball the third two weeks.

The control group did not throw any weighted baseballs. Each subject in the control group, after eight minutes of warm-up with the regulation baseball, threw another eight minutes at near maximal speed. At the end of the second eight minutes each subject threw five pitches at maximal speed followed by four additional minutes of playing catch at half speed. The control group also had their practice session on Monday and Wednesday. On Friday of each week the subjects in the control group warmed-up with the regulation baseball for about fifteen minutes, then threw the regulation baseball for ten maximal throws which were recorded for speed and accuracy. Since there is no way to insure that the subjects were throwing maximally, this factor

must be considered. However, the subjects in both groups were constantly encouraged to throw maximally and it is the opinion of the author that the subjects did so.

Testing Routine

As it has already been said, Friday of each week all subjects met for testing on speed and accuracy. The following procedure was adhered to at all testing periods. On the first, third and fifth Fridays the experimental group would warm-up as explained previously. After the sufficient amount of warm-up throws had been completed each subject threw three orientation throws with the clock running and the line attached to the baseball and timing device working. After throwing the three orientation throws using a regulation baseball, each subject in the experimental group threw ten maximal throws which were recorded for speed and accuracy. On the second, fourth and sixth weeks the same procedure was followed except the subjects would not warm-up with the weighted balls but only the regulation baseball. The speed was recorded on the electric clock and an accuracy score was given each throw according to where the ball hit the target. Each subject in the control group followed the same procedure on all testing days except that each subject in the control group always warmed-up with a regulation baseball instead of the weighted ball used by the experimental group. The total testing period covered six weeks.

Records

All information was recorded on specially made 3 x 5" cards with a column for the time and accuracy score of each of the ten throws made by each subject at weekly testing period. An average of the ten accuracy scores and an average of the ten speed scores were given each subject as his accuracy and speed score for that day.

Statistical Technique

Analysis of variance was used to evaluate the differences between experimental and control groups, the differences between individuals in the experimental group and the individuals in the control group and the differences between tests.[45]

[45] A. S. Edwards, Statistical Analysis (New York: Rinehart and Company, 1954).

CHAPTER IV

PRESENTATION AND ANALYSIS OF DATA

The purpose of this experiment was to determine whether the speed of a thrown baseball could be increased by throwing a weighted baseball and to measure the effect of throwing a weighted baseball upon accuracy. The experimental group was composed of seven freshman pitchers which threw the weighted ball three times a week with the weight being increased two ounces every two weeks for six weeks. The control group was also composed of seven freshmen pitchers who threw the regulation baseball three times a week for six weeks. Throwing days were Monday, Wednesday, and Fridays for both groups. All subjects threw exactly the same amount of the time each day. Both groups were tested on Fridays with the regulation baseball after sufficient warm up.

This chapter is divided into two parts, the first giving the results and statistical analysis of the effects of the weighted baseballs on speed of throwing and the second part giving the results and statistical analysis of the effects of the weighted baseball on accuracy of throwing.

I VELOCITY

Groups

The results of the compiled data for the two groups proved that the experimental group increased in velocity much more than the control group. (Graph I) The Duncan Multiple Range Test showed that the initial means of the two groups were not significantly different. An analysis of variance was applied to the difference of velocity between the two groups at the end of the testing period. The value ($f=10.295$) was significant at the .01 level.

Test

An analysis of variance was applied to the test. A value of ($F=11.077$) was significant at the .01 level. This shows that both groups improved significantly in the experiment.

