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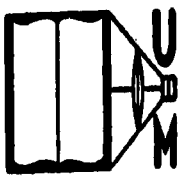
TITLE RELATIONSHIP BETWEEN PHYSICAL SKILLS AND GROWTH IN ELEMENTARY SCHOOL CHILDREN

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RELATIONSHIP BETWEEN PHYSICAL SKILLS AND GROWTH IN ELEMENTARY SCHOOL CHILDREN

by
Louis A. Govatos

A dissertation submitted in partial fulfillment
of the requirements for the degree of
Doctor of Philosophy in the
University of Michigan
1952

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CHAPTER I

INTRODUCTION

The object of the present inquiry is to determine what relationships exist between selected measures of the growth of the child in size, bone structure, strength, intelligence, achievement and specific physical skills such as running, jumping, throwing, and kicking.

The performance of an individual in any physical activity, as for other achievements, is determined by factors of heredity and of experience. Individual differences exist with respect to structures, functions, previous general experience, and specific training in the physical activity concerned. The extent to which a child may be able to make use of his mental and physical potentialities, is dependent upon what he brings to a wholesome environment. Since heredity and environment are both involved, the amount of influence upon the individual is dependent upon their degree of interaction.

The investigation reported here is concerned primarily with problems of relationship between measured factors and does not attempt to ascribe their origins to either nature or nurture.

This study is part of a longitudinal, multi-discipline investigation centered in the Child Development Laboratories of the University Elementary School of the University of

Michigan. By adding cross-sectional measures of physical skills it becomes possible to interpret them from a more elaborate description of total growth.

In selecting growth measures that might influence or predict performance in any specific motor activity, only those factors which are readily evaluated and subject to quantitative treatment are included in this study. Other attributes of growth, such as, glandular secretions, circulation, nutritional state, and muscle tonus are omitted.

The Problem. - The specific purpose of this study is to determine the relationship that exists between performances in physical skills and various aspects of growth in elementary school children between the ages of six and eleven years. The physical skills selected include performances in jumping, kicking, running and throwing, while the growth values include height, weight, grip, carpal, dental, reading, and mental ages established by Olson and Hughes (49)(50)(51).

The purpose of this study is to test the following hypotheses:

1. There are significant differences between boys and girls of the same chronological age groupings in the mean motor performances of some of the physical skills selected.

2. The level of performance in certain physical skills is positively related to organismic age which is an arithmetic average of the following growth attributes: height, weight, grip, carpal, dental, reading and mental ages.

3. The mean motor performance of the combined physical skills measured is related more to organismic age than to chronological age.

4. The degree of homogeneity between the selected aspects of growth will determine the consistency and level of performance of children as measured by the arithmetic average of the combined physical skills. Conversely, the degree of heterogeneity between the selected growth measures will determine the variability and level of performance of the children.

5. Selected aspects of growth, taken independently, will be related to performance in some of the physical skills more than to others.

Need for the Study. - Even though much emphasis has been placed on the study of motor performances of elementary school children, very little treatment has been given to the relationships existing between various aspects of growth and physical skills. A review of the literature revealed some attempt to relate performances in physical skills to aspects of growth. One study showed the relationship between motor performances and height, weight, and carpal measures of children in the primary grades. Other studies have correlated measures of growth, such as, height, weight, grip, and intelligence with motor performances at the later elementary and secondary levels. Otherwise, most studies have been concerned chiefly with achievement, ability, or developmental aspects of motor performances at the preschool, elementary and adolescent levels.

In the field of physical education many research workers have been concerned with establishing normative data, increasing efficiency in motor skills by practice, and devising classification systems based upon the factors of height, weight, and age of the participants with little attention given to

other growth processes. In recent years impetus has been given to the study of various aspects of growth by research workers in the field of child development with emphasis on the child as a whole. Such investigations have given rise to the concept of organismic age which is an arithmetic average of certain growth attributes calculated at a given point in time (52).

Definition of Terms. - The basic concepts used in the analysis and interpretation of the data are defined within the context of this study. The following definitions were adapted from those of Olson, Seashore, Shirley and others.

Maturity:	refers to a child's total state of readiness to carry on an activity at a given point in time.
Development:	connotes qualitative changes in structures and functions, with progress toward maturity.
Heterogeneity:	refers to the degree of variability between selected aspects of growth at any developmental level. Operationally it is measured by the standard deviation or probable error of growth measures about the central tendency.
Growth:	refers to increase in size.
Skill:	refers to a child's present effectiveness in terms of the results he achieves in a given performance.

Limitations of the Study. - There are several limitations which are apparent in this study. They are listed as follows:

1. In addition to the growth data which are available on each subject, a longitudinal approach to motor development would have been more desirable.

2. The numbers used in this study were limited to those children whose growth data were complete and readily available from the files of the Child Development Laboratories of the University Elementary School at the University of Michigan. At the age levels, six, eight, ten and eleven years, the numbers are very small. This limited number of subjects may be attributed to the temporary status of some of the enrollees at the primary level, to children who leave and to late entries at the upper elementary age levels for whom only limited data are collected.

3. No attempt has been made to determine the amount of practice, training, or experience each child has had previously.

4. It is reasonable to believe that motivation was high, since each child expressed a desire to be taken to the Field House and be tested on the physical skills used. However, there is no way of controlling and measuring the amount of motivation.

CHAPTER II

PREVIOUS INVESTIGATIONS OF GROSS MOTOR SKILLS AND OTHER GROWTH PROCESSES

Physical Skill Tests. - Within the past twenty years much attention has been given to the classification of boys and girls according to the factors of age, height and weight for purposes of homogeneous grouping in physical events. Teachers in the field of physical education have laid great stress on the importance of these factors on physical performance, and have adapted their teaching methods to fit the needs of children of varying general athletic ability and skill.

Neilson and Cozens (48) tested 79,000 subjects in twenty-seven school districts throughout California, and set up achievement norms for boys and girls from the fifth through the ninth grade. Thirty-three events were given to the boys and twenty events to the girls. The writers devised a classification chart based on height, weight, and age of the participants, and assigned exponents from 1 to 17 for each of these factors. The sum of the exponents was obtained and transformed into class letters ranging from A to H. Means and standard deviations were computed and distributions were smoothed for each class in each event. Scoring was made uniform by giving a score of 100 to a performance three standard deviations above the mean, 50 to performances at the

mean, and 0 to performances three standard deviations below the mean. Each scale has been constructed so that any given score on one scale has the same relative performance value on the other scales.

In 1927 Brace (5) developed a test which was designed to measure inherent rather than acquired motor ability between the ages of eight and eighteen. His test was composed of twenty stunts which were scored in terms of success or failure. The least homogeneous group on which the tests were tried was that of college women, who on the average were slightly handicapped by weight. The motor ability scores were found to have little correlation with age. The correlation coefficient between age and the motor ability scores was .18 for the children and .22 for the college women.

In 1932 Johnson (40) set up a battery of tests which was given to 1500 pupils of both sexes and ages ranging from 11 to 38 years. His battery is composed of ten exercises involving various methods of locomotion, and performed down the length of a four-and-one-half by fifteen foot gymnasium mat. The tests were designed to measure the "neuromuscular status" of individuals, for the purpose of sectioning physical education classes into homogeneous groups. A score of 10 was given for the perfect execution of each exercise. The individual's final score was based on a maximum of 10 points.

Physical ability tests which included items of running,

jumping, climbing and other gross motor activities were devised by Richards (56), Reilly (55), and Rowe (57) for the purpose of grouping boys and girls according to ability within each grade in school.

Kindervater (43) investigated the motor abilities of fifth, sixth, seventh, and eighth grade boys in the St. Louis Elementary Schools. The test items used were: 40-yard dash, standing broad jump, basketball throw for distance, and push-up. An attempt was made to classify each student according to his ability regardless of age, weight, or height. Three groups were set up: Midget, Junior, and Senior. Of the 9,546 white boys tested, 6,182 passed, 3,364 failed giving a percentage for the group of 64.7 passing. Of the 1,770 colored boys tested, 985 passed and 785 failed for a group percentage of 55.6. His results showed a higher percentage of white than colored boys passed the minimum requirements.

