1948

# A study of laterality as it is related to certain gross motor skills of one hundred and fifteen children at the kindergarten and primary grade levels

https://hdl.handle.net/2144/13789

A STUDY OF LATERALITY
AS IT IS RELATED TO CERTAIN GROSS MOTOR
SKILLS OF ONE HUNDRED AND FIFTEEN CHILDREN
AT THE KINDERGARTEN AND PRIMARY GRADE LEVEL

BOSTON UNIVERSITY

SCHOOL OF EDUCATION

Thesis

# A STUDY OF LATERALITY AS IT IS RELATED TO CERTAIN GROSS MOTOR SKILLS OF ONE HUNDRED AND FIFTEEN CHILDREN AT THE KINDERGARTEN AND PRIMARY GRADE LEVELS

Submitted by

John Paul Clark

(B.S. Ed. Boston University, 1946)

In partial fulfillment of requirements for

the degree of Master of Education

1948

# READERS

| | |
|---|---|
| 1st Reader | G. Lawrence Rarick,<br>Associate Professor of Education |
| 2nd Reader | LeRoy G. Seils,<br>Instructor of Education |
| 3rd Reader | Arthur G. Miller,<br>Instructor of Education |

## Acknowledgments

The writer wishes to express his sincere appreciation to Dr. G. Lawrence Rarick and Dr. LeRoy G. Seils for their kind direction and helpful suggestions in regard to the experimental work and the reporting of this study.

## CONTENTS

Chapter Page

## LIST OF TABLES

LIST OF TABLES
(Continued)

[illegible]
([illegible])

[illegible] [illegible]

[illegible]

# CHAPTER I

There are many studies to be found dealing with right and left handedness, but the majority of such studies are concerned with dominance and its social implications, that is, its effect upon the speech, reading, writing and social adjustments of individuals. Only a few, however, deal with laterality as it pertains to physiological dominance and its relationship to gross motor performances.

This study is an attempt to investigate laterality in four skill areas usually included in the physical education activities of kindergarten and primary grade children.

## PURPOSE OF THE STUDY

The purpose of this investigation is threefold, namely:

1. - To study laterality preference as an indication of performance in certain gross motor skills of primary and kindergarten school children.

2. - To attempt to determine if right dominance has been clearly established in certain gross motor skills at the primary and kindergarten grade levels. If right dominance has not been clearly established at the kindergarten and primary grade levels, does it tend to become predominant between kindergarten and the third grade level?

3. - To determine if the children at the kindergarten and primary grade levels perform as well or better on the side not preferred in certain gross motor skills.

## SCOPE OF THE STUDY

This study involved the use of certain tests designed to measure the proficiency of Kindergarten and Primary Grade children in motor skills common to children of this age level. The skills considered were batting, throwing, kicking and ball bouncing. The tests designed to measure these skills were applied to each child so that the performance level for each child was determined on both the right and left side.

## REVIEW OF LITERATURE

Haefner[1] studied the relation between hand and foot tendencies of children. He chose sixty-eight left-handed children and sixty-eight right-handed ones and subjected them to a battery of hand tests that included direction of hand movement in the following: (1) drawing, (2) throwing, (3) receiving, (4) easy reaching, (5) energetic reaching, (6) using a baseball bat, (7) using a broom and (8) clasping hands with the thumbs protruding upwards. The one hundred and thirty-six subjects also were given four foot tests: (1) stepping off, (2) stepping up, (3) kicking and (4) pressing down.

Haefner concluded that a very marked degree of foot dominance appears in only a small percentage of children. In the majority of the group tested, he found that a considerable number of the common

---

[1] Ralph Haefner, "The relation between hand and foot tendencies of children." Pedagogical Seminar, 38:338-51, December, 1930.

foot activities are performed with what would be considered the minor foot. In a small percentage of the group the majority of the foot activities are performed also with the minor foot. In a fair sized minority of the group the presence of a dominant right-hand or a dominant left-hand need not be accompanied by a corresponding dominant right or dominant left foot. According to Haefner the coefficients of correlation between hand and foot test scores are likely to be low.

Tuttle and Travis[2] in their study of the relation of precedence of movement to handedness attempted to measure inherent unilateral organization and to determine the relationship to expressions of unilateral choice.

Three experimental groups, one right-handed, one left-handed and one ambidextrous were selected by use of a laterality index to test the influence on lead preference from instructions and the task involved in responding.

Tuttle and Travis concluded that "the procedure of lead in simultaneous contraction of homologous muscle groups is determined largely by instructions given and the task to be performed."[3]

Vogel's[4] experiment, an outgrowth of the work by Tuttle and Travis, studied the relationship of dominance to acts of skill --- throwing and

---

[2] Waid W. Tuttle and Lee E. Travis, "Relation of Precedence of Movement in Homologous Structures to Handedness", _American Physical Education Association Research Quarterly_, 6:sup 3-14, October, 1935.

[3] _ibid_., p.14

[4] Otto H. Vogel, "Relationship of Dominance to Acts of Skill.", _American Physical Education Association Research Quarterly_, 6:sup 15-18, October, 1935.

batting a baseball.

Vogel concluded, "that physiologically right dominant individuals both threw and batted right-handed. The physiologically left dominant subjects showed a mixed behavior in performing the acts of batting and throwing, although most of them showed right-handed responses. The physiologically left-handed individuals showed right-handed performance."[5]

Irwin[6] conducted a study of the relation of dominance to the performance of physical education activities. The primary purpose of this study was to determine the physiological dominance of the upper and lower extremities and its relation to the performance of physical education activities.

Irwin used the order of response test, a stimulus and response arrangement whereby the results were recorded on a Kymograph. In the upper age groups an athletic performance test covering a wide range of physical education activities was used as a basis for comparison. (Athletic Dominance Index). In the lower age group an indication of dominance was secured through the administration of simple physical tests.

Irwin in his conclusion states, "the results of both the Athletic Dominance Index and the order of response test on two hundred and thirty-nine elementary and high school boys showed that handedness does not approximate a normal distribution. The scores for footedness were

---

[5] *ibid*., p.18

[6] Leslie W. Irwin, "Study of the Relationship of Dominance to the Performance of Physical Education Activities", *American Association for Health and Physical Education Research Quarterly*, 9:98-119, May, 1938.

more evenly distributed due to the fact that a much higher percentage of subjects were ambidextrous with respect to the feet.

"There is close agreement between subjects statement of handedness and actual performance. The reverse is true of footedness.

"There is a lower percentage of right-handed subjects in each age group according to the order of response test than by the athletic dominance index. The total results in the upper age groups in which both measures were secured, showed that by the athletic index 82% of the one hundred and fifty-four subjects were right-handed. By the order of response test 50% were right-handed."[7] According to Irwin this indicated that "many of the subjects actually performing physical education activities right-handed are inherently ambidextrous as measured by the order of response."[8]

Irwin's youngest group, boys six to ten years of age, indicated that a comparison of subjects' statements of handedness and results of the order of response tests have but little agreement between them. Irwin explains that "this might be expected as young children are likely to determine their handedness by the performance of a few activities such as writing or throwing. The baseball batting, baseball throwing and hockey dribble supported the subjects statements.

"There was a wide difference between the subject's statement of footedness and the results as shown by the order of response test."[9]

---

[7] <u>ibid</u>., p.118

[8] <u>loc</u>. <u>cit</u>.

[9] <u>ibid</u>., pp.111-112

According to Irwin the subject apparently tended to think that the same foot and arm are dominant. He claimed this to be logical in that foot dominance is not as readily determined as arm dominance and there are not so many situations wherein foot preference is involved. "The results of footedness as determined by actual performance in the five simple physical tests are in harmony with the results of the order of response test and in disagreement with the subject's statement of footedness."[10]

Gesell and Ames in their study of the development of handedness claimed that, "the problem of handedness has been somewhat oversimplified by literature. There has been a tendency to regard handedness as a specific trait comparable to eye color or skin pattern. It has been too freely assumed that a child is either right-handed or left-handed once and for all."[11]

Gesell and Ames treated handedness as an extremely complex trait which is intricately bound up with the total action system of the child. Their subjects included normal infants, preschool children and school children ranging from eight weeks to ten years of age. The total number of cases analyzed at any given age level varied from twelve to forty-five.

"From five to ten years of age test situations were instituted to secure responses to cube, pencil and paper and free construction situations."[12] At all ages the responses were recorded cinematically and

---

10. <u>loc</u>. <u>cit</u>.