Individuals

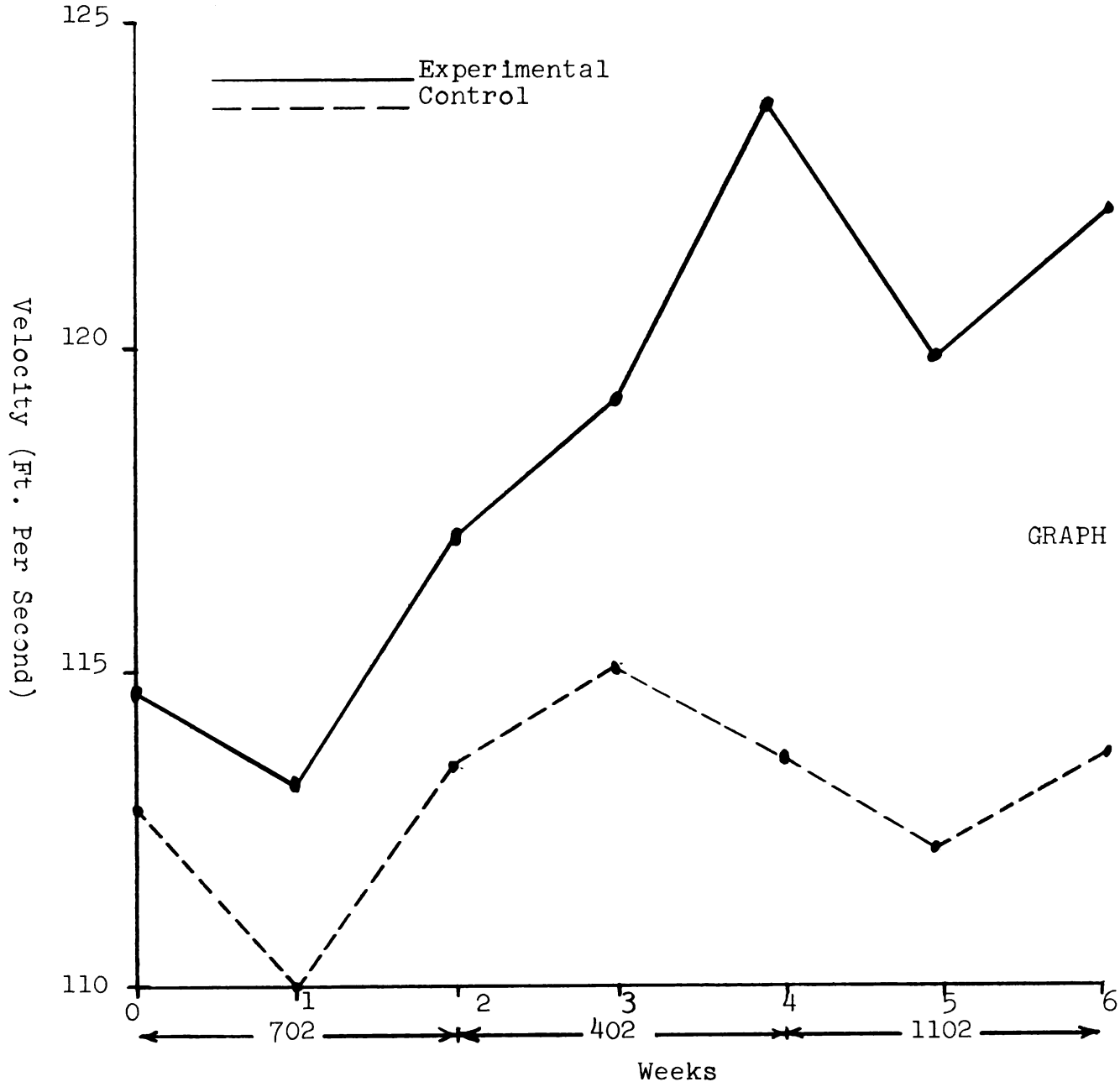
The individuals were also compared by using analysis of variance. According to the data presented in Appendix A there was a significant difference between individuals. ($F=16.777$, $p=.01$), this means that the subjects responded in a significantly different manner to the training program.

Discussion.