In developing achievement scales for girls and boys in the primary grades, Taylor (61) selected eight physical skills included in the physical-education program of the Jackson (Mississippi) Public Schools. She administered these physical skills to 1,560 pupils who were classified according to age and sex. The following events were used: 30-yard dash, kicking and throwing a six-inch ball for distance, jumping rope, bouncing a six-inch ball, standing broad jump, tossing a bean-bag for accuracy, and throwing

a six-inch ball for accuracy. Achievement scales were constructed according to the range of the values of the standard deviations on each side of the mean. Standard scores ranging from one to one-hundred were used in constructing the achievement scales. A standard score of one-hundred was placed at three standard deviations above the mean; a standard score of fifty was placed at the mean; and a standard score of one at three standard deviations below the mean. The increment for each unit of the standard scores was found by dividing three times the standard deviation by fifty. The increment for each unit was then added to the mean until a standard of one-hundred was attained. Likewise, the increment for each unit was subtracted from the mean until a standard score of one was reached.

In 1946 Sinclair (60:38) conducted an investigation on the physical skills to be developed in the first seven grades, and with an indication of the relative emphasis to be placed on each. The level of introduction of the skills selected was established by consideration of "(1) the needs of the individual in reference to development and his ability to participate in specific activities, (2) the individual in terms of strength, size, coordination, mental and emotional development, and (3) the interests of the individual." The physical skills recommended for the various grade levels are listed as follows:

First grade: catching large balls, climbing, crawling, dodging, jumping, galloping, pulling, pushing, running, skipping, sliding, starting, stooping, stopping, and throwing.

Second grade: bounce pass, bouncing (to self), double forward roll, hopping, jumping rope, kicking balls, etc.

Third grade: backward roll, batting with hands, blocking (soccer), catching (small balls), fielding, pitching, step-hop, and throwing small balls.

Fourth grade: batting (with bat), cartwheel, handstand, headstand, kicking, polka, punting, serving (volley ball), forward and backward rolls, tagging (baseball), and tripping (soccer).

Fifth grade: crouch start, soccer and basketball dribble, dropkick, tap and clog, pivot, schottische, volleyball setup, softball slide and soccer tackling.

Sixth grade: blocking (football), broad jump, carrying ball (football), driving, guarding, high jump, interference (football), marking (soccer and other games), recovery from net (volleyball), throw-in (soccer), and two step.

Seventh grade: heading (soccer), recovering (basketball), shooting (basketball), waltz, and free shot (basketball).

No attempt was made to test the performance of any of the skills mentioned.

Acquisition of Physical Skills during Infancy. - The development of motor activities is closely related to changes in the size of the various parts of the body, and to changes occurring in gross bodily size. During the period of physical growth, there are continual changes in bodily proportions. At birth a child's movements lack coordination. After a period of time a baby develops some degree of control and is able to give direction to various movements.

At first an infant's reaching consists of crude shoulder and elbow movements. His aim is poor and his approach is rather clumsy. In time, however, he is able to make selective movements with his wrist, rotate his hands, and aim more

accurately. The act becomes coordinated at approximately forty weeks into a single performance. The early development of behavior in the arms and hands is of primary importance to the infant. These are motor reactions which are fundamental in the course of development of every individual. Recent researches have shown that maturational factors are of primary importance in the development of motor coordinations during the first few years of life.

Gesell (18) pointed out that development is always dynamic and never discontinuous. Therefore, it is impossible to separate one period of development from another. Gesell's normative items gave tests for older ages for skills which were dependent upon the use of the hands. The ability to relinquish hold of an object voluntarily, for example, is a complicated adjustment for some twelve-month old children.

Concerning the acquisition of skill, Halverson (27) said that:

> Rapid increase in the development of motor skill by the hand is absolutely essential to normal growth as it is only by such development that the infant can acquire adequate knowledge of his environment. Backwardness in development of skill in the use of this prehensile organ must necessarily result in retardation of mental development.

Dewey (12) said, however, there was no simple and easily applied criterion for judging where the essential increase in skill leaves off and individual differences began, as is the case in walking. Since the hands were used for many activities it was difficult to select events which were better

illustrations of normal growth than others.

In 1935 Bayley (3) made a longitudinal study of sixty-one infants from two months to fifty months in ages. She included items of hopping, jumping, and climbing. Bayley found that the developmental sequence did not depend on a regular order of appearance of specific abilities, but rather, on rapid increments in the entire level of ability.

Gesell and Thompson (20) and McGraw (44) studied the effects of motor training and practice on alternate members of twin pairs under eighteen months of age. Gesell gave one twin opportunity for daily training in prehension and in stair climbing. He concluded that stair climbing was not dependent on practice, since the initial advantage of the trained twin was not permanent. Gesell (19) further stated that, "Training somewhat hastens and perfects the manifestations of skill, but it is well to recognize that all forms of skill can rest only on a solid basis of behavior capacities which are determined by natural growth processes."

Similarly, McGraw (44:260) said that, "Unless the period of deprivation has been extended unduly, the restorative powers of the young child are enormous; hence the performances of a child whose activities have been restricted can at a later date under the proper conditions be brought to approximate the activities of the child whose opportunities for action have been stimulated."

Acquisition of Physical Skills by Pre-School and Elementary School Children. - Motor activities are of special interest to students of child development, because of their relationship to other aspects of mental and physical growth. Very early in life the child is confronted with many tasks which involve the use of physical skills. From the buttoning of his clothing to the more complex manipulations in our culture, the child encounters a variety of physical requirements. Some children are able to meet these requirements adequately, while others are faced with motor inadequacies. The ways in which a child uses his physical and mental equipment may be of great importance in determining his abilities in all aspects of motor behavior.

The physical abilities of children may be differentiated in terms of gross and fine motor performances. The former emphasized overt bodily movements as a whole, whereas the latter involved smaller movements of the hands or feet with emphasis on speed. According to Jones and Seashore (38:123) "The fine motor skills are revealed through deftness and accuracy in limited movements." They pointed out that the human hand is a highly adaptive and specialized vehicle of motor adjustment. It is not the intent of this study to review the literature on fine motor performances, but merely to differentiate between fine and gross motor activities in passing. With a few exceptions, however, emphasis is placed chiefly on studies relating to gross motor performances.

Hicks (31) reported a study of the effects of systematic well-motivated practice upon the ability of young children to hit a moving target with a ball. Sixty children between the ages of two-and-a-half to six-and-a-half years made up the practice and control group, with the practice period lasting eight weeks. The results of the experiment indicated that both groups made gains from initial to final tests; gains for the practice group were larger but not statistically significant. The boys made larger average scores than the girls in different age groups. The younger children made lower average scores on the test. The results further indicated that improvement in skill may result from factors other than specific practice, such as, structural maturation and general practice.

Goodenough and Smart (24) tested the motor abilities of all children, ages two-and-a-half to five-and-a-half, in attendance at the Nursery School and Experimental Kindergarten of the University of Minnesota at annual intervals. The writers raised the question of "whether or not motor abilities involving different muscle groups and differing in apparent complexity showed any tendency to vary concomitantly in the same individual when other factors, such as, age, sex, physical size and strength, intelligence and similar traits were held constant." Their tests consisted of the time required for walking a 25-foot line, finger tapping, time required to thread a series of five needles, simple-reaction

time, etc. As the investigators anticipated, there was general improvement in the scores earned on all tests with advancing age. Improvement was represented either by a decrease in length or time required to perform a test, or by an increase in the amount accomplished during a set time.

According to Jersild (34:48) "Growth, within a normal environment, is relatively more influential than opportunities for special training or exercise in determining the emergence and rate of development of certain modes of behavior....On the other hand, learning plays an important role in the acquisition of performances and skills of a more individual and optional character (such as roller skating versus walking). Growth is important in determining the development of new capacities and powers and in setting limits to what can be mastered or learned, while learning determines the extent and ways in which capacities and abilities will be put to use."