11. Arnold Gesell and Louise B. Ames, "Development of Handedness", <u>Pedogogical Seminar</u>, 70:155, June, 1947

12. ibid, p.156

stenographically.

Their study revealed that of those children developmentally examined between sixteen weeks and ten years of age who eventually establish clear-cut right-handedness, there occur marked shifts in the handedness from age to age, particularly in the first year of life.

The table constructed by Gesell and Ames showing the characteristic age shifts in the handedness of subjects, all of whom eventually showed definite clear-cut right-handedness, is as follows:

"16 - 20 wks: Contact unilateral and in general tends to be with left-hand
24 wks: A definite shift to bilaterality
28 wks: Shift to unilateral and oftenest right-hand is used
32 wks: Shift again to bilateral
36 wks: Bilateral dropping out - unilateral coming in - right or left - left predominates in the majority
40 - 44 wks: Same type of behavior, but now right predominates
48 wks: In some a temporary and in many a last shift to the left-hand as well as the right - either used unilaterally
52 - 56 wks: Shift to clear unilateral dominance of right
80 wks: Shift from clear-cut unilateral behavior to marked interchangeable confusion - much bilateral and use of non-dominant hand
2 yrs: Relatively clear-cut unilateral use of right-hand
2½ - 3½ yrs: Marked shift to bilaterality

4 - 6 yrs: Unilateral, right-handed behavior predominates

7 yrs: Last period when left-hand, or even both hands bilaterally are used

8 yrs: Unilateral right once more

The above is a common pathway rather than a rigid time schedule."[13]

---

[13] *ibid*, p.157

# CHAPTER II

## PROCEDURE

The subjects used in this study included one hundred and fifteen normal Massachusetts school children. Of the one hundred and fifteen children studied, twenty-five were kindergarten pupils, thirty were first graders, thirty were second graders and thirty were third graders. There were thirty-seven girls included in this group; eleven of whom were kindergarten pupils, six were first graders, eight were second graders and twelve were third graders. Forty-three subjects were taken from a large congested city district, forty-seven from a small rural town and twenty-five from residential communities.

TABLE I

MEAN AGE IN MONTHS AND YEARS, STANDARD DEVIATION AND RANGE IN MONTHS, OF THE ONE HUNDRED AND FIFTEEN SUBJECTS GIVEN BY GRADES

| GRADE | MEAN AGE | | | |
|---|---|---|---|---|
| | Months | Years & Months | Standard Deviation | Range in Months |
| Kindergarten | 68.36 | 5 - 8 | 3.632 | 12 |
| Grade I | 84.27 | 7 - 0 | 6.535 | 25 |
| Grade II | 93.9 | 7 - 10 | 8.376 | 44 |
| Grade III | 106.23 | 8 - 10 | 7.531 | 29 |

Table I gives the mean age and age range by grade for the group studied. It will be noticed that the second grade has the largest range

in ages, grades I and III have about the same, and kindergarten has the smallest range.

The mean age of the kindergarten children was five years, eight months; that of first graders was seven years; that of second graders was seven years ten months; and the mean age of third graders was eight years, ten months.

### INITIAL EXPERIMENT

The items selected for this study include:

1. - Batting a ball, both right and left handed.
2. - Throwing a baseball for distance, both right and left handed.
3. - Kicking a soccer ball for distance both right and left footed.
4. - Bouncing a ball both right and left handed.
5. - Gripping the hand dynamometer both right and left handed.

An initial experiment was conducted for the purpose of refining the skill items selected, establishing verbal instructions to be given to the subjects, and refining the administration techniques and equipment to be used with the various items.

Ten subjects, for this initial phase of the study, performed the skills mentioned. The subjects consisted of kindergarten, first, second and third grade boys and girls. They performed the batting activities, swinging bats of various size and weight at various sized balls ranging from a junior-sized baseball to a fourteen-inch (14") soft ball.

The subjects also performed in the distance throw using several

sized balls thereby enabling the writer to choose the sized ball most practical for this item. The same procedure was carried out in the kicking and ball bouncing skills to attain the desired refinement.

## SELECTION OF ITEMS

The skill items of batting, throwing, kicking and bouncing a ball were selected for use in the study because they appear to be activities common to the group levels being studied and lend themselves readily to bilateral performance. Of the one hundred and fifteen subjects studied only two had never batted a ball before, both girls in kindergarten; there was no one who had never thrown a ball; three claimed they had never kicked a ball before, two of whom were kindergarten girls and one first grade boy from the rural community; all had previous experience in bouncing a ball.

The reliabilities of the skill items employed in this test were determined by conducting a test and retest on tem first graders, ten second graders, and ten third graders. The Pearson Product Moment Method of computing the coefficients of correlation was used in determining the reliabilities.

The coefficients of correlation between the first and second trials on each item are as follows:

Throw for distance right-hand -- .992
Throw for distance left-hand -- .942
Kick for distance right-footed - .733
Kick for distance left-footed -- .850
Ball bounce right-hand -- .693
Ball bounce left-hand -- .896

The writer used the batting reliability found by Seils[1] in his study, as the batting skill was conducted with the same apparatus and technique devised by Seils.

The coefficient of correlation for the batting skill as reported by Seils[2] is .696.

The coefficient of correlation for grip strength using the hand dynamometer was .90 as established by Metheny[3].

## SKILL ITEMS DESCRIBED

### Batting Skill

The method employed in the batting skill incorporated the use of the batting apparatus designed and employed by Seils[4] in his study. This apparatus consists of a two-foot (2') square sturdy wooden platform with a hole in the center into which is inserted a wooden upright six-feet (6') high. A three and a half foot (3½') wooden beam is suspended at a right angle from this upright. Into the end of the beam is inserted a hook from which is hung a chain supporting a 12" official soft ball. The batting apparatus is so constructed that the administrator con control the speed, arc and direction of the ball.

In the initial experiment it was found that the grade groups being

---

[1] Leroy G. Seils, "The Relationship Between Measures of Physical Growth and Gross Motor Performances of Primary School Children" (Boston University School of Education Thesis, Ed.D. 1948)

[2] ibid ., p.63

[3] Eleanor Metheny, "Present Status of Strength Testing for Children of Elementary School and Preschool Age", American Association for Health, Physical Education and Recreation Research Quarterly, 12:118, March, 1941

[4] Seils, loc.cit.

studied did poorly when a regulation baseball was used, and in general did too well when a fourteen-inch (14") softball was used. Substituting a twelve-inch (12") softball it was found that there were no extremely high scores and no exceptionally poor ones, i.e. no subject hit on all tries, nor did anyone miss all attempts.

A rope supported the ball during the initial experiments, until it was found that when the administrator released the ball and it started its swing, the ball had a definite lash effect to it causing it to jerk on the rope as it swung through its arc. Replacing the rope with a light chain, it was found that the added weight of the chain eliminated the ball lash allowing the ball to travel through its arc without jerking. The chain, it was found, could also be adjusted more rapidly to the desired height for the various subjects. The ball was held firmly by leather thongs and friction tape and was connected to the chain by a short sturdy leather thong.

The size of the bat used in this phase of the study was also determined in the initial experiment. It was found that the size and weight of a medium bat used by the subjects caused them to miss many attempts due to the fact that at these lower levels the children do not have the strength to swing the bat around fast enough to meet the ball. Finally a juvenile bat was employed in the initial experiment which proved to eliminate this strength factor almost completely. The bat ultimately used for the batting skill was twenty-four inches (24") long and weighed fourteen-ounces.

The general procedure for the batting skill consisted in explaining to the child, "This is a game to see how many times you can hit the ball hanging from the chain when I let it swing towards you."

The administrator demonstrated the way the subject was to stand and hold the bat, from both the left and right side. Here again the initial experiment proved helpful in that many of the very young subjects were effected in their choice of sides by the position taken by the administrator. In some cases the subjects took the position first demonstrated by the writer. In other cases the subjects chose the position last demonstrated. It was decided, in an attempt to eliminate first or last impressions upon the subjects, to alternate the demonstrations of left and right positions with each succeeding subject. To clarify -- the adminstrator would demonstrate how to bat right-handed first and left-handed second for Subject "A." For Subject "B" batting from the left-hand side would be demonstrated first followed by a right-handed demonstration.