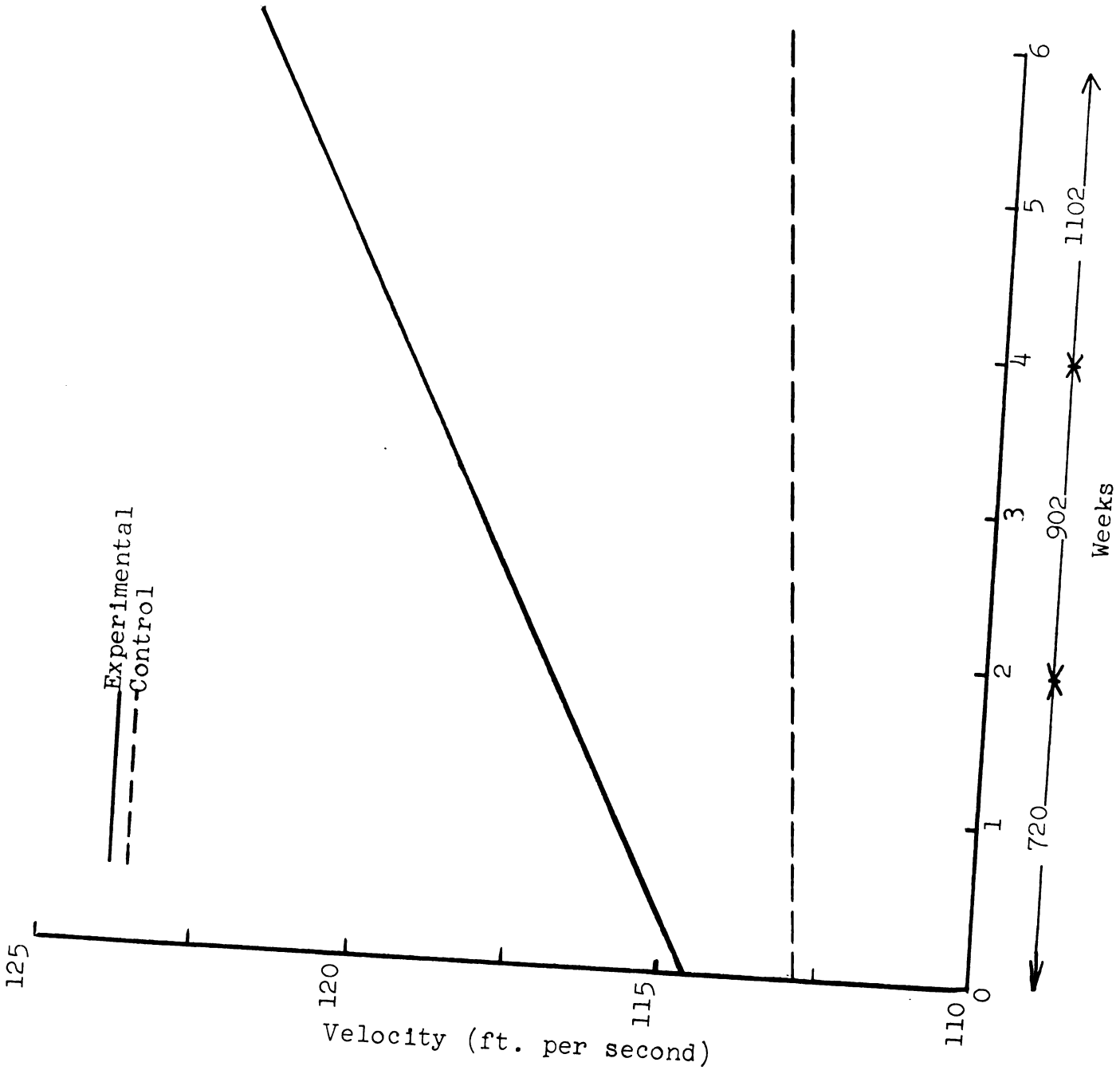
According to Graph I, the experimental group improved the same or more than the control group every week except

the fifth week when the eleven ounce ball was used by the experimental group. This was the week following the assassination of President John F. Kennedy. It was also the week of Thanksgiving vacation, at which time all students are dismissed from school on Wednesday. Because of the presidents funeral on Monday no workout was scheduled. Wednesday, therefore, was the first and only day both groups were able to throw. Because of the Thanksgiving holiday both groups were tested on Wednesday. There was a great velocity drop in both groups which may have been a psychological effect of the President's assassination. Another possible explanation is the lack of throwing that week. The following week both groups continued the experiment without interruption. Even though a regular schedule was followed neither group recovered fully in velocity.

