Thesis for the Degree of M. A.

MICHIGAN STATE UNIVERSITY

Robert Clark Lummer

1957

THE EFFECT OF 'OVERLOAD WARMUP' ON SPEED AND ACCURACY

IN BASEBALL THROWING

by

Robert Clark Lummer

AN ABSTRACT OF A THESIS

Submitted to the College of Education of Michigan State
University of Agriculture and Applied Science in
partial fulfillment of the requirements
for the degree of

MASTER OF ARTS

Department of Health, Physical Education, and Recreation

1957

Approved ______________________________

Robert Clark Lummer

ABSTRACT

Statement of the Problem. The purpose of this study was (1) to determine if "overload warmup" increases the speed of throwing; (2) to determine if varying loads in "overload warmup" alters the speed of throwing; and (3) to determine the effect of "overload warmup" on the accuracy of throwing.

Methodology. Sixteen subjects, volunteers from the physical education service courses at Michigan State University, threw a regulation weight baseball (5 ounces) after warmup with both a regulation and overweight ball. The four balls used in "overload warmup" weighed 7, 9, 11, and 13 ounces. Each subject used all four weighted balls at four testing periods.

Scores for velocity were timed by an electric clock accurate to 1/100's of a second. Accuracy was measured by the hits on the target ranging from 5 to 0. Simultaneous scores for velocity and accuracy were taken of ten throws for each testing session.

The results were treated statistically by analysis of variance for several matched groups. Those proving significant by this method were then tested for significance by the "t" test.

Conclusions. The following conclusions have been drawn from the data collected.

1. "Overload warmup" had no effect on the speed of throwing.

An increase was found, however, in the mean velocity scores for all four weighted balls.

2. Warming up with an overweight ball had no harmful effects on the speed of throwing.

3. Warming up with the nine ounce ball resulted in increased accuracy, regardless of the effect on velocity.

THE EFFECT OF 'OVERLOAD WARMUP' ON SPEED AND ACCURACY IN BASEBALL THROWING

by

Robert Clark Lummer

A THESIS

Submitted to the College of Education of Michigan State
University of Agriculture and Applied Science in
partial fulfillment of the requirements
for the degree of

MASTER OF ARTS

Department of Health, Physical Education, and Recreation

1957

ACKNOWLEDGEMENTS

A study of this nature involves the co-operation of many people. The writer is most grateful to all the subjects who took their time to participate in each of the testing periods, Mr. Leo Folsom for his help in administering the tests, and Dr. Wayne D. Van Huss whose advise and guidance was so helpful in the writing of this study.

The author also wants to formally thank his wife, Emily, whose patience and understanding were invaluable toward the success of this study.

R. C. L.

TABLE OF CONTENTS

TABLE OF CONTENTS (Continued)

LIST OF FIGURES

LIST OF CHARTS

CHAPTER I

THE PROBLEM AND DEFINITIONS OF TERMS USED

In recent years studies by Chui[1], Wilkins[2], Zorbas and Karpovich[3], and Capen[4] have shown either increases in speed of movement or no harmful effects after a program of weight training. Another facet of the speed of movement problem worthy of investigation is the effects of warmup with an object, (i.e., bat or bats, baseball, shotput, etc.) with a weight in excess of the regulation weight used in competition. Hagerman[5] studied the effects of warming up with an eleven ounce baseball on the subsequent speed of throwing a baseball (five ounces). The mean speed of throwing increased for the regulation pitching distance. While his results were not statistically significant it was felt the problem was worthy of further study.

---

[1]Edward Chui, "The Effect of Systematic Weight Training on Athletic Power," Research Quarterly, 21:188-194, October, 1950.

[2]Bruce M. Wilkins, "The Effect of Weight Training on Speed of Movement," Research Quarterly, 23:361-369, October, 1952.

[3]W. B. Zorbas and Peter V. Karpovich, "The Effect of Weight Lifting Upon Speed of Muscular Contraction," Research Quarterly, 22:145, May, 1951.

[4]Edward K. Capen, "The Effect of Systematic Weight Training on Power, Strength and Endurance," Research Quarterly, 21:83-93, May, 1951.

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

I THE PROBLEM

Statement of the problem. The purpose of this study was (1) to determine if "overload warmup" increases the speed of throwing; (2) to determine if varying loads in "overload warmup" alters the speed of throwing; and (3) to determine the effect of "overload warmup" on the accuracy of throwing.

Need for the study. It is generally agreed that one of the assets of a successful baseball pitcher is a good fast ball.[6,7,8,9] In order to make his full repertoire of pitches - curve, drop, slider or change of pace - more effective he should possess a fast ball that will keep the batters off stride by alternating the speed with which he throws. If this is not accomplished the batters will regulate the timing of their swing to meet the oncoming ball. In order to prevent this occurrence it is the responsibility of the pitcher to throw at an accelerated rate at strategic points throughout a batting situation. While this is an acknowledged and widely

---

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

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

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

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

advocated resource of a pitcher very little work has been undertaken to determine if it is possible for a pitcher to increase his speed. It was the purpose of this study to determine if the "overload warm-up" method might be a technique to accomplish this task.

Limitations of the study. In order to facilitate the testing due to the number of subjects and the time element, in daily scheduling and overall length of the project, the pitching distance from the "pitching rubber" to the target was reduced to 40 feet from the regulation 60 feet 6 inches. The reason for this adjustment was the amount of time lost in missing the target as experienced in the earlier study using similar methods.

While fast balls are not the only pitch to be possessed by a pitcher, this investigation tested only this type of pitch and the effect on it as a result of "overload warmup".

Members of the Michigan State University varsity baseball team were excluded from the experiment as it was felt their extra team practice sessions between testing periods would influence any score made. The daily throwing they participated in at practice sessions might tend to build up their throwing ability and speed.

Each subject was instructed before each testing period to throw at his maximum. Since there was no way to insure this factor it must be considered here in analyzing the data. The tester, however, feels that each subject did his very best and had that assurance from the subject after all the testing was completed.

II DEFINITION OF TERMS USED

"Overload Warmup" - refers to the pre-testing period in which the subject throws the weighted baseballs immediately prior to the testing with the regulation baseball.

—

CHAPTER II

RELATED LITERATURE

In this chapter the existing research on throwing and the most pertinent literature on weight training will be reviewed. The examination of the various authors' findings will put emphasis on methodology and results.