The bat was placed on the ground so as not to influence the subjects choice of side, and he or she was told to, "Bat the way you like best."

The choice of side made by the subject was recorded in the appropriate column provided on the score sheet.

The child was placed in the batting box as correctly as possible and the ball was adjusted according to the subject's height and to the adjustment called for on the score sheet for the particular trial.

The administrator then elevated the ball to eye level and merely released his hold on the ball when the subject appeared ready. The writer was careful not to push the ball or in any way accelerate it beyond the natural speed of the swing. Another necessary precaution was to keep the chain taut before releasing the ball to avoid the lashing of the ball. The ball was hald at eye level by the administrator for every trial and for all subjects.

The administrator recorded the trial result as a hit or a miss in the appropriate trial columns provided on the score sheet.

The subject had ten trials -- first on the preferred side, and then took the corresponding ten trials on the other side. The subject's score sheet had appropriate columns for preference, the score, or number of hits and misses on both left and right sides and the ten adjustments for each of the ten trials on either side.*

A hit was considered to be any contact the bat made with the ball. A "foul tip" was considered a hit.

### Throw for Distance

The throwing skill employed in this study was a throw for distance from both the left and right sides.

The initial experiment was again the proving grounds to determine the size of the ball that would be used in this activity. A tennis ball, various small sized rubber balls, a junior league baseball and a regulation baseball were all employed at this initial stage. It was found that the regulation baseball was the most satisfactory in that

---

* A copy of the score sheet used throughout the study appears in the appendix.

the ball could be more easily duplicated if necessary. The regulation baseball, to be sure, shortened the distances obtained by the younger subjects, but this was not expected to effect the results of this skill. In general, it was found that the baseball was more easily controlled by the subjects than were the tennis and rubber balls. There were no subjects in the initial or final experiment who had never before thrown a baseball.

As a time-saving device, and for ease of administration, it was found profitable during the initial investigation to measure and mark off from the throwing point arcs of ten feet (10') interval in the direction in which the subject was to throw. A trial was then measured from the arc between the throwing point and the place the ball landed. All trials were recorded in feet, i.e. if a subject threw the ball sixty-two feet four-inches (62'4") it was recorded as sixty-two feet (62'). If the throw was sixty-two feet eleven-inches (62'11") it was recorded as sixty-three feet (63').

The general procedure for the throw for distance skill consisted of explaining to the subject that he or she was to throw the ball as far as he or she could. A run was not permitted for this skill.

The administrator again demonstrated, as in the batting skill, with both right and left hands, attempting to avoid influencing the subject's choice of arms.

The subject was told to pick up the baseball, assume the throwing position, and the hand preference noted and recorded in the appropriate column on the subjects score sheet.

All trials were measured from the throwing line to the point where

the ball first made contact with the ground. The result was recorded in the appropriate column provided on the score sheet.

All subjects were given five trials with each arm, allowing the subject, of course, to choose the arm he or she preferred for throwing.

### Kick for Distance

The Kick for Distance skill employed in this study consisted of having the subject stand behind a line, take one step and kick a soccer ball as far as possible.

The skill was first tried in the initial experiment and a large rubber ball, a volley ball and a soccer ball were employed. The soccer ball was found to be most satisfactory. The subjects kicked farther with the volley ball and rubber ball, but again this was not considered as materially effecting the results as the soccer ball, due to its additional weight, reduced the scores of all subjects. The rubber ball traveled the farthest, but in a great many instances this was due to the amount of bounces the ball would take, and it was considered to be not a reliable measure. The volley ball was easy for the subjects to kick, but it was discovered that many of the children could get a lift out of the volley ball and thereby greater distance. Other subjects less skilled in kicking could not lift the ball into the air and "topped" it getting lower results. The added weight of the soccer ball appeared to bring better results.

It was first decided to record the kick for distance in the same manner as the throw for distance, i.e. from the point of kick to the spot where the ball first came in contact with the ground. This was

impractical, as has been explained above, in that some of the subjects could kick the ball into the air, whereas many others were unable to get the ball into the air. It was therefore decided to record the kick for distance as the distance from the point where the subject made contact with the ball to the point where the ball finally came to rest.

The general procedure employed in the kick for distance skill consisted of explaining to the subject, "You are to take one step and kick the ball as far as you can."

The administrator then demonstrated with the left and right foot the method of standing with both feet together taking one step with the non-kicking foot and then kicking the ball with the kicking foot. Again as in batting, the method of alternating the demonstration was employed.

The student was then placed behind the kicking line and the soccer ball was placed on the line. The administrator noted the choice of foot made by the subject and recorded it in the appropriate column provided on the score sheet.

All subjects were given five trials with each foot and all results were recorded in the spaces provided on the score sheets.

The ball used throughout the experiment was a rubberized, official size and weight soccer ball manufactured by The Pennsylvania Rubber Company. The area used for this skill was a flat grass surface.

### Ball Bounce

The ball bouncing skill used in this study consisted of having the subjects bounce a medium sized rubber playground ball within a

circle having a nine-inch (9") radius.

In the initial experiment various sized balls were bounced within circles having varying diameters. Through a process of elimination a circle having a radius of nine-inches (9") was considered to be neither too difficult nor too easy an area for the subjects studied. The ball finally employed for this skill was a commonly used rubber playground ball known as a PG-6 Utility Ball having a circumference of seventeen and a half inches (17½") and manufactured by The Voit Rubber Corporation. The ball was small enough in area to enable each subject at these grade levels to get enough of his hand on the ball to control its bounce. It was observed in the initial experiment that very small balls, the size of a tennis ball, are more difficult for young subjects to control in bouncing than are large balls the size of a volley ball. For this reason a ball neither too difficult nor too easy for the subjects involved was employed for the ball bouncing skill.

The general procedure followed in the ball bouncing skill entailed the drawing of a circle having a nine-inch (9") radius upon a smooth even surface (usually a cement walk).

The administrator took the proper position adjacent to the circle and demonstrated the technique of bouncing the ball within the circle using both right and left hands. The method of alternating the demonstration, as in the batting skill was again employed in the ball bouncing activity.

The subject was instructed to take the same position as the

administrator had demonstrated and to bounce the ball within the circle as many times as possible or until told to stop. It had been arbitrarily decided in the initial experiment that twelve consecutive bounces within the circle was a sufficient number.

The administrator noted the choice of hands made by the subject and recorded this fact in the appropriate column provided on the score sheet. Every subject had three trials with each hand and all results were recorded in the columns provided on the score sheet.

### Grip Strength

The grip strength as measured by the hand dynamometer, though not a skill item, is included in this study. The results of the grip right and left are to be incorporated with the results of the throw for distance as it is considered by the writer that the distance throw is the only skill in this study to which grip strength might pertain.

## TREATMENT OF DATA

The subjects' scores in each skill item were computed by totaling the trial results. Thus, if a subject bounced the ball right-handed nine times for trial one, twelve times for trial two, and eleven times for the third trial, his score on the Ball Bounce Right would be thirty-two. The scores for the batting skill were computed by totaling the number of "hits" each on the right and left sides. In both the Kick for Distance and Throw for Distance the scores were the totals of the five trials on each side.

Grip Strength scores were recorded on one trial for each hand.

Means and Standard Deviations from the means were computed[5] by grades on all skills for both right and left performances.

Critical ratios of the difference between the right and left means were computed[6] for all grades in the four skill areas.

In determining the significant difference of the means the 1% level was decided upon. Therefore, in order for the difference of the means to be statistically significant at the one percent level a critical ratio of 2.6 must be obtained. *

Scores were compared by the percentage method showing the preference and best performance of all subjects in the four skill areas. A percentage table was also computed showing the grip strength and throwing performance of all subjects.

The standard of a 75% preference-performance score was arbitrarily established as an indication of performance and the preference-performance scores in each skill were compared to this standard.

---

[5] Harry Greene, Albert Jorgensen and J. R. Gerberick, Measurement and Evaluation in the Secondary School, (New York: Longmans, Green and Company, 1946) p.528ff, 548ff

[6] Herbert Sorenson, Statistics for Students of Psychology and Education, (1st ed New York: McGraw Hill Book Company, Inc., 1936) p.332

* See appendix for Significant Differences.

# CHAPTER III

## FINDINGS OF THE STUDY

The findings are presented in terms of mean performance scores, both right and left handed, for each of the four grade levels considered. In addition critical ratios between mean right and left scores have been computed. The percentage preference for the right and left side as well as the percentage showing superior right or left performance has been determined.