Gutteridge (26) observed the records of 1973 children between the ages of two and seven years. She noted a difference in the age of entry of each type of activity (climbing, jumping, ball throwing, bouncing a ball, ball catching) in the motor repertoire of these children. Each activity had a period of rapid increase in achievement followed by a slowing down when mastery of the basic movements had been established. Even though she found considerable variation in motor ability from child to child, there was evidence of consistency of pattern in individual motor behavior.

In another study involving the effects of training, Goodenough and Brian (23) used a ring toss game with twenty four-year-old children. Three groups of children were given twenty trials per day for fifty days. Ten children performed without any instruction in the manner of throwing, six had their errors pointed out to them, and the remaining four were required to use one method of tossing rings. Some of the results obtained by the investigators showed practically no relationship between initial status and gain; learning curves showed large individual differences with relatively small increments of improvement; and, the group that was directly trained gained the most.

Even though the development of motor ability is dependent on maturation, one cannot discount the influence of practice in the acquisition of skill. Bayley and Espenschade (4) suggested that differences in performance may not only be due to differences in opportunity for practice, but also to freedom from inhibitions and to the child's attitude toward the activity. According to the writers the most important factors in tests of motor abilities were found to be strength, speed, and coordination of movements.

At the Laboratory School of Indiana State Teachers College, Perkins (53) tested pupils in the first three grades on the basic skills of jumping, throwing, catching, and agility. Standards were kept uniform throughout each class to insure accuracy in measurement. Points (six was the highest

possible score) were assigned to each test according to the degree of skill demonstrated by each child. The writer found the following factors as accounting for variations in skill; previous experience, body build, muscle coordination, and balance. No statistical techniques were mentioned in this study.

Jenkins (33) conducted a study of the gross motor achievements of 300 girls and boys between the ages of five and seven years. She used the following events: thirty-five yard dash, fifty-foot hop, baseball throw for distance, soccer kick for distance, standing broad jump, running broad jump, jump and reach, bean bag toss for accuracy, and baseball throw for accuracy. For purposes of the present study, only the mean performances, according to age-sex groups, of the following events have been adapted from Jenkins' study.

Event	5-years		6-years		7-years	
	Girls	Boys	Girls	Boys	Girls	Boys
Thirty-five yard dash	9.7s	9.3s	8.8s	8.5s	8.0s	7.9s
Ball throw for distance	14.5'	23.6'	17.8'	32.8'	24.4'	41.4'
Soccer kick for distance	8.0'	11.5'	10.1'	18.4'	15.0'	25.4'
Standing broad jump	31.6"	33.7"	38.0"	39.3"	41.0"	42.2"
Jump and reach	2.2"	2.5"	3.5"	4.0"	4.3"	5.0"

Jenkins' conclusions indicated certain sex differences. The boys showed no significant differences over the girls in the bean bag toss for accuracy, baseball throw for accuracy and the jump and reach. Otherwise the boys showed superior performance in throwing, jumping, and running.

Carpenter (6,7) tested 128 boys and 125 girls of the first three grades in fourteen events involving large muscle groups

and speed. On the basis of the results obtained she devised two batteries of skills one for each sex. The two batteries chosen were: run and under, run and over, hop, and dash for the boys; run and under, run and over, hop, and broad jump for the girls; in addition to right and left grips for both entries. Carpenter obtained reliability coefficients on all the events measured, however, only those which were applicable to the present study are listed as follows:

Right grip	.8247
Left grip	.8193
Standing broad jump	.8941
Thirty yard dash	.9082
Baseball (12") throw for distance.	.9969
Baseball (12") accuracy throw	.6411

In a recent unpublished dissertation, Warner (62) collected data on the motor abilities of 941 boys enrolled in physical education classes in the Detroit Elementary Schools and in the Lincoln Consolidated School at Ypsilanti. A statistical study was made of the average gains of motor development for each year of growth. Norms for the test items for each grade (third, fourth, fifth) were established, and the relationships between motor ability and age, height, and weight were determined. The writer used a battery of 24 gross motor test items. Only those test items which were similar to the events investigated in the present study were considered. The mean performances and standard deviations of the following test items have been adapted from Warner's study.

Event	Mean Performances			Standard Deviations		
	Third	Fourth	Fifth	Third	Fourth	Fifth
Soccer kick for distance	26'7"	34'	42'10"	14.85	14.40	15.45
Thirty yard dash	6.5s	5.8s	6.3s	.86	.57	.77
Ball throw for distance (12")	59'1"	75'	89'	15.40	19.74	20.18
Standing broad jump	45.5"	48"	51"	8.42	8.92	8.68

On examining the above data, one observes an increase in the mean performances at each grade level, with the exception of the thirty yard dash. Warner called the reader's attention to the discrepancy in the mean performances on the thirty yard dash, however, he offered no explanation for the superior average performance of the fourth over the fifth grade. Otherwise there is an increase in motor performance at each succeeding grade level.

Seils (59) obtained measures of physical growth and gross motor performances on 510 primary-grade children in four Massachusetts communities. The physical growth measures included age, height, weight and carpal attributes. The gross motor performances consisted of the following events: Forty yard dash, stick test lengthwise, side-stepping, standing broad jump, throwing for distance, pendulum-controlled striking, and hoop-controlled catching. Seils found the mean performance in the forty yard dash increased at each successive grade level for both boys and girls. The mean performance for the boys on the standing broad jump increased at each grade level. However, the girls remained almost the

same in the first and second grade, but increased in the third.

The reliability coefficients, on measures of motor performance by boys and girls in the first, second and third grade, are reported as follows from four investigations.

Event	Carpenter (8)		Hartman (28)	Jenkins (33)	Seils (59)
	Boys	Girls	Boys/Girls	Boys/Girls	Boys/Girls
Dash	.6715	.7049	.88±.02	.74±.049	.904
Broad Jump	.7984	.8027	.86±.02	.82±.036	.906
Ball Throw	.9631	.8696	.83±.06	.90±.020	.982

Distances in the dash varied with each investigator; Hartman and Jenkins used 35-yards; Carpenter, 30-yards; and Seils, 40-yards. In measuring throwing, Carpenter used a 24" rubber ball; Hartman, a 12" softball; Jenkins, a 6" baseball; while Seils used a tennis ball.

Warner (62) tested 111 boys (42-3rd, 35-4th, 34-5th) on fourteen motor ability test items, which included the following skills, and retested them a week later to obtain the reliability coefficients. The following reliability coefficients were obtained:

Event	3rd Grade	4th Grade	5th Grade
Standing Broad Jump	.97	.99	.91
Soccer Kick for Distance	.95	.98	.97
Thirty Yard Dash	.95	.59	.56
Distance Throw (12" ball)	.93	.99	.99
Accuracy Throw (12" ball)	.64	.51	.41

Yarmolenko (65) devised a general motor test which included: speed and exactness of walking, grasping and relaying objects, lying down and getting up, ball throwing, standing jump, strength and motor endurance. These tests were administered to fourteen groups (thirty in a group of each sex) of children

between the ages of eight and fifteen years. Each child was scored according to his deviations from the norms for his age and sex. On the basis of his results, Yarmolenko observed the following three stages in the motor growth curve (65:308): (a) a negative acceleration in the ninth and tenth years; (b) a positive acceleration at ages ten to twelve for girls and ten to thirteen for boys; and (c) with the approach of puberty a second period of retarded development more evident for girls than for boys. Yarmolenko summarized the relations between the age curves of the sexes, by stating that the boys' coefficients of speed of walking, speed of lying down, all three coefficients of strength, exactness of ball throwing, and dynamic endurance surpassed those of the girls. The opposite relationship, however, was found with the measures for speed of grasping and exactness of walking.

In determining the effect of maturation on motor performance, Keeler (41) tested 874 boys in the Denver Public Schools, grades five through twelve, and freshmen at the University of Denver with the Johnson Physical Skill Test. He found that physical skill, as measured, improves with chronological maturity from age 9 to 16 years with the exception of the fourteenth year. From age 16 through 20 the score was nearly constant, after which time the score decreases at about the same rate as increase took place before age sixteen.

In 1932 Cowan and Pratt (9) tested 540 children, ages

three to twelve, with the hurdle jump as a test of motor coordination. According to the writers the test was indicative of an increase in skill with age, and was valuable as a measure of retardation in motor coordination. Norms for both sexes at different age levels have been developed by the writers.