Very little has been done in the way of determining the effect of using extra weights in increasing the velocity of throwing. As a result of observation, interviews and experience the author knows more has been done than is recorded in the research literature. Many individuals in seeking to better their ability or advantage have used weight training in warmup. Some of these are well-known methods, such as swinging several bats before taking a turn at the plate, pitchers carrying lead balls in their pitching hand between innings and wearing tennis shoes in practice swimming sessions. Others are kept as trade secrets by persons who feel it is to their advantage. Little of this material, however, has been studied under controlled conditions or reported in the research literature.

I BASEBALL THROW

Slater-Hammel and Andres[10] compared the velocities of fast balls and curve balls to obtain data on the demands of a batter in respect to the speeds of pitched balls. Six members of the Indiana University pitching staff were tested during the 1950-51 season in the school gymnasium. Each subject threw twenty fast balls and twenty curve balls for score against an electronic device, which measured the velocity. Copper electrodes were attached to the fingers and the balls were coated with a conducting silver which closed the circuit when held together. Upon release of the ball the circuit was opened that started the clock while sound waves picked up by a speaker unit were used to stop the clock when the ball hit its target. Each subject was allowed his customary warmup and necessary rest between pitches and threw from the regulation pitching distance of 60 feet 6 inches. The results of this study showed that the mean duration of flight (0.47 seconds to 0.59 seconds for fast balls and 0.54 seconds to 0.70 seconds for curve balls) gave the batter approximately half that time to decide on his swing.

Hagerman[11], at Michigan State University, evaluated the influence of a warm-up period with a weighted ball (11 ounces) on the

---

[10]A. T. Slater-Hammel and E. H. Andres, "Velocity Measurement of Fast Balls and Curve Balls," Research Quarterly, 23:95-97, March 1952.

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

velocity of a thrown baseball. Eight subjects threw fifteen pitches for score against an electric timer, which started upon release of the ball from the pitcher's fingers and closed upon impact with a target simulating the area of a strike zone. The recorded scores were thrown after a warmup with a regular baseball and then after a warmup with a weighted ball of eleven ounces. The student's "t" yielded a 2.06 score while 2.635 was necessary to be significant at the 5% level of confidence.

In a study to determine the differences in relative speeds of various pitched balls, Kenny[12] found the overhand fast ball to be the fastest in 85% of the cases tested. Using twenty-one subjects, ranging from high school to professional in experience, he had each man throw five pitches in each of six categories - overhand fast, overhand curve, underhand fast, underhand curve, sidearm fast, and sidearm curve. The subjects could throw in any order they desired and could switch from one type of pitch to another before completing five in one category. Velocity was measured by a synchronous timer to 1/100's of a second. Another interesting result of the study is that in 42% of the cases the subjects threw faster using a type of throwing style different from what they normally use.

Only a discussion of the method used by Carlson[13] will be introduced here since his problem was to develop an objective test

---

[12]James D. Kenny, "A Study of Relative Speeds of Different Types of Pitched Balls," (unpublished Master's thesis, State University of Iowa, 1938), pp. 27.

[13]Roy Luverne Carlson, "A Study of the Baseball Throw as a Predictive Index of Athletic Ability," (unpublished Master's thesis, University of Southern California, 1941), pp. 82.

for predicting success in athletics using the baseball throw for accuracy as an index. The subjects threw from a distance of 34 feet with a regulation baseball ten times for score after five practice pitches. Seven pieces of canvas 5 3/4 inches apart and 34 1/2 inches from front to back served as the target. The first had a circular hole 36 inches in diameter and each piece decreased in diameter by six inches to the last which was intact. At the bottom of each canvas there was a compartment into which the balls fell after striking the canvas and thus enabling a score to be secured at the end of the ten throws. As only accuracy was being measured this was very feasible and satisfactory.

II WEIGHT TRAINING

Studying the effects of systematic weight training on strength, athletic power, and muscular and circulatory-respiratory endurance, Capen[14] found that training with weights improved scores in power events significantly even though a control group scored higher on the initial 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 freshman 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.

---

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

Chui[15], in an experiment to ascertain some of the pertinent facts concerning the effects of systematic weight training on athletic power disclosed that weight training seemed to increase the amount of potential power in 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.

Wilkins concluded that the speed of movement of chronic (experienced) weight lifters is as great as that of others studied and improves as much or more with training.[16] He also found that daily training with weights may improve muscular endurance. Three groups were used to test the speed of movement of the arm. One was made up of members of an elementary weight lifting class, another of the members of the University of California weight lifting team and the last group consisted of students in elementary golfing and swim-

[15] Edward Chui, "The Effect of Systematic Weight Training on Athletic Power," Research Quarterly, 21:188-194, October, 1950.

[16] Bruce M. Wilkins, "The Effect of Weight Training on Speed of Movement," Research Quarterly, 23:361-369, October, 1952.

ming classes. Each group was tested before and after the experimental period of two months. The subjects rotated a bicycle crank at maximum speed with readings taken at fifteen second intervals for a period of seventy-five seconds. Among the conclusions also was that weight training had no slowing effect on the speed of arm movement over a semester's time.

In trying to determine whether increased strength gained through weight training was accompanied by an increase in muscular co-ordination and speed of movement Masley, Hairabedian, and Donaldson found this to be probably true.[17] Testing an experimental group and two controls, the first consisting of a beginning weight-lifting class and the latter of a volley ball group and members of a sports lecture course, results showed that speed and co-ordination were increased greater from six weeks of weight training than by the two controls without benefit of weight training. It was also concluded that weight training had no deleterious effect on the subjects.

Davis[18], 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

---

[17] 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.

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

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.

McCormic[19], in evaluating the influence of progressive resistance exercise on the upper extremities and its effects on 100-yard crawl stroke performance, found no significant results as to the benefits of weight training on speed of swimming. However, a second conclusion showed weight training had no deleterious effects on sprint swimming times in the 50- and 100-yard distances. Two groups of five subjects each were matched by times for the 100-yard crawl stroke. The experimental group participated in a weight training program while the controls did nothing but swim.

[19] Allyn L. McCormic, "The Effect of Progressive Resistance Exercise on the Upper Extremities and Its Effects on 100 Yard Swimming Performance," (unpublished Master's thesis, Michigan State University, East Lansing, 1956), pp. 49.