### Group Performance Scores by Grade Levels

Table II shows mean batting scores, right and left handed, for kindergarten, grades I, II and III.

TABLE II

MEANS, STANDARD DEVIATIONS, AND CRITICAL RATIOS FOR BATTING, BOTH RIGHT AND LEFT HANDED FOR KINDERGARTEN, GRADE I, GRADE II AND GRADE III

| GRADE | MEAN | | STANDARD DEVIATION | | CRITICAL RATIO |
|---|---|---|---|---|---|
| | Right | Left | Right | Left | |
| Kindergarten | 4.40 | 4.16 | 2.28 | 1.79 | .48 |
| Grade I | 5.07 | 5.17 | 1.97 | 2.03 | .19 |
| Grade II | 5.10 | 6.13 | 1.60 | 1.38 | 2.68 |
| Grade III | 6.33 | 6.60 | 1.90 | 1.41 | .62 |

An examination of Table II indicates that there is a progressive increase in mean batting performances from kindergarten through the third

grade.

At the level of significance selected, the second grade group shows the only significant difference between the right and left performance in batting.

The mean right and left performance scores for the Throw for Distance and the critical ratios between the means are shown for each grade level in Table III.

TABLE III

MEANS, STANDARD DEVIATIONS AND CRITICAL RATIOS FOR THE THROW FOR DISTANCE, BOTH RIGHT AND LEFT HANDED, FOR KINDERGARTEN, GRADE I, GRADE II AND GRADE III

| GRADE | MEAN | | STANDARD DEVIATION | | CRITICAL RATIO |
|---|---|---|---|---|---|
| | Right | Left | Right | Left | |
| Kindergarten | 132.00 | 83,44 | 54.50 | 27.14 | 4.18 |
| Grade I | 217.95 | 104.51 | 82.92 | 32.30 | 6.99 |
| Grade II | 233.40 | 116.00 | 91.05 | 59.79 | 5.91 |
| Grade III | 279.00 | 150.83 | 121.77 | 101.55 | 4.43 |

As will be noted there is a considerable increase in the means from Kindergarten to Grade I, a slight increase from Grade I to Grade II and a large increase from Grade II to Grade III.

At all four grade levels the difference in means for right and left performance in the Throw for Distance Skill is significant.

The standard deviations at all grade levels are large, with deviations from the right mean being greater than deviations from the left mean in all grades. The standard deviations from the means increase from

Kindergarten through Grade III.

The mean right and left performance scores for the Kick for Distance and the critical ratios between the means are shown for each grade level in Table IV.

TABLE IV

MEANS, STANDARD DEVIATIONS AND CRITICAL RATIOS FOR THE KICK FOR DISTANCE, BOTH RIGHT AND LEFT FOOTED, FOR KINDERGARTEN, GRADE I, GRADE II AND GRADE III

| GRADE | MEAN | | STANDARD DEVIATION | | CRITICAL RATIO |
|---|---|---|---|---|---|
| | Right | Left | Right | Left | |
| Kindergarten | 194.40 | 178.20 | 53.12 | 55.63 | .96 |
| Grade I | 212.58 | 192.00 | 76.35 | 71.76 | 1.08 |
| Grade II | 265.05 | 206.51 | 59.55 | 57.93 | 3.86 |
| Grade III | 276.49 | 244.51 | 89.81 | 86.60 | 1.44 |

An analysis of Table IV shows a steady increase in both right and left means for the Kick for Distance from kindergarten through Grade III.

A significant difference between the right and left means occurs only at the second grade level.

The standard deviation from the means are closely allied for the kicking from the right and from the left sides. Grades I and III have greater standard deviations than the Kindergarten and Grade II.

The right and left mean performance scores for the Ball Bounce and the critical ratios between the means, for each grade level, are shown in Table V.

## TABLE V

### MEANS, STANDARD DEVIATIONS AND CRITICAL RATIOS FOR THE BALL BOUNCE, BOTH RIGHT AND LEFT HANDED, FOR KINDERGARTEN, GRADE I, GRADE II AND GRADE III

| GRADE | MEAN | | STANDARD DEVIATION | | CRITICAL RATIO |
|---|---|---|---|---|---|
| | Right | Left | Right | Left | |
| Kindergarten | 16.92 | 14.52 | 11.38 | 10.64 | .77 |
| Grade I | 16.60 | 15.50 | 10.25 | 8.84 | .44 |
| Grade II | 20.31 | 14.80 | 10.47 | 9.86 | 2.10 |
| Grade III | 25.99 | 21.10 | 9.37 | 9.46 | 2.01 |

An inspection of Table V shows practically no increase in the mean performance for the Ball Bounce for the right hand between Kindergarten and Grade I. There is, however, a steady increase in mean right hand performance at the Second and Third Grade levels. A study of the left means shows little difference until the third grade level is reached, when the mean improvement is considerable.

The difference in mean performance between the right and left hand is not significant at any grade level as indicated by the low critical ratios.

The standard deviations from the right and left means shows only a slight difference for all grades.

### Pupil Laterality Preference and Proficiency Level

To further illuminate the findings, tables have been set up to show the number of subjects at each grade level who indicated right or left

preference and the percentage of these cases who performed better on either the right or left side.

Table VI shows the number of subjects at each grade level who indicated right or left preference and the percentage of these cases who performed better on either right or left side for the batting skill.

### TABLE VI

### NUMBER PREFERRING RIGHT OR LEFT FOR BATTING AND THE PERCENTAGE OF EACH SHOWING SUPERIOR PERFORMANCE SCORES FOR KINDERGARTEN, GRADE I GRADE II AND GRADE III

| | | Preferred Right Performed Better | | | | | Preferred Left Performed Better | | | |
|---|---|---|---|---|---|---|---|---|---|---|
| GRADE | N | Right | Left | Equal | Total % | N | Right | Left | Equal | Total % |
| Kdg. | 21 | 48% | 33% | 19% | 100% | 4 | 50% | 25% | 25% | 100% |
| I | 26 | 42% | 39% | 19% | 100% | 4 | 25% | 50% | 25% | 100% |
| II | 28 | 96% | 4% | 0 | 100% | 2 | 0 | 100% | 0 | 100% |
| III | 25 | 36% | 44% | 20% | 100% | 5 | 20% | 80% | 0 | 100% |

An analysis of Table VI indicates that the subjects in kindergarten and Grade I are approximately equal in their preference of the right side and their performance from the right side, although 6% more of the Grade I subjects preferring the right had a better performance from the left. In both grades 19% of the subjects preferring the right performed equally well from the left side. As regards left handed preference between Kindergarten and Grade I, it may be seen that although an equal number of subjects in both grades preferred to bat from the left, twice

as many Grade I subjects performed better on the left, and in both grades the same percentage performed equally as well from both sides. However, the number of cases indicating left preference is so small that little significance can be attached to the results.

Grade II showed by far the highest relationship between preference and performance, with 28 subjects preferring to bat from the right side and twenty-seven of them performing better from this side.

Grade III, however, showed the least relationship between right handed preference and right performance. Grade III, however, did show a high relationship between left preference and performance from the left side.

Table VII shows the number of subjects at each grade level who indicated right or left preference and the percentage of these cases who performed better on either right or left side for the distance threw.

TABLE VII

NUMBER PREFERRING RIGHT OR LEFT FOR THROW FOR DISTANCE AND THE PERCENTAGE OF EACH SHOWING SUPERIOR PERFORMANCE SCORES FOR KINDERGARTEN, GRADE I, GRADE II AND GRADE III

| | Preferred Right Performed Better | | | | | Preferred Left Performed Better | | | | |
|---|---|---|---|---|---|---|---|---|---|---|
| GRADE | N | Right | Left | Equal | Total % | N | Right | Left | Equal | Total % |
| Kdg. | 23 | 96% | 4% | 0 | 100% | 2 | 50% | 50% | 0 | 100% |
| I | 29 | 100% | 0 | 0 | 100% | 1 | 0 | 100% | 0 | 100% |
| II | 28 | 96% | 4% | 0 | 100% | 2 | 0 | 100% | 0 | 100% |
| III | 26 | 100% | 0 | 0 | 100% | 4 | 0 | 100% | 0 | 100% |

Table VIII shows the Grip Strength of the subjects used in conjunction with the Throw for Distance skill. An examination of Table VIII would indicate that of those subjects in Kindergarten, Grade I and Grade III having a higher Grip Strength score with the right hand, all threw better with the right arm. This relationship was only slightly less for Grade II where of the eighteen subjects gripping stronger with the right hand, sixteen threw farther with the right arm.