Hartman (28) used the hurdle jump, 35-yard dash, baseball throw, standing broad jump and jump and reach as measures of motor proficiency for 56 children between the ages of 49 and 78 months. He found the hurdle jump and the 35-yard dash to be the most reliable (.88 $\mathcal{L}$ .02) of the measures used. No significant sex differences were found for a younger group between the ages of 49 and 66 months. With an older age group, 67 to 78 months, sex differences were reported. The boys were superior in baseball throwing and hurdle jumping. The conclusion was that the hurdle jump was inadequate as a measure of the motor proficiency of the kindergarten child.

Relationship of Age, Height, and Weight to Performances in Certain Physical Skills. - According to some writers, performances in physical skills were related to age, height, and weight during the elementary and junior-high-school periods. They further stated that older, taller, and heavier children were stronger and more proficient in performing activities than children not having these characteristics. This relationship was less significant, however, with adolescent girls than with boys.

Hollingworth and Taylor (32) and Monahan and Hollingworth (47) presented comparative data on the height, weight, weight-height coefficients and grip strength of children between the ages of nine and eleven years. Forty-five children testing above 135 I.Q. (Stanford-Binet) were selected from the public schools of New York City. These children were compared with Baldwin's normative data for size, and Smedley for strength of grip, as well as with a comparable number of normal and feeble-minded children. The results of this study showed that the gifted child was not only larger, but also stronger than any other group.

In their study reported earlier on the hurdle jump as a diagnostic test of motor coordination, Cowan and Pratt (9) found that the relation of height to weight was not a significant factor in determining the height of the jump. They also stated that even though height of stature might influence the height of the jump, it was still negligible compared to age. Using the Pearson product-moment formula, the writers obtained the following correlations.

Between jump and height.....	.67
Between jump and weight.....	.61
Between jump and age	.77

For both boys and girls, Seils (59) found that the mean performances in the standing broad jump, ball throw and the forty-yard dash increased at each successive grade level. Correlations, however, showed little or no relationship between height or weight and scores obtained on the forty-yard dash for both sexes in the three grades. In the standing

broad jump there were constant and low relationships between weight or height and jumping performances. A very low relationship was found between performance on throwing a tennis ball and age, as well as for height and weight for both sexes.

Similarly, Warner (62) found very low relationships between age, weight, and height, and measures of motor ability. The following coefficients of correlation were obtained on 157 subjects, and adapted from Warner's study.

Event	Weight	Height	Age
Soccer Kick for Distance	.42	.52	.54
Thirty-Yard Dash	.10	-.01	-.16
Standing Broad Jump	.18	-.47	-.01
Baseball (12") Throw	.54	.44	.52

Every seventh out of 941 cases was selected in computing the above coefficients of correlation for the three grade levels.

The Relationship of Strength to Other Growth Attributes and Motor Ability. - In this country the scientific use of grip strength testing was introduced by Sargent. He used grip strength as one of the items in a battery of tests designed to measure the strength of Yale University students. To date, the test has been studied: (1) as a measure of strength; (2) as a measure of physiological growth; (3) as a factor of motor ability; (4) as related to hand dominance; and, (5) as an indicator of physical fitness (45). The validity of strength tests as measures for active physical

performance has been demonstrated in many studies. Zimmerli (66:244) has stated that, "Capacity for any physical activity must be proportional to strength, and that the two were inseparable."

Various measures of strength have been employed in assessing motor fitness and physical ability of individuals. By means of various forms of spring dynamometers in tests of squeezing, pulling, pushing, and lifting, Jones (35) analyzed the development of muscular strength during adolescence over a seven year period. He found that individual differences in the rate of physiological maturing during adolescence were associated with marked differences in growth patterns of static dynamometric strength. Early-maturing boys and girls were on the average superior to the late-maturing in tests of static dynamometric strength. However, in the case of the late-maturing, growth tended to be more uniform over a longer period of time. In another study, Jones (36) further observed that individuals low in strength were frequently found to have an assortment of handicaps, such as, poor health, late-maturing, asthenic physique, lack of status and feelings of inferiority. Strength had been found to depend more on physiological than chronological maturity.

Using a battery of tests designed to measure motor educability and reported earlier, Carpenter (7) found correlations between motor ability and strength of grip to be .38

for the boys and .24 for the girls.

Johnson (39) reported correlations between grip strength and mental age for 98 private school children of both sexes from three to thirteen years of age as follows:

Grip and Mental Age	.71
Grip, Mental Age, (C.A.)	.13
Grip, Mental Age, (Wt.-Ht. Index)	.45
Grip, Mental Age, (Wt.-Ht. Index, C.A.)..	.03

The partial correlations presented above seem to indicate that any apparent relationship between grip strength and mental age was mainly a function of physical size or chronological age.

In 1921 Baldwin (2) computed correlations of grip strength with height, weight, and breathing capacity for groups of about sixty children of each sex between the ages of seven and seventeen years. His subjects were drawn from the Horace Mann School of New York City. For ages 7,8,9, and 10 years, the values obtained were adapted from Baldwin's study and were arranged as follows.

Strength of Right Grip with:

	Boys	Girls
Height	.488 to .641	.423 to .801
Weight	.641 to .796	.429 to .540
Breathing Capacity ...	.523 to .623	.377 to .694
Left Grip	.709 to .866	.805 to .866

It was evident from the above data that correlations of grip with weight were observed to be higher for boys, and showed less fluctuation than those with height. For the girls, however, greater fluctuations and higher correlations were found with height than weight.

Wilson and Flemming (64) studied the interrelationships of mental and physical traits of 25 first grade school children from a selected superior socio-economic status. The writers failed to find any correlations which were significantly different from zero between mental age and height, weight, motor coordination, steadiness, and grip strength.

Metheny (45) administered grip strength tests to 202 pre-school children between two years and six months and six years and five months of age. A grip quotient, which was the actual grip strength multiplied by 100 and divided by the expected grip strength, was determined for each child. Metheny found no relationship between grip quotients and intelligence (Stanford- Binet). Using multiple correlations, on various combinations of anthropometric measurements, height was found to have the highest relationship to grip at this age level.

During the year 1922-1923, Gates (17) undertook an intensive appraisement of two groups, one consisting of 58 pupils of the junior primary division, and another of 57 pupils of Grade Four from the Horace Mann School. Interrelationships between mental and physical abilities were made. Physical traits, such as, height, weight, grip, ossified area, and ossified ratio were found to correlate very low with mental age (Stanford-Binet). The writer concludes (17: 342): "No one physical trait appears to be sensibly better

than another as a symptom of mental age or of any type of maturity here measured since all of the correlations were so low."

Relationship between Performances in Physical Skills and Mental Ability. - During the 1920's a wave of enthusiasm existed in regard to the relation between mental ability and performances in physical skills. Several investigations were undertaken to determine this relationship. The final results from these investigations indicated opinions varying from slight negative to slight positive relationships.

As early as 1901 Bagley (1) made use of target throwing as a test of motor ability. He studied the abilities of 110 fifth grade pupils to toss ten marbles, from a distance of two meters for three consecutive trials, at a target placed at a 45-degree angle on a table. Taking the average percent of error of the trials as an index of constancy of movement, Bagley found an increase of motor ability with age, and a slight superiority of boys' ability and intelligence as determined by teachers' estimates.

At the University of Minnesota Institute of Child Welfare, Goodenough and Brian (23) tested twenty four-year-old nursery school children with a ring-toss game. The writers found a slight negative correlation (-.349) between their total performance score and intelligence.

Milne and others (46) obtained the I.Q.'s of 202 girls,

between the ages of eleven and seventeen years, from a South African Group Intelligence Test, and also their performance scores on the 100-yard dash, shot put, and 600-yard run. After a statistical analysis of their data they concluded that basic intelligence and physical efficiency were entirely unrelated.

In an investigation of 95 superior children, between eight and twelve years of age and I.Q.'s over 115, and a similar group of children with "normal" intelligence, Kiefer (42) found exceedingly low positive and negative relationships between motor tests and intelligence for both groups. The motor tests consisted of the following events: tensiometer, tapping, steadiness, tracing, and strength of grip.