CHAPTER III

METHODOLOGY

The purpose of this study was to determine if "overload warmup" increases the speed or accuracy of throwing and if varying weights used in "overload warmup" alters the speed of throwing. In studying this problem the experimental method was elected as the type of research.[20] Discussion follows on the methods and procedures used in the scoring of the velocity and exactness of the subjects' throws for this investigation. Throughout the experimental period much encouragement was afforded each man to have him perform at his maximum.

I EQUIPMENT

Timing device. An electric timing clock, Chronoscope Model S-1[21], scaled to 1/100's of a second was employed to record the speed of each throw. Activation of the clock began with the release of the ball, causing two contact wires to "break" and close the circuit. When the ball in flight made contact with the target, the

---

[20] 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.

[21] Standard Precision Timers (Booklet No. 198, Springfield, Mass.: Standard Electric Time Co.), pp. 15.

area of which simulated the stroke zone, the circuit was opened and stopped the clock enabling a reading to be taken.

Target. The target proper was constructed of a 17 x 36 inch piece of five-ply plywood covered with a rubber matting and set off from the 30 x 56 inch frame that held it by four couplers wired to microswitches that stopped the clock when the target was contacted. (See Figure 1.) Since the contacts were so sensitive, the clock recorded a score when any part of the target or frame was hit. In such instances where the clock was stopped when hit outside the target scoring area a score of zero was given for the accuracy measurement and the recorded time used. 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 four measured 22 x 15 inches on its outside border, area three measured 33 x 22 1/2 inches at its outside perimeter and area two measured 44 x 30 inches.

Wiring device. A wire extended from the target to a jack plug in the clock and a similar wire went from a jack plug in the clock to the subject allowing sufficient length for flexibility in throwing and maneuvering. The wire was taped to the shoulder, forearm and wrist of the subject and attached to the index finger and middle finger of the throwing hand. At the hand the wire was separated into two sections, one being taped to the index finger, as far as the tip, and the other taped half way up the middle finger with a segment extending beyond, that was used to make contact with the first wire

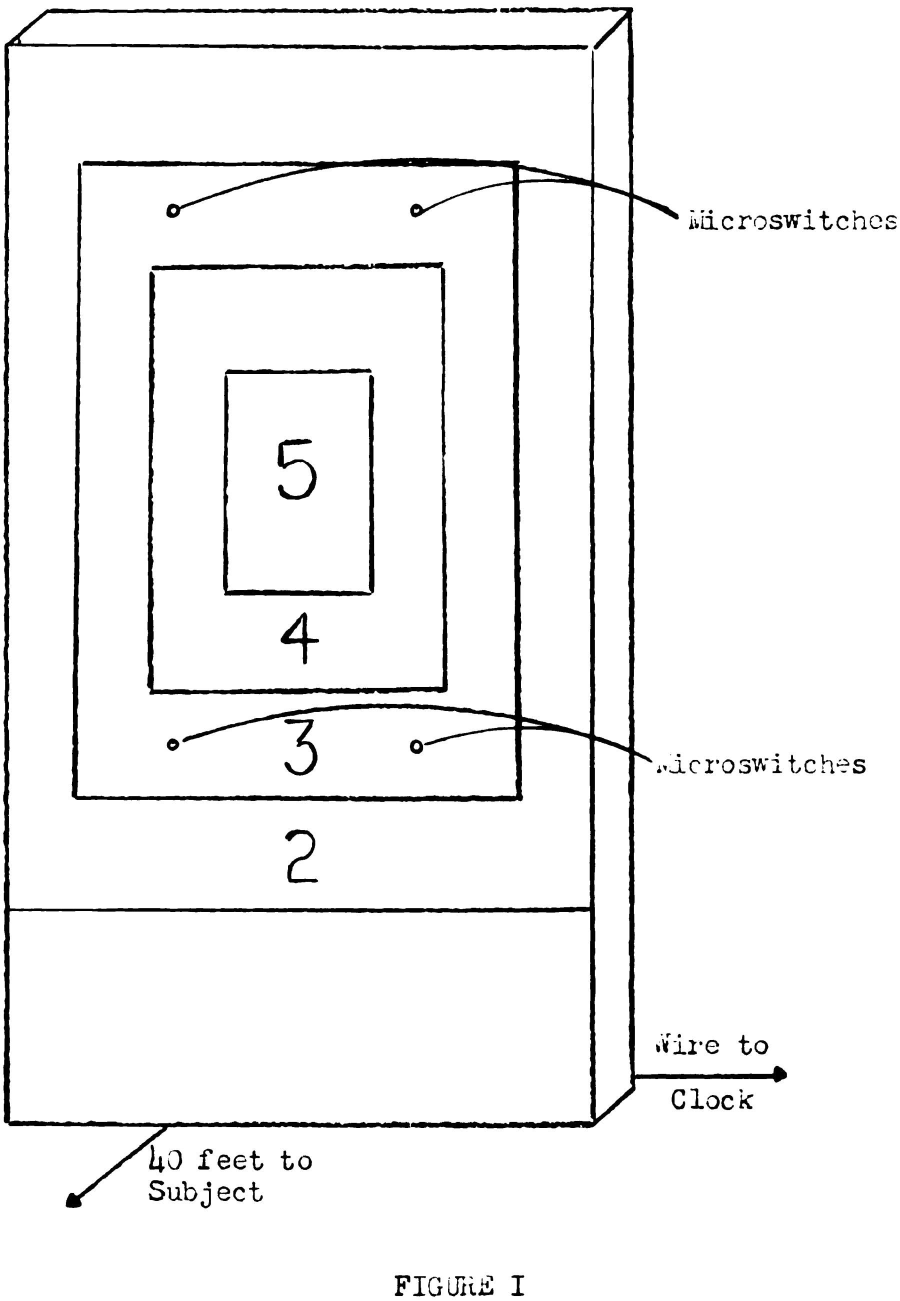

FIGURE I

TARGET DIAGRAM SHOWING VALUES OF SCORING AREA USED FOR SCORING ACCURACY effecting an open circuit when the ball was held in the pitching grip. This method proved very successful, as a previous endeavor to use conducting silver paint on the balls resulted in the paint chipping off constantly requiring frequent repainting. Checking it against a ball drop from a known height (10.08 ft.) the error was found to be ±.008 of a second, less than could be accurately read on the clock.