### TABLE VIII

### GRIP STRENGTH AND ITS ASSOCIATION WITH THROW FOR DISTANCE SCORES AT THE KINDERGARTEN, GRADE I, GRADE II AND GRADE III LEVELS

| | Gripped Stronger Right - Threw Better | | | Gripped Stronger Left - Threw Better | | | Gripped Equally Strong - Threw Better | | |
|---|---|---|---|---|---|---|---|---|---|
| GRADE | N | Right | Left | N | Right | Left | N | Right | Left |
| Kdg. | 10 | 100% | 0 | 9 | 89% | 11% | 5 | 80% | 20% |
| I | 14 | 100% | 0 | 14 | 93% | 7% | 2 | 100% | 0 |
| II | 18 | 89% | 11% | 8 | 100% | 0 | 4 | 75% | 25% |
| III | 20 | 100% | 0 | 8 | 75% | 25% | 2 | 50% | 50% |

Of the subjects having a higher Grip Strength with the left hand, a high percentage in all grades threw farther with the right arm.

In all but the Third Grade, which was equally divided, a much higher percentage of the subjects, having equal Grip Strength scores with both hands, threw farther with the right arm.

Table IX shows the number of subjects who indicated right or left preference and the percentage of those who performed better on right or

left side for the Kick for Distance.

An examination of Table IX disclosed that no one in Kindergarten and Grade I preferred to kick with the left foot. Of those preferring the right foot in these grades, Kindergarten had a higher percentage of subjects performing better with the right foot.

TABLE IX

NUMBER PREFERRING RIGHT OR LEFT FOR KICK FOR DISTANCE AND THE PERCENTAGE OF EACH SHOWING SUPERIOR PERFORMANCE SCORES FOR KINDERGARTEN, GRADE I, GRADE II AND GRADE III

| | | Preferred Right Performed Better | | | | | Preferred Left Performed Better | | | |
|---|---|---|---|---|---|---|---|---|---|---|
| GRADE | N | Right | Left | Equal | Total % | N | Right | Left | Equal | Total % |
| Kdg. | 25 | 72% | 28% | 0 | 100% | 0 | -- | -- | -- | -- |
| I | 30 | 63% | 37% | 0 | 100% | 0 | -- | -- | -- | -- |
| II | 29 | 90% | 10% | 0 | 100% | 1 | 100% | 0 | 0 | 100% |
| III | 26 | 73% | 27% | 0 | 100% | 4 | 50% | 50% | 0 | 100% |

Grade II had the highest relationship between right preference and right performance, and the one subject in Grade II preferring the left performed better with the right foot.

In Grade III the percentages related to right kicking are very similar to the Kindergarten percents. Of the Third Graders preferring the left, one half of them performed better with the right foot.

Table X shows the number of subjects indicating right or left preference, and the percentage of those cases who performed better with

the right or left hand for the Ball Bounce.

TABLE X

NUMBER PREFERRING RIGHT OR LEFT FOR THE BALL BOUNCE AND THE PERCENTAGE OF EACH SHOWING SUPERIOR PERFORMANCE SCORES FOR KINDERGARTEN, GRADE I, GRADE II AND GRADE III

| | Preferred Right, Performed Better | | | | | Preferred Left, Performed Better | | | | |
|---|---|---|---|---|---|---|---|---|---|---|
| GRADE | N | Right | Left | Equal | Total % | N | Right | Left | Equal | Total % |
| Kdg. | 24 | 54% | 38% | 8% | 100% | 1 | 0 | 100% | 0 | 100% |
| I | 29 | 62% | 31% | 7% | 100% | 1 | 0 | 100% | 0 | 100% |
| II | 29 | 72% | 21% | 7% | 100% | 1 | 0 | 100% | 0 | 100% |
| III | 25 | 52% | 36% | 12% | 100% | 5 | 80% | 0 | 20% | 100% |

Table X indicates that in all grades there was a slightly better right-handed performance by those preferring the right hand. Kindergarten and Grade III are very similar in right selection and performance. Of those subjects choosing to bounce the ball with the left hand, in Kindergarten, Grade I and Grade II all performed better with this hand. In Grade III, however, four-fifths of those choosing the left had a better right hand performance.

### Discussion of Results

In an attempt to more accurately interpret the percentage tables, the standard of a 75% preference-performance score was arbitrarily established as an indication of performance. Thus, in each skill there was the possibility of eight preference-performance scores, for example --- in the Throw for Distance skill; at the Kindergarten level 96% of the

subjects preferring the right performed better on the right and 50% of those preferring the left performed better on the left; in Grade I 100% of those preferring the right performed better on the right and 100% of those preferring the left performed better on the left; in Grade II, 96% of those preferring the right performed better on the right and 100% of those preferring the left performed better on the left; in Grade III 100% of those preferring the right performed better on the right and 100% of those preferring the left performed better on the left.

Therefore in the Throw for Distance skill, using the standard of a 75% preference-performance score, it may be seen that seven (7) of the above percentages are over 75% and one (1) is under 75%. This would indicate that in the Throw for Distance skill preference is an indication of performance.

Using the 75% standard for all the skills, the results are as follows:

Batting - 3 over 75% - 5 under 75%
Throw for Distance - 7 over 75% - 1 under 75%
Kick for Distance - 1 over 75% - 5 under 75%
Ball Bounce - 3 over 75% - 5 under 75%

An examination of the percentage tables disclosed that of the total group studied, the percent by skills that performed better from the right side was 37% for Batting, 91% for Throw for Distance, 74% for Kick for Distance, and 60% for the Ball Bounce skill.

Table XI shows the percentage of each grade that performed better on the right-hand side.

### TABLE XI

### PERCENT OF EACH GRADE GROUP THAT PERFORMED BETTER ON RIGHT-HAND SIDE FOR BATTING, THROW FOR DISTANCE, KICK FOR DISTANCE AND BALL BOUNCE

| | Kindergarten | Grade I | Grade II | Grade III |
|---|---|---|---|---|
| Batting ------ | 48% | 40% | 27% | 33% |
| Throwing ------ | 92% | 97% | 90% | 87% |
| Kicking ------ | 72% | 63% | 90% | 70% |
| Bouncing ------ | 52% | 60% | 70% | 57% |

Table XII is a compilation of the total percent of subjects by grade who performed the various skills better from the non-preferred side.

### TABLE XII

### PERCENT OF EACH GRADE GROUP THAT PERFORMED BETTER ON THE NON-PREFERRED SIDE FOR BATTING, THROW FOR DISTANCE, KICK FOR DISTANCE, AND BALL BOUNCE

| | Kindergarten | Grade I | Grade II | Grade III |
|---|---|---|---|---|
| Batting | 36% | 36% | 53% | 40% |
| Throwing | 8% | --- | 3% | --- |
| Kicking | 28% | 37% | 13% | 30% |
| Bouncing | 36% | 30% | 20% | 43% |

After examining Table XII it may be seen that in general, the subjects studied performed better on the side preferred in Batting, Throw for Distance, Kick for Distance and Ball Bounce.

It is to be noted that 53% of Grade II performed better in the Batting skill from the non-preferred side. This fact may be in agreement

with the findings of Gesell and Ames[7] for this age group.

---

[7] cf. p.8

# CHAPTER IV

## SUMMARY

This investigation attempted to study laterality preference as an indication of performance in certain skill areas at the lower grade levels. Also, the study attempted to determine if dominance has been established at these grade levels, and if the children at these levels performed the skills as well on the side not preferred.

A random sample of one hundred and fifteen normal boys and girls, composed of kindergarten, first, second and third grade children from rural, city and residential districts of Massachusetts were used as subjects in this study.

The subjects performed the gross motor skills of; batting a twelve-inch softball from the right and left side; throwing a baseball both right and left handed; kicking a soccerball with the right and left foot; and bouncing a medium sized rubber ball, both right and left handed, within a circle having a radius of nine inches. The Grip Strength of all subjects was measured by means of the hand dynamometer.

Reliabilities of the skill items, with the exception of batting, were established by testing and retesting ten first graders, ten second graders and ten third graders.