On the basis of the total body of available evidence, Jones (37) and Wellman (63) conclude that the relationship between intelligence and gross motor functions was close to zero in any fairly homogeneous school population.

In a study of 2430 Philadelphia school children, Fischer (14) correlated tests of the big muscle variety with scholastic grades and promotion. These tests involved performances in running, jumping, and throwing. Fischer drew the following conclusions:

1. There was a direct relation between the physical tests and promotion or scholastic results.

2. In general the high classes physically were also high mentally or scholastically and vice versa.

3. Sixty-four percent of the children who were not promoted were unable to pass two of the physical events with even an average performance aim.

It should be stated in passing that the writer correlated scholastic grades and promotion with certain physical skills rather than intelligence. No coefficients of correlation were given.

On the other hand, Heaton (29) correlated group intelligence tests with the 75-yard dash, push-up, running broad jump, and baseball throw. He studied 102 boys and 92 girls of eleven, twelve, and thirteen years of age, and compared the physical ability and development of children of low intelligence with children of high intelligence. The results of his experiment showed that "The average general level of physical development of children who rated high on intelligence tests was distinctly superior to that of children who rated low on intelligence....In general, there was more variation in the group of low mental ability than there was in the superior group (29:129)." Heaton further stated that poor performance on the physical skills measured may be attributed to actual physical underdevelopment, which may have been due to both innate and environmental causes.

In line with the experimental data already presented, Hertzberg (30) found that motor development alone did not correlate with mental age to any practical significant degree when the subjects were kindergarten children. Forty-six kindergarten children, in the Training School at Colorado State Teachers College, were given an intelligence test (Stanford

Revision) and seventeen tests of motor ability. Even though the coefficients of correlation obtained in this investigation were low they were positive. The writer concluded that motor dexterity could not be taken as an adequate guide to mental development of the kindergarten child.

However, Cunningham (10) found correlations ranging from .39±.09 to .65±08 between gross motor development and mental age in 89 young children between 12 and 42 months of age. Even though her results were based on too few cases to be very conclusive, Cunningham felt that the obtained coefficients suggested a degree of relationship between the Kuhlmann Revision of the Binet Scale and the motor tests at all levels.

Studies by Goll (21,22) of unselected Philadelphia school children of the fifth, sixth, seventh, and eighth grades, showed a small positive correlation (.115) between mental and physical ability. Goll used the National Intelligence Test, Scale B, Form 1 for determining mental ability, and motor skills involving running, jumping, climbing and throwing. Goll concluded that, "A pupil who was underheight would probably be below normal both mentally and in physical ability, while a pupil who was underweight would practically approach normal mentality but would fall below normal in physical ability." It was felt that the evidence to date has been entirely inconclusive to support the above statement.

There is definite need for research to substantiate or refute Goll's conclusion.

In her investigation of the genetic development of motor skills of 83 boys and girls between thirty-four and eighty-three months of age, Deach (11) found that ability in a motor skill was apparently more dependent upon physiological maturity than upon mental ability. She asked her subjects to throw, strike and kick balls of varying sizes at a special target from a set distance for each age level. Even though her subjects had an average I.Q. of 125 and apparently understood how a physical skill was to be performed, they were frequently unable to translate a demonstrated action into a motor performance.

In a study on the acquisition of motor skill, Hicks (31) found the correlation between the initial test on a moving target and mental age to be $.56 \pm .09$. Hicks concluded that skill in throwing at a moving target apparently had little relation to intelligence.

During physical education class periods at Madison, Wisconsin, Ragsdale and Breckenfeld (54) examined 155 junior-high-school boys on the following traits: (1) football, baseball, basketball, track and field athletics, and (2) C.A., height, weight, and general intelligence. The main findings are summarized as follows (54:49):

1. The correlation between age and intelligence was negative.

2. Intelligence had a negative correlation with all the motor skills except those involving speed of running, dribble, baserunning and the 50-yard dash. The correlations were small.

3. Like C.A. and height, weight was a variable that was negatively related to speed in running, positively related to strength, and has a low positive relationship to accuracy.

Even though the above studies suggested a low correlation between motor ability and intelligence, the latter's influence should not be discounted entirely in the initial performance of many physical skills. A high degree of intelligence helps one to comprehend more quickly the directions necessary for efficient accomplishment of an act. However, other factors such as physiological maturity, emotional tone, and motivation must be given serious consideration in determining the capacity of an individual to carry on any physical activity.

Summary

Various studies have revealed the establishment of batteries of tests designed to measure achievement and developmental aspects in motor development of elementary school children within prescribed age levels. Some of these tests were set up on a "pass" or "fail" basis, and others were adapted to either the primary or intermediate level. None of these motor tests were adapted to and made uniform for all children from the first through the sixth grade in any testing situation. Some emphasis has been placed on

establishing relationships between various physical skills and growth measures, but not on the child as a whole.

CHAPTER III

DESIGN OF THE STUDY

Description of the Subjects. - Out of a total enrollment of 137 children between the ages of six and eleven, only 101 were selected for this study. Those children who had complete growth data, such as, height, weight, grip, dental, carpal, reading and mental ages were used in this study. The remaining 26 percent of the children, who were a part of this University Elementary School population, were excluded because their enrollment in school was likely to be temporary, their initial entry was too late to provide adequate records for the growth studies, and some were unable to participate because of illness and other physical handicaps. Therefore, only those children whose growth records were complete, and who were physically fit and between the ages of 66 and 137 months inclusive were used in this investigation.

These children were in attendance at the University Elementary School, University of Michigan during the school year 1951-1952. This investigation was undertaken during October, November and December of 1951.

This sample, while obviously not a random sample of the University Elementary School population, may be considered as a sample selected according to the principles indicated above. Tests in later chapters dealing with significant

differences apply to the population of which this is a random sample.

The average I.Q. was approximately 125 for the group of subjects used in this study. These children come from families of moderate to above-average socio-economic status. No attempt had been made to determine the play facilities, previous experiences and training these children may have had in the physical skills selected for this study. At the University Elementary School the children participate in various physical activities under the direction of the classroom teacher.

Method of Obtaining Growth Data. - Measures of height, weight and grip were obtained in October and April for grades one to six inclusive (58). The boys and girls were weighed separately in individual rooms of the Health Unit by the school's pediatrician and nurse. Measurements of weight and height were taken while the children were undressed. Carpal and dental x-rays were taken at the School of Dentistry, University of Michigan, and plaster casts of the children's mouths and teeth were obtained by the school's dentist. These x-rays and casts were taken on or near the children's birthday schedules. A psychometrician administered the Stanford-Binet Intelligence Test to all children on their birthday schedule. The Stanford Achievement Test, Intermediate Battery, was also administered at the beginning and close of a six-month period (October and April) in grades four through six.

"As a minimum, the achievement shall include a reading test in grades one through three at each period." The Metropolitan Reading Readiness Test was given to the first grade in October. This test was designed to measure the child's total readiness. The Gates Reading Test was administered to the first grade in January and April of 1952. In the first three grades, any child who tested above 102 months on the Gates Reading Test was given, thereafter, the Stanford Achievement Test, Primary Battery.

Scheduling basic examinations on or around the child's birthday or six months following for children born in summer, is practical from the administrative and research point of view. It enables the research worker to obtain data on various growth processes at a convenient period in the child's life, without interfering too much with classroom procedures and optimum conditions for testing.

The records are filed in the Child Development Laboratories of the University Elementary School for further analyses.

The most recent growth ages of the children were collected by the writer from the files of the school. The investigator assessed about ninety x-rays of the hand and wrist by matching them with samples of the Flory's standards (16). By means of an arithmetical computation the last recorded growth data were extrapolated to estimated growth ages to correspond to the children's chronological ages at the time of administering the physical skills. This extrapolation

was necessary in order to correlate measures of growth and performances in physical skills at a given point in time. The assumption was made that increments of growth measured in age units followed a fairly uniform rate in a brief period of time provided there had been no deprivation, and that individual differences were not upset in short periods. The predictive studies, growth graphs in the atlases available and previous dissertations confirmed this assumption.