Each participant had two weeks to get into shape even before the pre-tests were given. After the pre-test the individuals were assigned to their groups by means of matching the velocities. The pre-tests were held on Friday and the study was started the following Monday. As indicated in Graph I both groups retrogressed on the first week of testing. This action follows the general rule of any learning skill. During the second week the experimental group increased their mean speed of throwing by 4.3 ft/sec. as compared to an increase of 3.5 ft./sec. in mean speed of the control group during this same week. During the



GRAPH I--VELOCITY



Graph Ia--VELOCITY

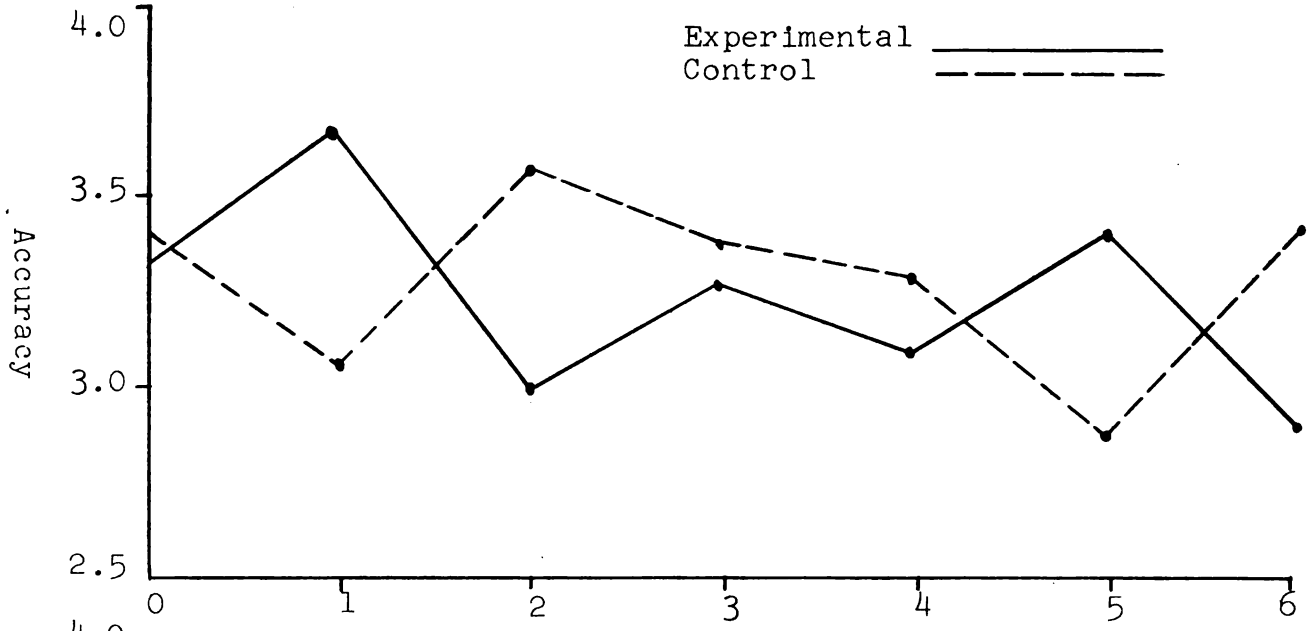
third week both groups increased 1.4 ft./sec. The fourth week was where the experimental had their largest increase in velocity. The experimental group increased their mean speed of throwing by 5.0 ft./sec. whereas the control group had a decrease of 1.2 fet./sec. in mean speed during this same week. The fifth week both groups decreased as previously stated. During the final week neither group was able to return to their maximum velocity but the experimental group increased 2.2 ft./sec. compared to only a 1.4 ft./sec. increase by the control group.

The differences between the experimental group and the control group, the differences between tests and the difference between individuals were all statistically significant. (Appendix C, Table I) These results support the thesis that the speed of throwing can be increased by throwing a weighted baseball.