Baseballs. In choosing the weighted balls to be used in the "overload warmup" it was decided to increase the regulation ball, which as stated in the Official Baseball Rules, must weigh not less than five nor more than five and one-quarter ounces[22], by two ounce increments. Weights for the four balls selected were set at seven, nine, eleven and thirteen ounces and were designated A, B, C, and D respectively. This was done so the subjects would not be aware of the weight of the ball they were throwing possibly influencing the results. The added weight was accomplished by drilling a hole in a regulation baseball, filling it with lead to the desired weight, and covering the lead with the cut out section of the cover.

Throwing area. The pitching distance was reduced to forty feet in an effort to cut down on the number of wasted pitches encountered in the previous study by Hagerman[23] when balls missed the target area and did not produce a score. Since the subjects were not trained pitchers 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 misses.

---

[22] Baseball Almanac (New York: A. S. Barnes and Company, Inc., 1949), p. 46.

[23] Hagerman, loc. cit.

II SUBJECTS

Sample. Sixteen volunteers from Physical Education service courses at Michigan State University served as subjects. The testing with the different weight balls was conducted in the Latin square order. Record cards were made up prior to selecting the subjects at which time the order of warmup 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 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 warmup balls. Each subject acted as his own control in that he daily threw both after the regular warmup and the "overload warmup" with each of the four weighted balls.

III PROCEDURE

Testing. For purposes of securing the data necessary to determine the effects of "overload warmup" on the speed and accuracy of throwing, the following procedure was adhered to at all testing periods. 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 score. This process was followed at each of the testing sessions with a different weight ball being used by each group of subjects for the "overload warmup". The total testing time for each subject covered a four week period as all testing was accomplished on Saturday. Before each recorded group of scores the subjects were reminded to give a maximum effort with each of his throws.

Records. All information was recorded on specially made 3 x 5 cards with a column for the time and accuracy score of the ten recorded throws with balls A, B, C, and D respectively.

Statistical Techniques. Analysis of variance was used in determining the significance of the data for the weighted balls in both velocity and accuracy.[24] Since the analysis was significant for the accuracy section of the study a student "t" was applied to each of the groups.[25] This enabled the author to find out just where the significance was applicable.

---

[24] R. L. C. Butsch, How To Read Statistics (Milwaukee: The Bruce Publishing Company, 1946), p. 169.

[25] Ibid, p. 157.

CHAPTER IV

RESULTS AND ANALYSIS OF DATA

The purpose of this study was to determine if "overload warmup" has any effect on the speed and accuracy of throwing. The problem was developed using four different weight balls, each increased over the regulation baseball (five ounces) by two ounce increments. Sixteen subjects, each acting as his own control, warmed up with each of the weighted balls as well as the regulation ball during four testing periods. The regulation ball was then thrown for score after the warmup was accomplished. This chapter is divided into two parts, the first giving the results and statistical analysis of the effects on speed of throwing and the second the results and statistical analysis of the effects on accuracy in throwing.

I VELOCITY

Results of the order of throw. The results of the compiled data for the four groups in the order in which the balls were thrown (Latin square method) showed a mean increase for each (Chart I). However, this was not significant when an analysis of variance for several matched groups was applied. The graph shows the mean scores of the sixteen subjects after a warmup with both the regulation and weighted balls for the four groups. Results of the mean scores have been converted into feet per second, from the original times in hundreds of a second, by the formula $V = \frac{d}{t}$. One standard deviation is represented by the line above and below the mean.

Comparing the differences in the individual's mean scores (feet per second) for each of the four groups by analysis of variance for several matched groups[26] the F value was found to be .709 between the groups. A F of 8.59 was necessary to be significant at the 5% level of confidence. By computing the analysis with a residual any variation in the rows was kept constant while testing the groups.[27] The statistical computations can be inspected in Appendix C.

Results of the daily trials. In order to determine the day to day effects on the velocity of the throws made by the subjects another analysis of variance was applied to these data. Only the scores after warmup with the regulation ball were used in this computation. The mean scores of the subjects throws on his first day of testing, regardless of the weight ball used in "overload warmup", were tabulated as well as the means of his throws for the second, third, and fourth days of testing (Chart II).

The results between groups was significant ($F = 14.94$, $P = 1\%$). Significance at the 1% level was also found between the rows ($F = 22.18$, $P = 1\%$).[28]

---

[26]Allen L. Edwards, Statistical Analysis (New York: Rinehart and Company, Inc., 1946), p. 225.

[27]Ibid., p. 229.

[28]See Appendix C.