Criteria Used in the Selection of the Physical Skills. - The physical skills used in this study were selected as being representative of activities which appear in the play experiences of elementary school children. Some of these activities appear individually or as segments of a more complex pattern in the play situation.

Since each child has his own design for growing, his participation in any event is determined largely by his total structure. Therefore the following criteria were taken into consideration:

1. The tests should be simple to administer so that each child can easily understand the directions.

2. Each test should be set up on the child's own individual accomplishment rather than on a "pass" or "fail" basis.

3. Each test should be adapted to and be uniform for all the children who are tested.

4. The tests should be economical to administer and not involve elaborate and complicated equipment.

5. The tests must be objectively measured by appropriate units expressed in figures so that no personal judgment is involved.

6. The tests must have reliability and objectivity so that they can be administered to the same children by a different examiner and still result in approximately the same scores.

7. The tests must have validity.

8. The tests should yield statistical scores for scientific treatment.

Description of the Testing Site and the Administration of the Events. - The writer was granted permission to use the Yost Field House at the University of Michigan, for the purpose of conducting investigations on the motor performances of elementary school children. The Field House was selected in order to keep testing conditions as uniform as possible, and also to avoid inclement weather. The children were tested during the months of October and November of 1951. The sixth-grade children were tested first, the fifth next, and so on down to the first grade. It was necessary to follow this scheduling procedure in order to take advantage of a larger playing area for the older children, before the University became too involved in its athletic program at the Field House. As time progressed the testing area for both the soccer kick and ball throw was reduced to fit the performance levels of the younger children. Otherwise the same testing area was used by all of the children participating in this study.

A cinder track for the 25-yard dash and a jumping pit consisting of a mixture of sand and sawdust for the standing broad jump were utilized. The target for the accuracy

throw and a black cardboard (10"x30") for the jump and reach were attached to an inside wall by adhesive tape. Both the baseball throw and the soccer kick for distance were conducted in the same area, and the dirt floor was utilized for this purpose. The area for the soccer kick and baseball throw for distance were marked off by scribing arcs (30 feet in length) from the middle of a throwing line (four feet) to designated distances. The nearest line was established twenty feet away from the center of the throwing line. Other lines were established for distances of 30, 40, 50 feet, and thereafter, every five feet to the eighty-foot line. A circle (six feet in diameter was established tangent to the soccer kick line to allow a child to take a few steps before releasing the soft-ball in the throw for distance. Dry lime was used in making the lines which were two inches in width and about thirty-feet in length. Distances for both the soccer kick and soft-ball throw were then measured from the initial point of contact with the ground to the middle of the width of the nearest line.

The temperature in the Field House was comfortable thus making it possible for the children to participate in their ordinary clothes without being burdened by heavy coats and boots.

The children appeared to be highly motivated by the thought of going to the Field House to participate in certain physical skills. This enthusiasm for participation was

expressed in their classrooms, as well as in their desire to be among the first to be selected. Upon completion of the physical skills many of the children wanted to know if they could participate again.

The physical skills were administered in a definite sequence with no deviations from the established order. The trials for the 25-yard dash were not administered consecutively, but were arranged between other events in order to reduce the element of fatigue to a minimum. The physical skills were administered in the following order:

1. Twenty-Five Yard Dash - First Trial
2. Soccer Kick for Distance - Three Trials
3. Twenty-Five Yard Dash - Second Trial
4. Softball Throw for Distance:
   Overhand - Three Trials
   Underhand - Three Trials
5. Twenty-Five Yard Dash - Third Trial
6. Standing Broad Jump - Three Trials
7. Jump and Reach - Three Trials
8. Softball Throw for Accuracy:
   Overhand - Three Trials
   Underhand - Three Trials

The Field House is situated about eight blocks from the University Elementary School. This distance made it necessary for the writer to transport the children to and from the Field House. Two children were tested alternately on each skill. While one was being tested the other occupied himself by playing with an extra ball in another area.

By using this testing procedure forty minutes were required for two children to complete the physical skills measured. Otherwise it would have taken one child approximately twenty-five minutes to complete all the events if he were tested alone.

When it was possible to have two assistants, four children were transported to and from the Field House in order to conserve time and reduce the number of trips involved. Those children who didn't participate immediately in the physical activities were kept occupied by one of the assistants away from the testing area. For the most part, the same assistant, a graduate student in physical education, was available for the testing situations. The directions and demonstrations were always given by the writer who also served as examiner and recorder, while the assistant acted as the time-keeper for the dash and measured the distances for the soccer kick, ball throw, jump and reach, and standing broad jump.

The examiner recorded the scores for the soft-ball throw for accuracy while the assistant returned the ball to the testee. Each child was encouraged by the following remarks: "Do the best you can!" Again after each trial, "That's fine, now let's see if you can do better!"

The physical skills and the testing procedures used were adapted from Neilson and Cozen (48). In many instances, however, changes have been made in the testing procedures in

order to fit the testing situations used in this study. The details for each test are described in the following paragraphs.

Jump and Reach. - The child stands facing the wall, feet together, toes touching wall, and toes and heels touching the floor. He is then given a piece of chalk (one-inch in length) and instructed to make a mark on an adjustable piece of black cardboard (10"x30") which is attached to an inside wall by adhesive tape. This method is used for two purposes: (1) a chalk mark is more legible on the cardboard than on a rough brick surfaced wall, and (2) the cardboard prevents the child from skinning his fingers while making the mark. The child makes a mark on the cardboard as high as he can without standing on tiptoes. The child then stands with side to the wall, and while swinging both arms vigorously a jump is made. At the highest point of the jump a second mark is made on the black cardboard with a piece of chalk held in one hand. The distance between the two marks is the child's record. This event is designed to test the explosive power of the leg extensors.

Testing Procedure:

a. Select a suitable inside wall and attach a piece of black cardboard (10"x30") with adhesive tape.
b. Have on hand several pieces of chalk, each piece being one-inch in length.
c. Test one child at a time.
d. Record the distance between the marks to the nearest one-fourth of an inch.
e. Remove the chalk marks with an eraser after each child has been tested.

f. Give each child three trials in succession and record each trial.
g. The average of the three trials is the child's record.

Standing Broad Jump. - The child stands on both feet toeing a starting line. He may rock back and forth alternately, but must not lift either foot clear of the ground, or cross the toeing line. The jump is made from both feet to a landing on both feet. A jumping pit consisting of sawdust and sand is utilized. This event is designed to measure leg strength and coordination of the child's structure to project himself horizontally.

Testing Procedure:

a. Mark a starting line three feet long.
b. Have one child jump at a time.
c. The distance jumped is measured from the nearest point on the ground touched by any part of the body to the starting line.
d. One assistant will a ssist with the measuring tape.
e. Measure the distance to the nearest inch and record in feet and inches.
f. Each child is given three trials in succession.
g. The average of the three trials is the child's record.

Soccer Kick for Distance. - A regulation soccer ball (5-1bs. pressure) is placed on a rubber tee made out of a radiator hose, one-and-one-half inches in diameter and one-inch in height, at the starting line. The child is permitted to take one step in approaching the soccer ball. The distance is measured from the starting line to the point where the ball first strikes the ground. This event is designed to measure leg strength and coordination of the

child's structure, as indicated by the distance the ball travels through the air.

Testing Procedure:

a. A child is instructed to kick the soccer ball in the air as far as possible, from the middle of the starting line in the direction of the lines established at various distances.
b. The examiner will see that the child does not step over the starting line when kicking the soccer ball.
c. An assistant will place markers numbered one, two, and three at the points where the soccer ball touches the ground after being kicked.
d. The distance is measured to the nearest one-half foot.
e. A child is given three trials in succession.
f. The average of the three trials is taken as the child's record.

Twenty-five Yard Dash. - The child stands behind the starting line. In a semi-crouched position the child places either the right or left foot just behind the starting line. When the starter says: "Get set!" the runner is in position. On the word "Go!" and the simultaneous lowering of the starter's hand, the contestant runs in a straight line down the course. He crosses the finish line at full speed, slowing down gradually after it has been crossed. To minimize the effects of fatigue the first trial of the 25-yard dash is run before the soccer kick trials; the second trial after the latter; and the third trial after the softball throw for distance. This event is designed to test the speed of the individual for short distances.