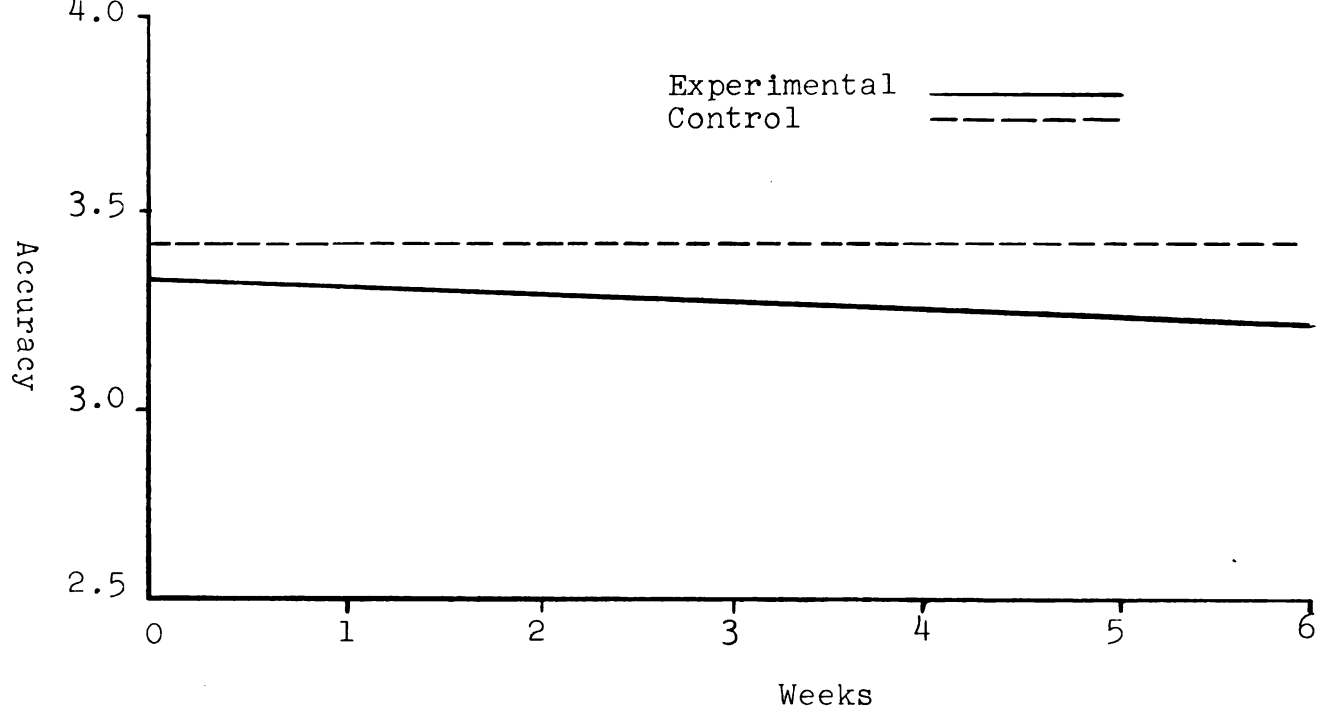
II ACCURACY

Groups

The results of the compiled data, shown in Graph II, for the two groups showed that the control group was significantly different from the experimental group. When analysis of variance was applied to this difference, the value ($F=4.054$) was significant at the .05 level. The accuracy of the experimental group was significantly poorer than the controls'. Even though the mean accuracy score