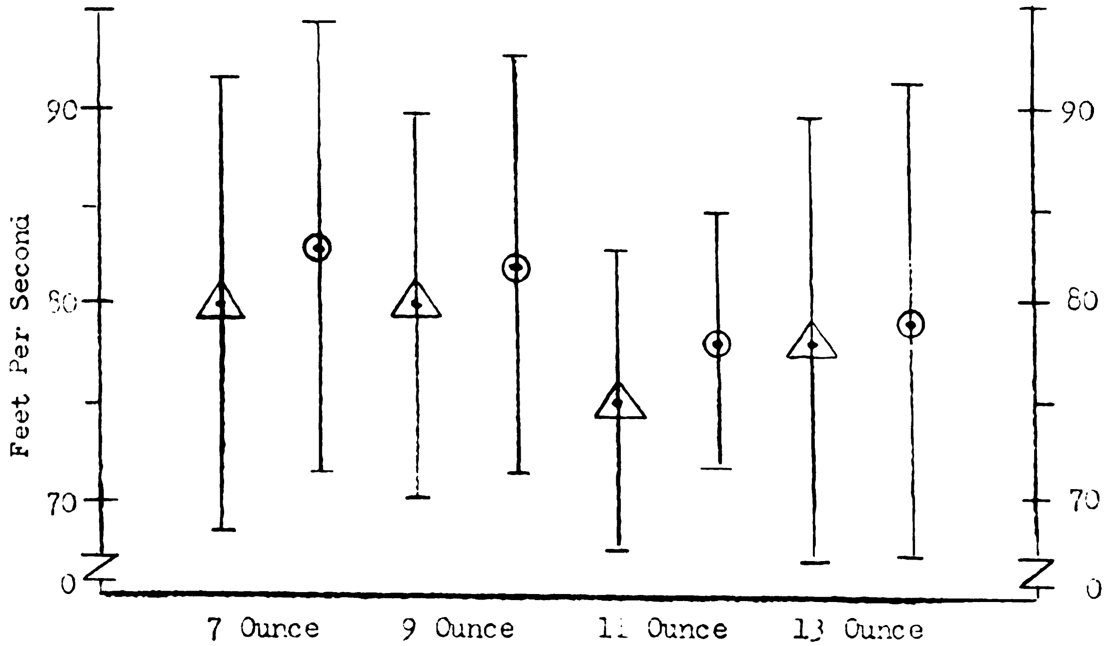

CHART I

COMPARISON OF VELOCITY MEAN SCORES

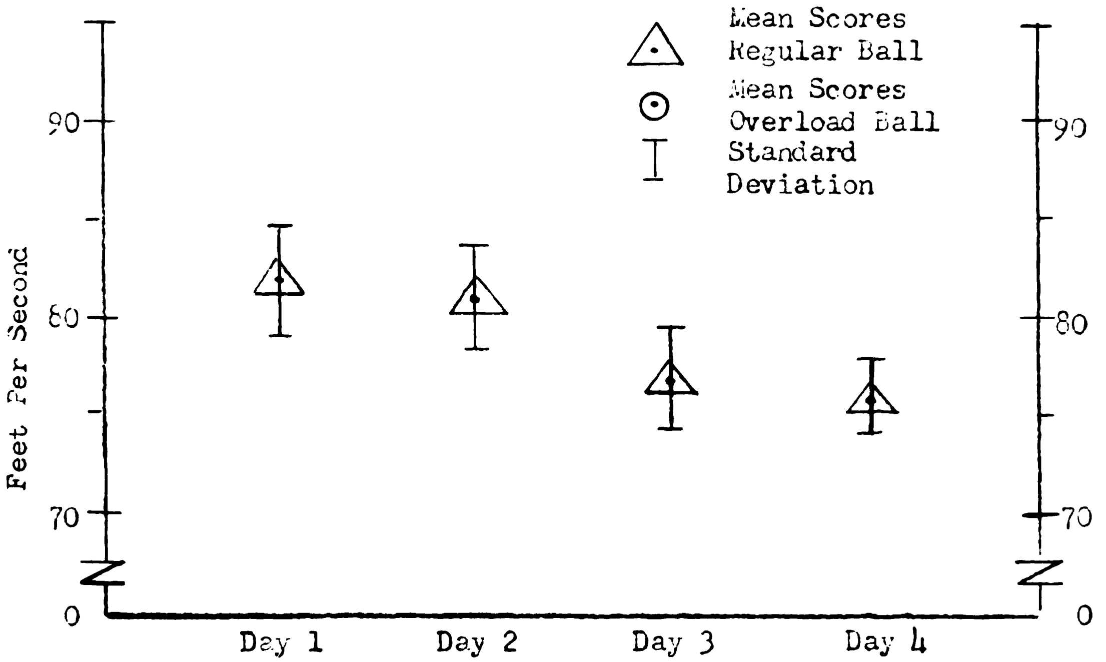

CHART II

COMPARISON OF DAY TO DAY TRIALS (VELOCITY)

Discussion. While the mean scores show an increase for each of the four groups after warmup with the various weighted balls the standard deviation in each case overlaps into the mean score found after warmup with the regulation ball. The error of measurement, (σm) as computed by a ball drop from a known height, was found to be $\pm$ .008 of a second. This was less than could be accurately read on the clock.

The standard deviation for the mean score after warmup with the eleven ounce ball was the smallest (6.431 feet per second) while for the thirteen ounce ball it was highest (12.042 feet per second). Standard deviation for the regulation ball warmup was smallest in the eleven ounce group (7.810 feet per second) and largest in the seven ounce group (11.747 feet per second).

The analysis of variance for the four weighted ball groups showed no significance in weight of ball used in warmup with the speed of throwing. The eleven ounce ball warmup had the best increased score and the least overlap of one standard deviation into the score for the regulation ball warmup in that group.

Statistics for the day to day trials of each subject show that the mean scores decreased for each succeeding trial, the initial mean being 82 feet per second and decreasing to 76 feet per second on the fourth day of testing. This was significant at the 1% level of confidence and might show that the subjects could have built up a resistance to the testing although a week was allowed between each testing period. Standard deviation also decreased in the same order with 10.630 feet per second on the first trial and 7.874 on the last.

They were more consistent in their scores as evidenced by the decrease in standard deviation.

The standard error of the mean for each day was also calculated. It was found to be ± 2.657 for the first trial, ± 2.645 for the second, ± 2.462 for the third, and ± 1.968 for the fourth. As shown in Chart II the standard error of the mean overlaps each succeeding trial with the exception of the third where the mean differences in scores was four feet per second and the standard error only ± 2.645 for the second trial.

A psychological advantage was gained by the subjects as expressed by their comments that they felt they could throw faster after the "overload warmup".

II ACCURACY

Results of the order of throw. Considering the results of the mean scores for accuracy as recorded after a warmup with both the regulation and overweight balls the graph (Chart III) shows the information obtained. The standard deviation for each mean score is represented by the line above and below the mean. The seven ounce ball showed a decrease of -.10 whereas the nine, eleven and thirteen ounce balls showed increases of .39, .09, and .14 respectively. In only one case, the nine ounce ball, did the standard deviation overlap into the mean score of the regulation ball warmup.

An analysis of variance for several matched groups[29] was computed using the differences of the scores for accuracy between the

---

[29] Edwards, op. cit., p. 225.

regulation and overweight balls for each of the four groups tested. A significant F at the 5% level of confidence was found. Between the rows significance was also found at the 5% level.[30]

Since the results were significant at the 5% level of confidence between the groups of weighted balls a "t" test was computed to determine the source of the significance.[31] The mean scores after warmup with the regulation and overweight balls were tested in each of the four groups. Entering the table of "t" with fifteen degrees of freedom (df = N - 1) the necessary results for the 1% level of confidence was 2.947 and for the 5% level 2.131.

The seven ounce ball (Group A) showed significance (P = 1%) as the "t" resulted in a figure of 6.66, however, this was negative as the mean scores showed a decrease in this group. Group B proved significant at the 5% level of confidence with a "t" of 2.747. Groups C and D were not significant. The hypothesis that the weight of the ball used in warmup would increase accuracy was indicative of the nine ounce ball only as supported by these statistics.