Means and standard deviations of the right and left scores obtained by all the subjects were computed by grade. Critical ratios were found showing the differences between the right and left means.

The percentage of preference for the right and left side as well as the percentage showing superior right or left performance was computed for all skills. The arbitrary standard of a 75% preference-performance score was compared to these results.

The following summarizes the findings of the study: An analysis of the mean data for the group studied showed; (1) in Batting, there was no significant difference between right and left performance, except at the second grade level, where a significant difference was obtained; (2) in the Throw for Distance there was a significant difference between right and left performance at all grade levels; (3) in the kick for distance, the second grade again showed the only significant difference; (4) in the Ball Bounce, there were no significant difference at any grade level.

An analysis of the percentage data, showing the percentage preferring the right and left as well as the percentage showing superior performance, indicated that; (1) in Batting, Grade II had the highest relationship between right preference and right performance, and the highest relationship between left preference and left performance; (2) in the Throw for Distance all grades showed a very high relationship between right preference and right performance, and Grades I, II and III showed a very high relationship between left preference and left performance; (3) regardless of the hand having the higher grip strength score, a very large majority threw better right handed; (4) in the Kick for Distance, right preference and right

performance was by far the more popular; (5) in the ball bounce, almost all the subjects preferring the left performed better on the left, those preferring the right had inconclusive right-handed results.

Using the arbitrarily established standard of a 75% preference-performance score as an indication of performance, it was seen that, of the four skills used in the study, the Throw for Distance was the only skill having a majority of scores above the 75% standard.

An examination of the percentage of each grade group that performed better on the right side in the four skills, disclosed that a majority of the subjects performed better from the right-hand side in Throw for Distance, Kick for Distance and Ball Bounce.

An examination of the percentage of subjects who performed the four skills better on the non-preferred side, disclosed that only in the batting skill did a very slight majority of second graders perform better on the side not chosen.

## CONCLUSIONS

After examining the percentage tables in Chapter III, and the results, after arbitrarily establishing the standard of a 75% preference performance score, it may be concluded that preference is an indication of the performances of the one hundred and fifteen subjects in the Throw for Distance skill. Also, it may be concluded that preference is not a good indication of the performace of those subjects in the Batting, Kick for Distance or Ball Bounce skills.

It may be concluded that right dominance has been established in the throwing and kicking skills and has not become established in

the batting or bouncing skills.

Finally, it may be concluded that the one hundred and fifteen subjects studied, performed better on the side preferred in batting, throwing, kicking and bouncing a ball.

# BIBLIOGRAPHY

## SELECTED BIBLIOGRAPHY

Coons,J.C.and R.J.Mathias, "Eye and Hand Preference Tendencies", *Pedagogical Seminar*, 35:629-32, December,1928.

Gesell,Arnold L. and Louise B.Ames, "Development of Handedness", *Pedagogical Seminar*, 70:155-75, June,1947.

Greene,Harry,Albert Jorgenson, and J.Raymond Gerberich, *Measurement and Evaluation in the Secondary School*, New York; Longmans Green and Company, 1946, Chapter XV.

Haefner, Ralph, "Relation Between Hand and Foot Tendencies of Children", *Pedagogical Seminar*, 38:338-51, December,1930.

Heinlein,J.H.,,"A Study of Dextrality in Children", *Pedagogical Seminar*, 36:91-119, March, 1929.

Irwin, Leslie W., "Study of the Relation of Dominance to the Performance of Physical Education Activities", *American Association of Health and Physical Education,Research Quarterly*, 9:98-119, May, 1938.

Metheny, Eleanor, "Present Status of Strength Testing for Children of Elementary School and Preschool Age",*American Association forHealth, Physical Education, and Recreation*, Research Quarterly, 12:115-30, March, 1941.

"Right or Left-Handed?", *Science Digest*, 19:67-8, May, 1946.

Seils,Leroy George, "The Relationship Between Measures of Physical Growth and Gross Motor Performance of Primary School Children", *Boston University,School of Education Thesis*, Ed.D. 1948

Sorenson,Herbert, *Statistics for Students of Psychology and Education*, 1st.ed. New York:McGraw-Hill Book Company Inc., 1936, pp.330ff.

Tuttle,Waid,and Lee Travis, "Relation of Precedence of Movement in Homologous Structures to Handedness", *American Physical Education Association,Research Quarterly*, 6:sup3-14, October, 1935.

Vogel,Otto H., "Relationship of Dominance to Acts of Skill", *American Physical Education Association,Research Quarterly*, 6:sup15-18, October, 1935.

# APPENDIX

GRADE III AGE-Years 8 Months 9 SEX M

NAME XXXX

ADDRESS XXXX

HEIGHT 52 WEIGHT 63

GRIP RIGHT 36 GRIP LEFT 36

BATTING

| | | Score | | | | |
|---|---|---|---|---|---|---|
| Preference | | Right | | Left | | |
| Right | Left | Hit | Miss | Hit | Miss | Adjustment |
| ✓ | | | ✓ | ✓ | | Navel |
| | | ✓ | | | ✓ | 1 above |
| | | ✓ | | ✓ | | 1 below |
| | | ✓ | | ✓ | | 1 below |
| | | ✓ | | ✓ | | Navel |
| | | ✓ | | ✓ | | 1 above |
| | | ✓ | | ✓ | | 1 above |
| | | ✓ | | | ✓ | Navel |
| | | ✓ | | | ✓ | 1 below |
| | | ✓ | | ✓ | | Navel |
| | | 9 | | 7 | | |

THROW FOR DISTANCE

| Preference | | Score | |
|---|---|---|---|
| Right | Left | Right | Left |
| ✓ | | 45 | 20 |
| | | 43 | 20 |
| | | 34 | 17 |
| | | 40 | 19 |
| | | 52 | 18 |
| | | 214 | 94 |

KICK FOR DISTANCE

| Preference | | Score | |
|---|---|---|---|
| Right | Left | Right | Left |
| ✓ | | 38 | 45 |
| | | 63 | 52 |
| | | 60 | 38 |
| | | 35 | 58 |
| | | 50 | 40 |
| | | 246 | 233 |

BALL BOUNCE

| Preference | | Score | |
|---|---|---|---|
| Right | Left | Right | Left |
| ✓ | | 2 | 3 |
| | | 2 | 5 |
| | | 7 | 3 |
| | | 11 | 11 |

SAMPLE SCORE SHEET

### RAW SCORES OF THE ONE HUNDRED FIFTEEN KINDERGARTEN, FIRST, SECOND, AND THIRD GRADE SUBJECTS STUDIED

LEGEND:

| | |
|---|---|
| C | case number |
| KDG | kindergarten |
| GrI | grade one |
| GrII | grade two |
| GrIII | grade three |
| GR | grip right |
| GL | grip left |
| BR | bat right |
| BL | bat left |
| TR | throw right |
| TL | throw left |
| KR | kick right |
| KL | kick left |
| BBR | ball bounce right |
| BBL | ball bounce left |
| 1A | indicates retest on case one |

Preferred side is underlined.