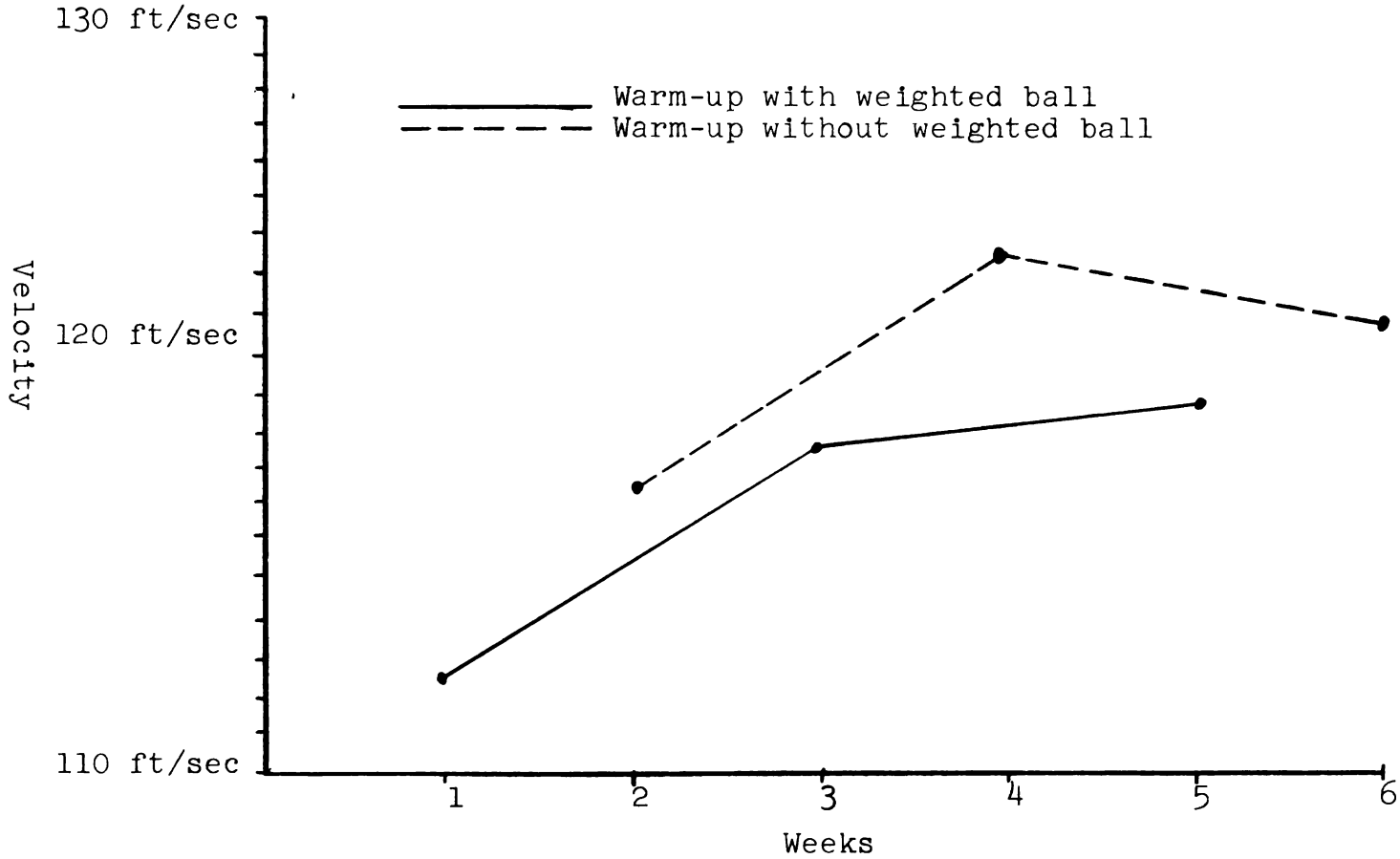


GRAPH II
ACCURACY



GRAPH IIa
ACCURACY

GRAPH III--EXPERIMENTAL GROUP
INTER-COMPARISON ON
VELOCITY



of the control group was higher initially the Duncan Multiple Range Test showed no significant difference between the groups prior to the experiment.

Individuals

The individuals were again significantly different ($F=4.949$, $P=.01$).

Test

The changes in accuracy across the tests was not significantly different.

Discussion

According to Graph II the control group did not decrease in accuracy whereas the experimental group decreased slightly. It should be noted in Graph IIa the decrease in the experimental was small but significantly smaller. Another interesting situation should be noted in Graph III. (It has previously been mentioned that on the first, third, and fifth weeks the experimental group would warm-up preceding their test period with the weighted ball and on the second, fourth and sixth weeks the group would warm-up with the regulation baseball.) The Graph shows that when the experimental group warmed-up with the weighted ball immediately preceding the testing period that their mean accuracy scores were higher.

According to Graph IIa, which is a straight line representation of accuracy, neither group increased in accuracy. This situation might be explained by the fact that all of the participants in both the experimental and control groups were in good throwing and physical condition prior to the study.

The control group was higher in accuracy four of the six weeks in which the experiment was performed. The first week of the experiment the experimental group went to their highest point on the accuracy scale. The value of 3.7 on a 5 point scale was the highest for either group during the entire study. Due to the lack of continuity among the mean accuracy scores, remainder explanations are left to Graph II, Graph IIa and Graph III.