Results of day to day trials. Comparing the day to day trials of the subjects' throws for their first, second, third, and fourth testing periods, the results show that the accuracy increased with each succeeding testing day, with the exception of the last. There was a slight increase over the third day's score but not more than the second day. The graph (Chart IV) depicts these data for each of

---

[30] See Appendix C.

[31] Edwards, op. cit., pp. 175-177.

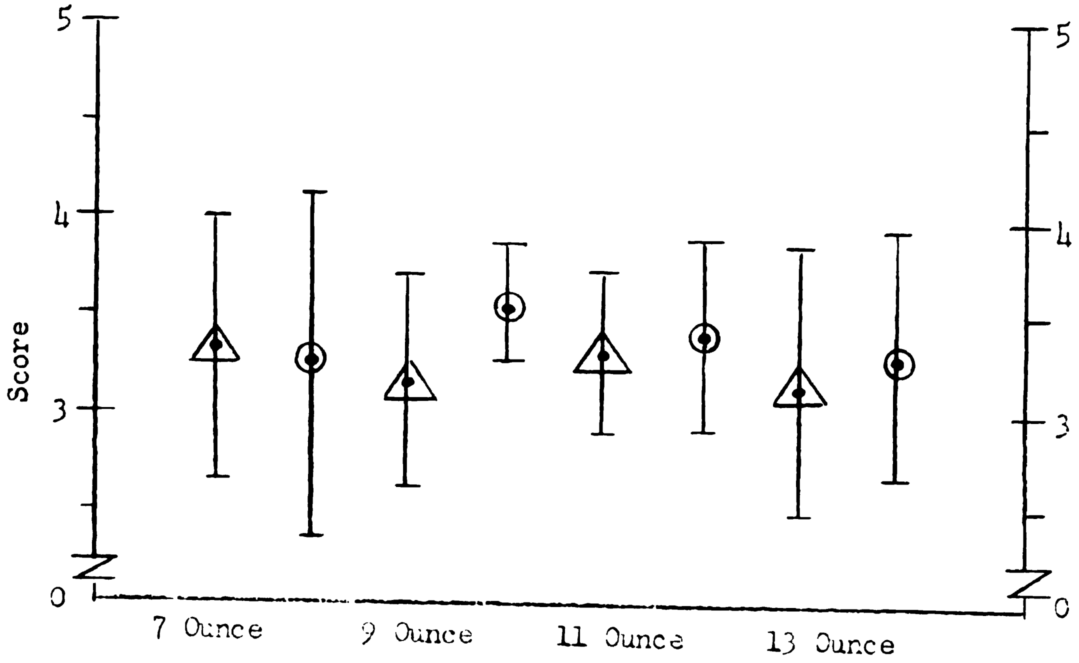

CHART III

COMPARISON OF ACCURACY MEAN SCORES

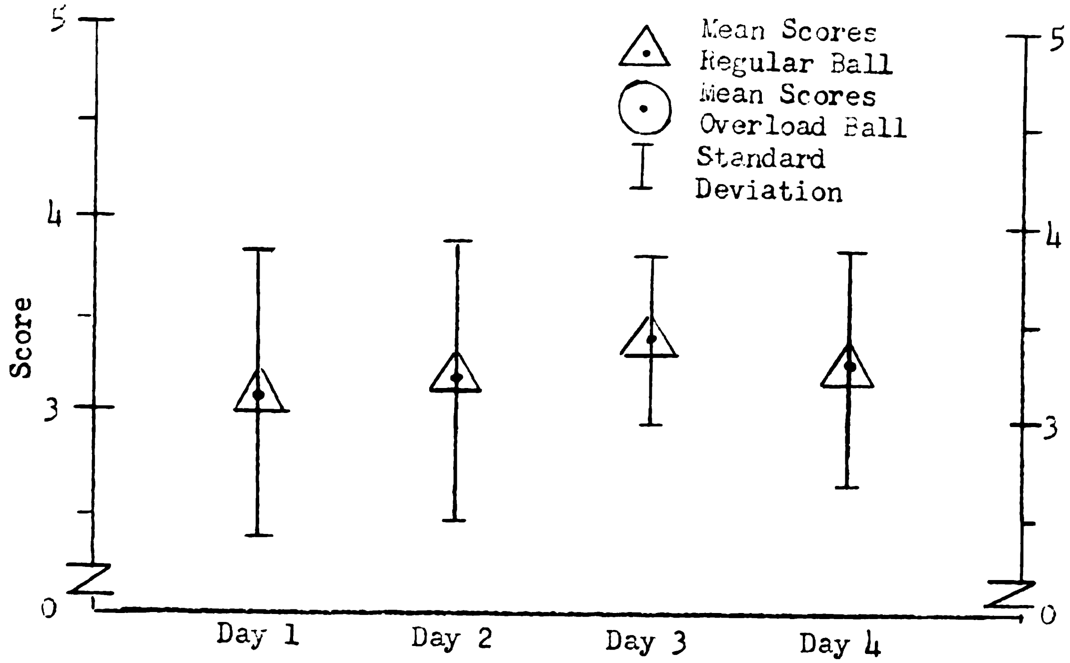

CHART IV

COMPARISON OF DAY TO DAY TRIALS (ACCURACY) the four balls after warmup with the regulation ball and the standard error of the mean for each.

Applying an analysis of variance for several matched groups to the day to day trials using the differences of the scores for both the regulation and overweight warmup balls, no significance was found.[32]

Discussion. While the mean scores showed an increase in three of the four groups (nine, eleven, and thirteen ounces) after warmup with the overweight ball the first group (seven ounce) produced a decrease. As evidenced by the "t" test the significance was attributed to the nine ounce ball.

The standard deviation for the four groups fluctuated from .974 for the seven ounce ball to .316 for the nine ounce ball after warmup with the weighted balls. After warmup with the regulation ball the standard deviations were more consistent, ranging from .774 for the seven ounce ball to .447 for the eleven ounce. The only group not showing an overlap of standard deviation into the regulation ball score after the overweight warmup was the nine ounce ball.