| C. | GR | GL | BR | BL | TR | TL | KR | KL | BBR | BBL |
|---|---|---|---|---|---|---|---|---|---|---|
| KDG | | | | | | | | | | |
| 1. | 25 | 22 | 6 | 5 | 55 | 47 | 167 | 197 | 15 | 5 |
| 2. | 26 | 20 | 4 | 3 | 66 | 61 | 151 | 162 | 14 | 7 |
| 3. | 18 | 21 | 0 | 3 | 62 | 80 | 105 | 118 | 10 | 18 |
| 4. | 10 | 12 | 2 | 1 | 147 | 59 | 211 | 99 | 5 | 6 |
| 5. | 18 | 20 | 4 | 5 | 154 | 58 | 269 | 276 | 12 | 11 |
| 6. | 24 | 24 | 1 | 5 | 92 | 69 | 277 | 236 | 10 | 12 |
| 7. | 18 | 20 | 5 | 3 | 119 | 77 | 167 | 136 | 5 | 9 |
| 8. | 14 | 12 | 7 | 5 | 206 | 74 | 238 | 252 | 36 | 15 |
| 9. | 16 | 14 | 7 | 5 | 180 | 100 | 250 | 253 | 12 | 7 |
| 10. | 15 | 15 | 6 | 7 | 187 | 85 | 274 | 345 | 14 | 3 |
| 11. | 20 | 20 | 4 | 4 | 89 | 155 | 224 | 184 | 3 | 6 |
| 12. | 18 | 16 | 7 | 2 | 161 | 72 | 212 | 201 | 9 | 9 |
| 13. | 24 | 22 | 4 | 5 | 213 | 94 | 165 | 139 | 11 | 8 |
| 14. | 12 | 18 | 4 | 5 | 98 | 90 | 172 | 192 | 31 | 35 |
| 15. | 30 | 40 | 4 | 5 | 200 | 156 | 289 | 271 | 15 | 21 |
| 16. | 20 | 25 | 10 | 9 | 196 | 113 | 280 | 245 | 31 | 34 |
| 17. | 28 | 22 | 5 | 5 | 112 | 99 | 193 | 185 | 10 | 7 |
| 18. | 26 | 22 | 5 | 4 | 164 | 76 | 140 | 97 | 14 | 8 |
| 19. | 30 | 24 | 6 | 5 | 245 | 116 | 176 | 139 | 35 | 36 |
| 20. | 16 | 14 | 3 | 3 | 56 | 44 | 112 | 102 | 7 | 7 |
| 21. | 20 | 20 | 0 | 0 | 64 | 51 | 83 | 81 | 10 | 8 |
| 22. | 18 | 20 | 4 | 3 | 106 | 75 | 144 | 122 | 36 | 16 |
| 23. | 16 | 16 | 3 | 3 | 129 | 60 | 202 | 152 | 36 | 32 |
| 24. | 34 | 24 | 7 | 4 | 112 | 94 | 177 | 170 | 36 | 32 |
| 25. | 25 | 26 | 3 | 5 | 132 | 73 | 202 | 148 | 7 | 8 |

RAW SCORES continued

GrI

| C. | GR | GL | BR | BL | TR | TL | FR | FL | BBR | BBL |
|---|---|---|---|---|---|---|---|---|---|---|
| 1. | 28 | 34 | 9 | 5 | 335 | 109 | 364 | 332 | 13 | 14 |
| 1A. | | | 7 | 5 | 348 | 114 | 311 | 329 | 27 | 10 |
| 2. | 38 | 40 | 6 | 8 | 314 | 105 | 152 | 176 | 15 | 11 |
| 2A. | | | 7 | 7 | 303 | 115 | 195 | 171 | 19 | 20 |
| 3. | 36 | 38 | 6 | 7 | 305 | 135 | 294 | 198 | 23 | 18 |
| 3A. | | | 8 | 8 | 348 | 129 | 395 | 217 | 19 | 17 |
| 4. | 32 | 32 | 4 | 4 | 154 | 108 | 136 | 103 | 30 | 26 |
| 4A. | | | 4 | 5 | 176 | 123 | 148 | 131 | 36 | 33 |
| 5. | 26 | 30 | 5 | 4 | 130 | 222 | 163 | 162 | 4 | 11 |
| 5A. | | | 7 | 5 | 125 | 179 | 175 | 180 | 7 | 12 |
| 6. | 30 | 25 | 8 | 5 | 321 | 108 | 147 | 179 | 25 | 32 |
| 6A. | | | 6 | 5 | 314 | 111 | 153 | 138 | 29 | 28 |
| 7. | 38 | 30 | 4 | 6 | 373 | 102 | 188 | 325 | 17 | 6 |
| 7A. | | | 7 | 9 | 420 | 95 | 205 | 213 | 22 | 9 |
| 8. | 28 | 26 | 5 | 2 | 170 | 132 | 117 | 79 | 5 | 5 |
| 8A. | | | 5 | 9 | 212 | 86 | 110 | 72 | 6 | 7 |
| 9. | 18 | 20 | 3 | 5 | 83 | 63 | 158 | 89 | 5 | 6 |
| 9A. | | | 4 | 5 | 89 | 72 | 132 | 83 | 4 | 3 |
| 10. | 36 | 37 | 7 | 9 | 298 | 124 | 241 | 147 | 11 | 7 |
| 10A. | | | 5 | 8 | 289 | 103 | 190 | 148 | 35 | 10 |
| 11. | 30 | 24 | 7 | 7 | 206 | 97 | 185 | 284 | 6 | 6 |
| 12. | 26 | 28 | 8 | 6 | 121 | 78 | 148 | 180 | 36 | 15 |
| 13. | 14 | 15 | 4 | 6 | 91 | 63 | 91 | 99 | 4 | 10 |
| 14. | 42 | 40 | 6 | 6 | 253 | 138 | 247 | 229 | 12 | 25 |
| 15. | 23 | 26 | 8 | 8 | 170 | 96 | 116 | 200 | 32 | 20 |
| 16. | 20 | 18 | 0 | 4 | 202 | 77 | 220 | 280 | 12 | 10 |
| 17. | 15 | 18 | 5 | 6 | 90 | 82 | 115 | 102 | 36 | 34 |
| 18. | 26 | 28 | 4 | 3 | 114 | 57 | 178 | 176 | 6 | 5 |
| 19. | 16 | 15 | 5 | 3 | 202 | 83 | 132 | 184 | 8 | 13 |
| 20. | 25 | 28 | 7 | 8 | 169 | 85 | 178 | 140 | 13 | 18 |
| 21. | 31 | 30 | 4 | 3 | 230 | 108 | 222 | 213 | 8 | 5 |
| 22. | 38 | 30 | 5 | 3 | 301 | 140 | 230 | 211 | 35 | 36 |
| 23. | 38 | 34 | 3 | 3 | 241 | 131 | 220 | 188 | 24 | 20 |
| 24. | 32 | 30 | 2 | 2 | 160 | 104 | 194 | 113 | 6 | 4 |
| 25. | 22 | 22 | 3 | 5 | 159 | 68 | 160 | 146 | 8 | 17 |
| 26. | 30 | 32 | 3 | 4 | 330 | 117 | 271 | 253 | 15 | 10 |
| 27. | 28 | 26 | 6 | 4 | 210 | 84 | 241 | 242 | 30 | 19 |
| 28. | 30 | 28 | 4 | 10 | 312 | 123 | 406 | 293 | 22 | 21 |
| 29. | 20 | 26 | 6 | 4 | 314 | 105 | 384 | 298 | 18 | 21 |
| 30. | 28 | 26 | 6 | 5 | 195 | 87 | 188 | 260 | 19 | 18 |
| GrII | | | | | | | | | | |
| 1. | 30 | 28 | 7 | 6 | 201 | 84 | 309 | 237 | 22 | 22 |
| 1A. | | | 7 | 8 | 203 | 99 | 285 | 279 | 18 | 26 |
| 2. | 30 | 30 | 4 | 7 | 180 | 85 | 190 | 113 | 5 | 4 |
| 2A. | | | 9 | 5 | 177 | 95 | 131 | 135 | 8 | 5 |