In comparing individuals in the experimental group with individuals in the control group, it was found that five of the seven subjects in the control group either improved their mean accuracy scores more or they decreased less than their closest match (see Appendix B). This improvement was not necessarily consistant each week.

The negative accuracy finding forces the rejection of the hypothesis that accuracy will be improved by throwing a weighted baseball (Appendix C, Table II). The statistics do not support the hypothesis that accuracy can be improved by throwing a weighted baseball, however, in the programs when a weighted ball was thrown immediately preceding the

testing of accuracy the scores were improved. The reasons underlying these results are obscure and were not the purpose of this study. They probably are intimately associated with the sequential pattern and recruitment of motor units. On the basis of these results it would appear that even though velocity has been improved by means of a longitudinal program that on a given day that peak performance is desired that "overload warm-up" should also be included.

CHAPTER V

SUMMARY, CONCLUSIONS AND RECOMMENDATIONS

Summary

The purpose of this study was to determine whether the speed of a thrown baseball could be increased by throwing a weighted baseball and also to determine if accuracy could be improved by the same method. Two groups of seven freshmen baseball pitchers served as the subjects. The experimental group consisting of seven subjects threw on Monday and Wednesday for twenty minutes each. The first eight minutes was devoted to warm-up with the regulation baseball. The second eight minutes were devoted to throwing the weighted ball with the last five throws near maximal. The last four minutes were used to regain the feel of the regulation baseball. The control group, which also consisted of seven subjects, threw on Monday and Wednesday for a period of twenty minutes. The first eight minutes were used for warm-up with the regulation baseball and the following eight minutes the subjects continued to be used throwing the regulation baseball, but at a faster rate of speed. The last five throws during that period were thrown at near maximum speed. The control subjects then threw the regulation baseball for another four minutes but not at

maximum speed. All subjects were supervised individually so that a close pattern in throwing effort was maintained.

On Friday of each week all subjects were tested. The experimental group alternated warm-up procedures on every other Fridays. On the first, third, and fifth Fridays the experimental group would warm-up for eight minutes with the regulation ball, five minutes with the weighted baseball and then return to the regulation baseball for two minutes. The purpose of returning to the regulation baseball was to become familiar with its' feel again before testing. The second, fourth and sixth Friday consisted of the same amount of time in warm-up but without the weighted baseball. All of the control group warmed-up fifteen minutes with the regulation baseball.

The weight of the ball was changed every two weeks for the experimental group. The first two weeks a seven ounce ball was used, the second two weeks a nine ounce ball and the final two weeks an eleven ounce baseball was used for the overload. At no time during the study did any control subject throw the weighted baseball.

The data obtained from the six tests was tested statistically using an analysis of variance and the Duncan Multiple Range Test. The differences in velocity between the two groups, the differences in velocity between individuals and the tests were all found to be significant at the .01 level of confidence. This statistical evidence supported the

hypothesis that speed of throwing can be increased by throwing a weighted baseball.

The difference in accuracy between the two groups and the difference in accuracy between individuals in the experimental group and individuals in the control group were found to be statistically significant in reverse. The hypothesis that accuracy is improved by throwing a weighted baseball must be repeated on the basis of the evidence.

Conclusions

The following conclusions are based on the data presented.

1. The speed of throwing a baseball can be increased by throwing a weighted baseball only twice a week for six weeks.
2. The accuracy of a thrown baseball cannot be increased by throwing a weighted baseball twice a week for six weeks.

Recommendations

The recommendations of this study are as follows:

1. It is recommended that if such a study is repeated, a different means for measuring velocity be used. Even though the system used in this study was improved and simplified over previous studies it would be a considerable savings in time and possibly the illumination of a psychological

factor, to the subjects, if an electric eye could be set up for the measurement of velocity.

2. A study of longitudinal effects of the "overload warm-up" following the fatigue factor should be accomplished in the near future.