Testing Procedure

a. Establish a starting line and a finishing line exactly twenty-five yards apart on a cinder track.



b. The examiner will be the official starter.
c. An assistant, standing at the finishing line, will serve as time-keeper with a stop-watch in his hand.
d. On the word "Go!" and the simultaneous lowering of the starter's hand, the contestant starts his run and the time-keeper starts his watch.
e. When the child reaches the finishing line, the time-keeper notes the time.
f. The time is recorded by the examiner.
g. The time is taken to the nearest tenth of a second.
h. The average of the three trials is taken as the child's record.

Soft-ball Throw for Distance. - The space marked out for the soccer kick is also used for the soft-ball throw for distance. However, a circle (six-feet in diameter) is established tangent to the center of the soccer kick line, in order to allow the child to take a few steps before releasing the ball. When throwing, the child must not step over the forward part of the circle line with any part of the body until the ball has struck the ground. The free overhand throw as used in hard baseball shall be used. The same rules shall also apply to the underhand throw. This event is designed to measure arm strength and coordination of the body as a whole.

Testing Procedure:

a. Make a circle six feet in diameter.
b. The child is instructed to throw the ball in the air as far as possible, and in the direction of the established chalk lines.
c. The distance will be measured from the closest point on the circumference on the throwing circle or nearest chalk line to the spot where the ball first strikes the ground.
d. The distance is measured to the nearest one-half foot on the measuring tape.

e. The distance is recorded for each trial and the average of the three trials is the child's record.

Soft-ball Throw for Accuracy. - A target consisting of five concentric circles, one, two, three, four and five feet in diameter is used. The center of all the circles is three and one-half feet from the ground. The circle lines should not be over one inch in width. In determining the diameter of each circle, include the width of the line. The circumference of the outside circle is one foot from the ground. A throwing line two feet in length is established fifteen feet away from the target. The child stands back of the throwing line and throws the ball at the target. One foot must be in contact with the throwing line at the time the ball is released. A regular 12-inch (inseam) ball is used. Each child has three throws, the first group overhand, and the second, underhand. Counting from the center outward, the circles score 10-8-6-4-2. Each number, except 10, is written on the target four times and in the appropriate place, so scoring would be easy. Throws going outside of the largest circle score nothing. Throws hitting on the line between two zones score for the inside zone. This event is designed to determine, in general, eye-arm-hand coordination of the child.

Testing Procedure:

a. Arrange the target according to specifications.
b. Mark a two-foot throwing line fifteen feet from the target.
c. Use one ball which is returned to the child after each throw by the assistant.

d. The examiner should observe that the child must have one foot in contact with the throwing line when the ball is released.
e. Test one child at a time.
f. The examiner writes down the score made on each throw, and adds up the three scores, the <u>total</u> of which represents the child's record.

The following materials were used for these test events: tape measure (50 feet); two 12-inch baseballs (inseam); one regulation soccer ball; rubber tees (one-and-one-half inches in diameter and one-inch in height); target (after Neilson and Cozens); adhesive tape to fasten the target to the wall; black cardboard (10"x30"); one 12-inch ruler; recording sheets and pencils; stop-watch; cards numbered one, two, and three to indicate positions for the ball throw and the soccer kick for distance.

CHAPTER IV

AGE CHANGES AND SEX DIFFERENCES IN SKILL AND GROWTH

Fifty-six boys and forty-five girls were given the motor skills involving running, kicking, jumping and throwing. Each child performed the skills individually, and his/her accomplishment was measured in terms of the results achieved in a given skill. The children were divided into six age groups of intervals of twelve months each. The 66 to 77 months age interval constituted the six-year-olds; 78 to 89 months, seven-year-olds; 90 to 101, eight-year-olds; 102 to 113, nine-year-olds; 114 to 125, ten-year-olds; and 126 to 137 months inclusive, the eleven-year-olds.

Means, medians and standard deviations of various distributions were determined from the raw scores derived from the physical skills and from the growth attributes expressed in age units for each age and sex group.

We do not know without the use of the Student-Fisher test which is made later, that similar results will hold for the parent population which is implicitly defined by this sample. The factual summary of Tables 1 through 16 is followed by a treatment of significant differences in mean motor performances and mean growth attributes between boys and girls of the same chronological age groupings, which is covered in Tables 17 and 18 with descriptive materials.

TABLE 1

MOTOR PERFORMANCES OF ELEMENTARY SCHOOL BOYS AND GIRLS CLASSIFIED IN TWELVE-MONTH-AGE INTERVALS ON THE JUMP AND REACH

Age Interval	Sex	Number	Range (In Inches)	Mean	Median	S.D. of the Distribution
66 to 77	Boys	8	2.7- 6.2	4.44	4.50	1.09
	Girls	3	3.5- 7.4	4.83	3.60	1.82
78 to 89	Boys	12	3.7- 7.0	4.78	4.55	0.97
	Girls	10	3.5- 6.9	4.98	4.85	1.17
90 to 101	Boys	6	3.0- 8.8	5.47	5.55	2.03
	Girls	7	3.3- 6.4	5.11	5.50	1.06
102 to 113	Boys	12	4.0-10.7	7.14	6.55	1.96
	Girls	13	4.7- 8.8	6.39	6.70	1.01
114 to 125	Boys	11	5.8- 9.1	7.49	7.60	1.25
	Girls	6	5.3-12.0	7.95	7.60	2.02
126 to 137	Boys	7	7.2- 9.5	8.06	7.80	0.81
	Girls	6	6.7- 9.4	8.40	8.45	0.88

On examining Table 1 it was noted that the mean performances for those boys and girls measured in this study increased with each increase in age grouping on the jump and reach. This increase was more evident, however, for boys between eight and nine years of age, and for the girls between nine and ten.

The mean performance on the jump and reach for these eight-year-old boys was 5.47 inches, and 7.14 inches for the nine-year-old boys. The mean difference between these two groups was 1.67 inches. For the nine-year-old girls the mean performance was 6.39 inches, and 7.95 inches for the ten-year-olds. This represented a difference of 1.56 inches between the two age groups. Similarly, there was a difference of 1.28 inches in the mean performances of the eight and nine-year-old girls measured. Whereas, the difference between other successive age groupings was less than one inch on the mean performances in the jump and reach.

For the groups measured the seven, ten, and eleven-year-old girls excelled the boys of comparable ages on the jump and reach. The standard deviations were not large, and the mean performances were relatively small for all the age groups. There was much overlapping in the range of performance between these age groupings. The mean for the eight-year-old boys was 5.47 inches with a sigma of 2.03. About 68 percent of the eight-year-old boys performed between 3.44 and 7.50 inches on the jump and reach. The mean motor performance for the ten-year-old girls was 7.95 inches with a sigma of 2.02. Approximately 68 percent of this group of girls ranged from 5.93 to 9.97 inches on the jump and reach.

The following table presents the mean motor performances of the boys and girls tested in this study on the standing broad jump.

TABLE 2

MOTOR PERFORMANCES OF ELEMENTARY SCHOOL BOYS AND GIRLS CLASSIFIED IN TWELVE-MONTH-AGE INTERVALS ON THE STANDING BROAD JUMP

Age Interval	Sex	Number	Range (In feet)	Mean	Median	S.D. of the Distribution
66 to 77	Boys	8	2.1-3.1	2.74	2.80	0.26
	Girls	3	2.9-3.4	3.20	3.30	0.23
78 to 89	Boys	12	2.4-4.7	3.61	3.65	0.73
	Girls	10	2.6-4.0	3.27	3.30	0.54
90 to 101	Boys	6	2.5-4.8	3.65	3.60	0.73
	Girls	7	3.1-3.9	3.59	3.70	0.29
102 to 113	Boys	12	3.4-5.2	4.36	4.50	0.54
	Girls	13	3.5-5.1	4.10	4.20	0.48
114 to 125	Boys	11	3.5-5.3	4.43	4.70	0.62
	Girls	6	3.3-6.2	4.62	4.75	0.92
126 to 137	Boys	7	4.6-5.8	5.10	5.00	0.42
	Girls	6	3.7-5.7	4.81	4.80	0.62

In Table 2 a marked similarity in trend of performance was noted for those boys and girls tested on the standing broad jump. The mean performances for both boys and girls increased for each successive age group in this event. The standard deviation for each group was less than one, which

was suggestive of the homogeneity of the sample on the standing broad jump test. The boys were superior to the girls at the seven, eight, nine and eleven-year levels. Otherwise the girls performed better at the six and ten-year levels than boys of comparable ages for the groups studied. When the boys were combined, the range in skill on the standing broad jump varied from 2.1 to 5.8 feet, while the range in this skill for the girls was from 2.6 to 6.2 feet.