RAW SCORES continued

| C. | GR | GL | BR | BL | TR | TL | KR | KL | BBR | BBL |
|---|---|---|---|---|---|---|---|---|---|---|
| GrII | | | | | | | | | | |
| 3. | 30 | 32 | 3 | 6 | 303 | 78 | 279 | 193 | 28 | 16 |
| 3A. | | | 4 | 7 | 299 | 77 | 226 | 156 | 21 | 14 |
| 4. | 38 | 36 | 6 | 9 | 127 | 103 | 184 | 142 | 29 | 17 |
| 4A. | | | 6 | 6 | 156 | 102 | 135 | 193 | 26 | 20 |
| 5. | 23 | 25 | 7 | 4 | 195 | 89 | 229 | 186 | 30 | 26 |
| 5A. | | | 4 | 7 | 186 | 76 | 240 | 189 | 36 | 31 |
| 6. | 25 | 26 | 6 | 6 | 193 | 84 | 283 | 307 | 36 | 19 |
| 6A. | | | 6 | 5 | 178 | 80 | 331 | 316 | 26 | 19 |
| 7. | 22 | 27 | 5 | 7 | 126 | 101 | 270 | 265 | 21 | 22 |
| 7A. | | | 7 | 9 | 108 | 86 | 285 | 290 | 28 | 21 |
| 8. | 29 | 30 | 7 | 5 | 287 | 124 | 284 | 249 | 16 | 7 |
| 8A. | | | 6 | 7 | 297 | 195 | 264 | 222 | 9 | 7 |
| 9. | 30 | 28 | 6 | 5 | 318 | 91 | 322 | 184 | 17 | 8 |
| 9A. | | | 8 | 8 | 297 | 89 | 244 | 184 | 21 | 10 |
| 10. | 30 | 20 | 6 | 5 | 247 | 69 | 201 | 161 | 13 | 7 |
| 10A. | | | 3 | 5 | 215 | 70 | 216 | 208 | 20 | 9 |
| 11. | 24 | 20 | 4 | 7 | 203 | 151 | 202 | 204 | 8 | 4 |
| 12. | 29 | 23 | 5 | 6 | 120 | 81 | 246 | 139 | 36 | 8 |
| 13. | 40 | 40 | 5 | 8 | 410 | 185 | 440 | 338 | 36 | 36 |
| 14. | 30 | 24 | 4 | 7 | 68 | 99 | 204 | 131 | 25 | 28 |
| 15. | 32 | 30 | 2 | 5 | 224 | 98 | 307 | 261 | 6 | 5 |
| 16. | 28 | 30 | 5 | 8 | 167 | 93 | 177 | 114 | 8 | 4 |
| 17. | 32 | 30 | 6 | 9 | 343 | 125 | 335 | 153 | 20 | 12 |
| 18. | 42 | 40 | 4 | 6 | 413 | 96 | 349 | 313 | 30 | 10 |
| 19. | 40 | 40 | 7 | 6 | 192 | 369 | 222 | 233 | 17 | 12 |
| 20. | 49 | 47 | 8 | 5 | 314 | 83 | 275 | 222 | 36 | 21 |
| 21. | 20 | 20 | 3 | 8 | 122 | 88 | 208 | 123 | 36 | 29 |
| 22. | 30 | 38 | 6 | 6 | 252 | 143 | 323 | 219 | 7 | 10 |
| 23. | 34 | 32 | 7 | 5 | 341 | 121 | 282 | 186 | 16 | 13 |
| 24. | 22 | 20 | 6 | 8 | 272 | 50 | 208 | 177 | 6 | 4 |
| 25. | 28 | 27 | 7 | 9 | 203 | 89 | 278 | 243 | 22 | 28 |
| 26. | 46 | 43 | 2 | 4 | 342 | 182 | 277 | 216 | 23 | 29 |
| 27. | 30 | 28 | 4 | 4 | 210 | 243 | 307 | 250 | 11 | 7 |
| 28. | 30 | 28 | 4 | 6 | 312 | 109 | 202 | 181 | 14 | 14 |
| 29. | 30 | 28 | 4 | 6 | 275 | 97 | 268 | 203 | 30 | 21 |
| 30. | 46 | 38 | 3 | 4 | 237 | 125 | 294 | 217 | 4 | 5 |
| GrIII | | | | | | | | | | |
| 1. | 36 | 40 | 3 | 7 | 184 | 400 | 286 | 172 | 25 | 14 |
| 1A. | | | 7 | 7 | 187 | 390 | 263 | 186 | 27 | 15 |
| 2. | 40 | 38 | 6 | 7 | 382 | 101 | 354 | 256 | 20 | 35 |
| 2A. | | | 9 | 9 | 374 | 99 | 313 | 313 | 32 | 24 |
| 3. | 34 | 30 | 5 | 6 | 411 | 82 | 219 | 205 | 29 | 31 |
| 3A. | | | 7 | 8 | 356 | 103 | 212 | 215 | 20 | 16 |
| 4. | 22 | 30 | 4 | 5 | 159 | 99 | 306 | 236 | 18 | 9 |
| 4A. | | | 3 | 5 | 168 | 105 | 288 | 233 | 17 | 10 |

## RAW SCORES continued

| C.<br>GrIII | GR | GL | BR | BL | TR | TL | KR | KL | BBR | BBL |
|---|---|---|---|---|---|---|---|---|---|---|
| 5. | 28 | 26 | 8 | 8 | 169 | 111 | 222 | 173 | 24 | 31 |
| 5A. | | | 6 | 7 | 192 | 113 | 248 | 178 | 27 | 26 |
| 6. | 30 | 31 | 7 | 6 | 218 | 131 | 290 | 250 | 26 | 28 |
| 6A. | | | 9 | 8 | 241 | 120 | 216 | 210 | 28 | 26 |
| 7. | 32 | 29 | 4 | 8 | 116 | 97 | 254 | 181 | 36 | 23 |
| 7A. | | | 6 | 7 | 124 | 112 | 194 | 160 | 29 | 21 |
| 8. | 32 | 30 | 7 | 7 | 191 | 96 | 450 | 347 | 36 | 32 |
| 8A. | | | 9 | 7 | 204 | 101 | 392 | 325 | 36 | 35 |
| 9. | 34 | 36 | 9 | 6 | 111 | 79 | 240 | 219 | 27 | 17 |
| 9A. | | | 7 | 5 | 122 | 91 | 238 | 202 | 26 | 26 |
| 10. | 42 | 42 | 6 | 8 | 214 | 310 | 180 | 254 | 36 | 28 |
| 10A. | | | 7 | 6 | 197 | 318 | 366 | 319 | 27 | 36 |
| 11. | 36 | 36 | 9 | 7 | 214 | 94 | 246 | 233 | 11 | 11 |
| 12. | 60 | 50 | 8 | 5 | 207 | 147 | 352 | 261 | 33 | 28 |
| 13. | 64 | 52 | 9 | 8 | 410 | 150 | 369 | 334 | 13 | 20 |
| 14. | 34 | 36 | 6 | 7 | 128 | 91 | 161 | 178 | 8 | 13 |
| 15. | 30 | 24 | 6 | 5 | 126 | 66 | 215 | 166 | 36 | 36 |
| 16. | 50 | 44 | 3 | 6 | 393 | 189 | 389 | 414 | 18 | 10 |
| 17. | 40 | 32 | 9 | 8 | 462 | 104 | 368 | 350 | 26 | 18 |
| 18. | 38 | 32 | 6 | 6 | 355 | 113 | 302 | 262 | 23 | 7 |
| 19. | 48 | 54 | 5 | 6 | 115 | 299 | 200 | 335 | 7 | 7 |
| 20. | 44 | 42 | 6 | 7 | 490 | 150 | 381 | 361 | 5 | 10 |
| 21. | 36 | 44 | 7 | 8 | 255 | 508 | 374 | 289 | 34 | 31 |
| 22. | 32 | 28 | 4 | 5 | 341 | 75 | 205 | 262 | 23 | 31 |
| 23. | 34 | 33 | 8 | 6 | 346 | 881 | 268 | 234 | 27 | 13 |
| 24. | 36 | 32 | 5 | 3 | 400 | 133 | 218 | 223 | 21 | 13 |
| 25. | 42 | 43 | 5 | 7 | 452 | 139 | 407 | 415 | 16 | 23 |
| 26. | 32 | 30 | 4 | 4 | 327 | 101 | 138 | 70 | 36 | 29 |
| 27. | 30 | 26 | 8 | 8 | 232 | 99 | 110 | 80 | 36 | 36 |
| 28. | 48 | 42 | 9 | 7 | 502 | 268 | 389 | 363 | 36 | 14 |
| 29. | 38 | 42 | 5 | 7 | 252 | 125 | 135 | 85 | 26 | 23 |
| 30. | 43 | 42 | 9 | 10 | 201 | 83 | 264 | 210 | 34 | 16 |

CHANCES OF TRUE DIFFERENCE IN
1000 COMPUTED AT THE 1% LEVEL[1]

| | CRITICAL RATIO | CHANCE OF TRUE DIFFERENCE IN 1000 |
|---|---|---|
| BATTING | | |
| Kindergarten | .483 | 684 |
| GradeII | .194 | 575 |
| Grade II | 2.676 | 996.1 |
| Grade III | .621 | 733 |
| THROWING | | |
| Kindergarten | 4.780 | 999.98 |
| Grade I | 6.985 | 999.997+ |
| Grade II | 5.914 | 999.997+ |
| Grade III | 4.430 | 999.993 |
| KICKING | | |
| Kindergarten | .959 | 831 |
| Grade I | 1.078 | 859 |
| Grade II | 3.862 | 999.94 |
| Grade III | 1.438 | 926 |
| BOUNCING | | |
| Kindergarten | .769 | 779 |
| Grade I | .441 | 670 |
| Grade II | 2.102 | 982 |
| Grade III | 2.011 | 97797 |

---

[1] Sorenson, <u>ibid</u>. p.367, Table 75.