In the day to day trials data, for the four testing periods, the mean scores of the throws after the regulation warmup were quite stable, ranging from 3.4 for the third day to 3.1 for the first day. This shows that accuracy may not be affected by succeeding testing periods required to collect the information for the study since there was no gradual decline as indicated in the velocity scores.

---

[32]See Appendix C.

Standard error of the mean for the daily trial was ± .0467 for the first day, ± .0455 for the second, ± .0293 for the third, and ±.0369 for the fourth. There was no overlap of the standard error into the succeeding days' trials.

CHAPTER V

SUMMARY, CONCLUSIONS AND RECOMMENDATIONS

One phase of the speed of movement problem, that has been neglected in research studies, is that of using an object heavier than the regulation weight used in competition for warmup. Only a few studies, cited earlier, have investigated this and its effect upon improving results. The purpose of this study was to determine the effect of warming up with an overweight baseball on the speed and accuracy of throwing. Varying weights of lead-filled baseballs (7, 9, 11, and 13 ounces) were used. Sixteen subjects, all volunteers from the Physical Education service courses at Michigan State University, used all the weighted balls at four different sessions. Each subject warmed up with the regulation ball after which the same ball was thrown for score and recorded on an electric clock accurate to 100's of a second. At the same testing period the subject warmed up with one of the weighted balls and followed this with ten throws of the regulation ball for score. It was then possible to compare the means of both throws to find the effects on speed and accuracy. Since each subject threw both the regulation and weighted balls in warmup, each acted as his own control.

The scores were measured by attaching a wire to the fingers of the throwing hand, which resulted in an open circuit until the ball held against them was released in the throwing motion. When the ball came in contact with wooden target, placed forty feet from the pitcher, the clock was stopped and a reading taken. The target was constructed with four microswitches wired to the timing clock making this possible.

Ten scores were secured of each subject after warmup with both the regulation and overweight balls at each session. The mean scores, converted to feet per second, were then analyzed by analysis of variance to determine their significance. Velocity and accuracy were separated and handled independently. Since no significance was found for speed in throwing, although the mean scores showed an increase in all cases, no further study was completed. In testing accuracy for significance it was found to be reliable at the 5% level of confidence; at this point a "t" test was applied to the means of each ball group to locate the significance. The nine ounce ball proved to be significant at the 5% level.

CONCLUSIONS

From the data collected and the statistical interpretations found the following conclusions have been formulated from the results of this study.

1. "Overload warmup" had no effect on the speed of throwing. An increase was found, however, in the mean velocity scores for all four weighted balls.

2. Warming up with an overweight ball had no harmful effects on the speed of throwing.

3. Warming up with the nine ounce ball resulted in increases in accuracy regardless of the effect on velocity.

RECOMMENDATIONS

From the results obtained in this investigation and the trend indicated from the improved mean scores of throwing, the following recommendations for further work on this problem are presented:

A training period be used in which the subjects are permitted the opportunity to use the overweight ball in warmup for a period of several weeks. A Control Group be used which would use only the regulation ball in warmup. The two groups would be tested at the beginning and end of this training period and the scores examined for significance.

Use of the members of the varsity baseball team as subjects to determine if this "overload warmup" has any effect on a trained baseball player.

The investigator feels the wiring device to the subject's hand and fingers could be improved by affixing a very thin piece of metal to the cover of the ball and extending the wire to the tips of the fingers. When the metal, attached to the ball, made contact with the wire on the pitcher's hand an open circuit would be affected. It is felt this would give better consistency and accuracy in scoring velocities.

In place of the target with equidistant areas for scoring accuracy just the strike zone be used and the corners of this strike zone marked to determine if a pitcher after warmup with a weighted ball can hit these areas more accurately. This would simulate a more realistic situation as is actually encountered in pitching to a batter.

BIBLIOGRAPHY

BIBLIOGRAPHY

Baseball Almanac. New York: A. S. Barnes and Company, Inc. 1949.

Butsch, R. L. C. *How To Read Statistics*. Milwaukee: The Bruce Publishing Company, 1946.

Campbell, William Giles. *Form and Style in Thesis Writing*. Boston: Houghton Mifflin Company, 1954.

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

Carlson, Roy Luverne. "A Study of the Baseball Throw as a Predictive Index of Athletic Ability." Unpublished Master's thesis, The University of Southern California, Los Angeles, 1941.

Chui, Edward. "The Effect of Systematic Weight Training on Athletic Power," *Research Quarterly*, 21:188-194, October, 1950.

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

Edwards, Allen L. *Statistical Analysis*. New York: Rinehart and Company, Inc., 1946.

Hagerman, Randall Lee. "The Effect of 'Overload Warm-up' on the Speed of Throwing," Unpublished Master's thesis, Michigan State University, East Lansing, 1956.

Kenny, James D. "A Study of Relative Speeds of Different Types of Pitched Balls," Unpublished Master's thesis, State University of Iowa, 1938.

Lai, William T. *Championship Baseball*. New York: Prentice-Hall, Inc., 1954.

McCormic, Allyn Lohr. "The Effects of Progressive Resistance Exercises on the Upper Extremities and Its Effects on 100 Yard Swimming Performance," Unpublished Master's thesis, Michigan State University, 1956.

McGraw, John J. *How to Play Baseball*. New York: Harper and Bros., 1914.

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

Mathewson, Christy. Pitching in a Pinch. New York: G. P. Putnam's Sons, 1912.

Research Methods Applied to Health, Physical Education, and Recreation. Washington, D. C.: American Association for Health, Physical Education, and Recreation, 1952.

Sisler, George. Sisler on Baseball. New York: David McKay Company, Inc., 1954.

Slater-Hammel, A. T. and E. H. Andres. "Velocity Measurements of Fast Balls and Curve Balls," Research Quarterly, 23:95-97, March, 1952.

Standard Precision Timers. Booklet No. 198. Springfield, Massachusetts: Standard Electric Time Company

Wilkins, Bruce M. "The Effect of Weight Training on Speed of Movement," Research Quarterly, 23:361-369, October, 1952.

Zorbas, W. B. and Peter V. Karpovich. "The Effect of Weight Lifting Upon Speed of Muscular Contraction," Research Quarterly, 22:145, May, 1951.

APPENDICES

APPENDIX A

VELOCITY SCORES

RECORDED IN FEET PER SECOND WITH ORDER OF DAY TO DAY TRIALS IN PARENTHESIS. SCORES AFTER WARMUP WITH REGULAR BALL REPRESENTED BY X, SEVEN OUNCE A, NINE OUNCE B, ELEVEN OUNCE C, AND THIRTEEN OUNCE D.