APPENDICES

APPENDIX A

VELOCITY SCORES

Recorded in Feet/Second

Subject	Initial Test	1st Week	2nd Week	3rd Week	4th Week	5th Week	6th Week
			Experimental				
Mike Rocca	122.4	111.8	118.7	118.2	128.5	119.6	124.5
Jerry Sherman	116.4	114.5	117.2	122.1	130.9	123.1	126.6
Larry Lenz	115.8	114.6	122.3	124.2	123.2	124.2	125.3
Ken Vanderlip	114.9	118.0	124.0	121.7	129.2	131.3	128.6
Jim Johnson	113.9	110.3	112.8	117.4	118.3	112.0	117.9
Tom Swiss	112.9	111.6	114.4	116.2	121.3	117.5	118.3
Tony Putnam	106.9	105.9	110.8	110.4	113.7	110.3	111.9
SUM	803.2	786.7	820.2	830.2	865.1	838.0	853.1
MEAN	114.74	112.38	117.17	118.60	123.58	119.71	121.87
			Control				
Fred Howard	116.5	109.0	115.6	116.8	113.5	116.7	114.7
Andy Hoban	115.6	112.5	115.3	115.4	116.2	110.4	116.4
Bill Holmes	114.5	113.2	114.9	120.3	119.7	116.9	115.6
Dave Hood	113.7	105.5	113.4	114.5	114.3	112.9	114.1
Terry Pitcher	113.1	112.4	113.2	113.8	114.6	112.3	109.4
Dave Crouch	111.9	110.1	113.6	116.7	108.0	109.7	108.5
Doug Spehar	105.1	105.1	108.4	107.4	108.0	105.5	105.7
SUM	790.4	767.8	794.4	804.9	794.3	784.4	784.4
MEAN	112.91	109.68	113.48	114.98	113.47	112.05	112.05

APPENDIX B

ACCURACY SCORES

Subject	Initial Test	1st Week	2nd Week	3rd Week	4th Week	5th Week	6th Week
			Experimental				
Mike Rocca	4.3	4.0	3.9	3.0	3.8	3.7	3.5
Tom Swiss	4.1	3.4	4.0	3.5	3.5	3.2	2.8
Jim Johnson	3.7	3.2	3.2	3.2	2.9	4.2	3.4
Larry Lenz	3.2	3.9	3.4	3.9	3.1	3.3	3.0
Tony Putnam	3.1	3.3	2.4	3.6	1.8	3.2	2.6
Jerry Sherman	3.0	2.3	2.1	3.1	3.1	3.0	2.7
Ken Vanderlip	2.0	3.0	2.2	2.8	2.8	3.3	2.7
SUM	23.4	23.1	21.2	23.1	21.0	23.9	20.7
MEAN	3.34	3.30	3.02	3.30	3.00	3.41	2.95
			Control				
Dave Hood	4.3	4.3	3.5	3.3	3.1	2.7	2.7
Fred Howard	3.9	2.0	2.7	2.6	2.8	2.6	3.6
Bill Holmes	3.6	3.0	3.9	4.2	3.8	3.6	4.1
Terry Pitcher	3.4	3.4	3.9	3.6	3.8	2.5	3.2
Dave Crouch	3.3	3.2	4.1	4.0	4.3	3.9	4.1
Doug Spehar	3.1	3.5	3.5	3.2	2.8	2.1	3.8
Andy Hoban	2.0	2.7	3.4	3.2	2.4	3.1	2.2
SUM	23.6	22.1	25.0	24.1	23.0	20.5	23.7
MEAN	3.37	3.16	3.57	3.44	3.29	2.93	3.39

APPENDIX C

ANALYSIS OF VARIANCE TABLES

TABLE I

VELOCITY

Source	Sum of Squares	d.f.	E.M.S.	"F" Value
Total	3,382	97		
Groups	776	1	776.00	10.295 **
Test	501	6	83.500	11.077 **
Individual	1,517	12	126.416	16.771 **
Error	588	78	7.538	

** significant at the .01 level of confidence

TABLE II

ACCURACY

Source	Sum of Squares	d.f.	E.M.S.	"F" Value
Total	38	97		
Groups	1	1	1.000	4.054 *
Test	3.1	6	.5171	2.096
Individual	14.65	12	1.221	4.949 **
Error	19.25	78	.2467	

* significant at the .05 level of confidence
** significant at the .01 level of confidence

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