SUBJECT	X	A	X	B	X	C	X	D
1	98	100 (1)	96	95 (3)	73	75 (4)	99	100 (2)
2	94	96 (1)	83	80 (3)	75	75 (4)	89	90 (2)
3	109	111 (1)	103	111 (3)	100	94 (4)	105	114 (2)
4	68	66 (1)	66	68 (3)	66	68 (4)	68	71 (2)
5	88	92 (2)	92	92 (1)	71	76 (3)	69	71 (4)
6	86	88 (2)	83	85 (1)	78	86 (3)	80	76 (4)
7	84	88 (2)	87	90 (1)	71	73 (3)	68	71 (4)
8	72	77 (2)	72	78 (1)	72	74 (3)	70	72 (4)
9	74	77 (4)	79	82 (2)	80	84 (1)	73	75 (3)
10	68	73 (4)	69	72 (2)	66	70 (1)	68	68 (3)
11	73	75 (4)	74	75 (2)	76	78 (1)	73	75 (3)
12	78	81 (4)	76	77 (2)	70	74 (1)	78	77 (3)
13	70	77 (3)	72	74 (4)	70	75 (2)	72	72 (1)
14	68	71 (3)	71	74 (4)	72	74 (2)	71	74 (1)
15	74	75 (3)	76	76 (4)	73	82 (2)	77	76 (1)
16	78	81 (3)	80	80 (4)	82	84 (2)	80	85 (1)
Total	1282	1328	1279	1309	1195	1242	1240	1267
Mean	80	83	80	82	75	78	78	79
Difference		3		2		3		1
σ	11.74	11.53	9.95	10.77	7.81	6.48	11.22	12.04

APPENDIX B

ACCURACY SCORES

SCORES AFTER WARMUP WITH REGULAR BALL REPRESENTED BY X, SEVEN OUNCE A, NINE OUNCE B, ELEVEN OUNCE C, AND THIRTEEN OUNCE D. ORDER OF DAY TO DAY TRIALS IN PARENTHESIS.

SUBJECT	X	A	X	B	X	C	X	D
1	3.3	2.8 (1)	3.3	3.4 (3)	3.6	3.7 (4)	1.6	2.5 (2)
2	4.3	3.8 (1)	3.3	3.8 (3)	3.0	3.6 (4)	3.5	3.8 (2)
3	3.4	3.8 (1)	4.1	4.2 (3)	4.1	3.7 (4)	4.1	3.8 (2)
4	1.2	.8 (1)	2.9	3.3 (3)	2.8	2.3 (4)	2.1	1.7 (2)
5	3.0	3.3 (2)	2.2	3.1 (1)	3.6	3.1 (3)	2.9	3.1 (4)
6	3.0	3.3 (2)	2.9	3.7 (1)	4.0	4.0 (3)	4.1	3.6 (4)
7	4.5	4.4 (2)	3.5	4.0 (1)	3.0	3.6 (3)	2.8	2.8 (4)
8	2.4	2.5 (2)	2.0	3.1 (1)	2.8	3.5 (3)	2.6	2.3 (4)
9	3.5	4.0 (4)	2.9	3.5 (2)	3.2	3.0 (1)	2.9	3.4 (3)
10	3.6	3.5 (4)	3.0	3.6 (2)	3.6	4.2 (1)	2.8	3.8 (3)
11	3.5	3.9 (4)	3.8	3.7 (2)	3.3	3.7 (1)	3.5	4.0 (3)
12	2.8	1.1 (4)	3.5	3.8 (2)	2.7	2.7 (1)	3.9	3.9 (3)
13	3.8	3.4 (3)	2.4	3.5 (4)	3.6	3.4 (2)	3.3	3.5 (1)
14	3.7	3.5 (3)	4.3	3.5 (4)	3.6	2.7 (2)	3.5	3.1 (1)
15	3.1	4.0 (3)	2.5	3.4 (4)	2.6	3.5 (2)	2.9	3.9 (1)
16	4.2	3.7 (3)	3.7	3.0 (4)	3.5	3.7 (2)	4.0	3.5 (1)
Total	53.3	51.8	50.3	56.6	53.0	54.4	50.5	52.7
Mean	3.33	3.23	3.14	3.53	3.31	3.40	3.15	3.29
Difference	-.10			.39		.09		.14
σ	.774	.974	.648	.316	.447	.489	.692	.648

APPENDIX C

ANALYSIS OF VARIANCE TABLES

TABLE I

ORDER OF THROW (VELOCITY)

Source	Sum of Squares	df	Estimate of Variance
Between groups	20	3	6.67
Between rows	33	15	2.20
Residual	423	45	9.40
Total	476	63	
F of groups = .709	F of rows = .23		

TABLE II

DAY TO DAY TRIALS (VELOCITY)

Source	Sum of Squares	df	Estimate of Variance
Between groups	771	3	257.0
Between rows	5724	15	381.6
Residual	775	45	17.2
Total	7270	63	
F of groups = 14.94	F of rows = 22.18		

APPENDIX C (Continued)

TABLE III

ORDER OF THROW (ACCURACY)

Source	Sum of Squares	df	Estimate of Variance
Between groups	194	3	64.66
Between rows	844	15	56.26
Residual	1004	45	22.31
Total	2042	63	
F of groups = 2.89	F of rows = 2.52		

TABLE IV

DAY TO DAY TRIALS (ACCURACY)

Source	Sum of Squares	df	Estimate of Variance
Between groups	120	3	40.00
Between rows	846	15	56.40
Residual	1076	45	23.91
Total	2042	63	
F of groups = 1.67	F of rows = 2.35		

Date Due

Dec 9 '57		NOV 13 1965	
Jul 24 '58			
Aug 8 58		JUL 31 1967	
Sep 29 58			
Jan 30 59			
Feb 19 59		ROOM USE ONLY	
11 Jun 59		NOV 24 1969	
27 Jun 59			
15 Jul 59			
4 Sep 59			
DEC 1 1960			
JAN 6 1961			
JUL 11 1961			
AUG 8 1961			
JAN 5 1962			
DEC 2 1963			
JAN [illegible] 1964			
JUN 28 '65			

168

Demco-293