Table 3, which follows, presents the mean motor performances of elementary school boys and girls tested on the soccer kick for distance.

TABLE 3

MOTOR PERFORMANCES OF ELEMENTARY SCHOOL BOYS AND GIRLS CLASSIFIED IN TWELVE-MONTH-AGE INTERVALS ON THE SOCCER KICK FOR DISTANCE

Age Interval	Sex	Number	Range (In feet)	Mean	Median	S.D. of the Distribution
66 to 77	Boys	8	4.0-16.5	8.44	8.25	3.48
	Girls	3	6.7- 8.3	7.26	6.80	0.54
78 to 89	Boys	12	7.3-33.3	15.99	15.00	7.25
	Girls	10	4.2-12.0	7.55	6.20	2.90
90 to 101	Boys	6	10.6-48.3	25.60	19.65	14.57
	Girls	7	10.7-17.5	14.02	13.30	2.94
102 to 113	Boys	12	11.0-41.7	26.14	23.45	8.88
	Girls	13	6.0-45.8	18.38	15.30	10.29
114 to 125	Boys	11	14.4-49.8	30.90	30.50	8.93
	Girls	6	10.3-33.5	20.05	16.85	8.27
126 to 137	Boys	7	28.5-48.8	41.10	45.30	7.01
	Girls	6	20.2-50.3	32.95	32.20	10.64

An examination of Table 3 showed an increase in mean performances on the soccer kick for the boys and girls tested at each age level. With the exception of the six-year-olds, there were marked differences in the mean performances between the boys and girls at each age level. At every age

level the boys were superior to the girls of the same age. With the exception of the nine and eleven-year age levels, the boys showed greater variability in the performance of the soccer kick than the girls measured in this study. The mean performance of the eight-year-old boys was 25.60 feet with a sigma of 14.57. Approximately 68 percent of the boys at this age level performed between 11.03 and 40.17 feet on the soccer kick for distance. For these groups the girls were more homogeneous than the boys in the performance of the soccer kick. When the boys were combined the range in performance on the soccer kick varied from 4.0 to 49.8 feet. For the girls the range varied from 4.2 to 50.3 feet. Even though the mean performances of the boys were better than the girls at each age level, the latter showed a slight advantage in the minimum and maximum distances attained.

Table 4, which follows, presents the mean motor performances of the boys and girls tested on the twenty-five yard dash in this study.

TABLE 4

MOTOR PERFORMANCES OF ELEMENTARY SCHOOL BOYS AND GIRLS CLASSIFIED IN TWELVE-MONTH-AGE INTERVALS ON THE TWENTY-FIVE YARD DASH

Age Interval	Sex	Number	Range (In Seconds)	Mean	Median	S.D. of the Distribution
66 to 77	Boys	8	5.5-6.7	5.94	5.95	0.36
	Girls	3	5.3-6.2	5.60	5.30	0.43
78 to 89	Boys	12	4.7-7.0	5.58	5.60	0.62
	Girls	10	5.1-6.1	5.57	5.50	0.32
90 to 101	Boys	6	4.9-5.7	5.17	5.10	0.29
	Girls	7	5.0-6.3	5.44	5.40	0.40
102 to 113	Boys	12	4.3-5.6	5.01	5.00	0.36
	Girls	13	4.8-5.9	5.08	5.00	0.29
114 to 125	Boys	11	4.5-5.5	5.00	5.00	0.30
	Girls	6	4.0-5.5	4.87	5.00	0.49
126 to 137	Boys	7	4.7-5.0	4.81	4.80	0.39
	Girls	6	4.4-5.2	4.82	4.85	0.27

In the above table the mean performances for the boys and girls decreased in the time required to complete the twenty-five yard dash at each age level. A decrease in time is indicative of a better performance in this event. The mean performances of the seven and eleven-year-old boys

and girls were almost identical. The standard deviations were less than one for each group measured, suggesting that the boys and girls were fairly homogeneous in the performance of this event at the various age levels. The best performance on the twenty-five yard dash (4.0 seconds) was obtained by a ten-year-old girl. In this study the girls were superior to the boys at the six, seven and ten-year-age levels.

Table 5, which follows, presents the mean motor performances of boys and girls tested at various age levels on the ball throw for distance (overhand).

TABLE 5

MOTOR PERFORMANCES OF ELEMENTARY SCHOOL BOYS AND GIRLS CLASSIFIED IN TWELVE-MONTH-AGE INTERVALS ON THE BALL THROW FOR DISTANCE (OVERHAND)

Age Interval	Sex	Number	Range (In feet)	Mean	Median	S.D. of the Distribution
66 to 77	Boys	8	15.3- 35.8	24.33	24.55	5.83
	Girls	3	8.8- 25.5	15.86	13.80	7.00
78 to 89	Boys	12	16.2- 63.3	41.09	42.00	14.25
	Girls	10	10.8- 27.5	17.98	16.20	5.54
90 to 101	Boys	6	17.8- 78.7	47.93	50.50	21.60
	Girls	7	11.5- 36.7	23.76	22.70	7.83
102 to 113	Boys	12	24.8- 98.5	57.88	56.65	20.57
	Girls	13	18.7- 48.7	31.63	31.00	9.30
114 to 125	Boys	11	32.8-108.0	67.93	67.70	21.95
	Girls	6	17.2- 60.5	42.38	47.05	16.18
126 to 137	Boys	7	77.0-125.7	97.37	93.50	16.22
	Girls	6	36.3- 53.8	46.20	47.00	6.01

For the groups studied achievement in the ball throw for distance (overhand) varied considerably according to age and sex (Table 5).

The girls showed marked improvement in performance up to the eleven-year-age level, at which age further advance-

ment was at a retarded rate. There was a marked improvement in the overhand ball throw for boys from six to the seven-year-age level (17 feet), and an even rate of improvement from seven to ten (10 feet), with a rather sharp increase of 29 feet between the ten and eleven-year-age levels. In throwing the baseball for distance (overhand), the boys averaged 24.3, 41.1, 47.9, 57.9, and 97.4 feet for the six consecutive age groups, while the girls averaged 15.9, 18.0, 23.8, 31.6, 42.4, and 46.2 feet respectively.

For these children sex differences were marked at the six age levels. The actual difference between the boys and the girls 6, 7, 8, 9, 10 and 11-years of age was 8.47, 23.11, 24.17, 26.25, 25.55 and 51.17 feet respectively. As indicated by their standard deviations, the boys showed greater variability in performance than the girls at each age level with the exception of the six-year interval.

When the boys were combined into a larger grouping, their range in the overhand ball throw for distance was from 15.3 to 125.7 feet; whereas, the girls ranged from 8.8 to 60.5 feet. There was greater variability in performance among the girls tested at the ten-year than at the eleven-year-age level. The ten-year-old girls also surpassed the eleven-year-old girls in the distance the ball was thrown. The boys showed the greatest amount of variability (S.D. 21.95) in the performance of the ball throw for distance (overhand) at the ten-year level.

The following table presents the mean performances for those boys and girls who were tested on the ball throw for distance (underhand).

TABLE 6

MOTOR PERFORMANCES OF ELEMENTARY SCHOOL BOYS AND GIRLS CLASSIFIED IN TWELVE-MONTH-AGE INTERVALS ON THE BALL THROW FOR DISTANCE (UNDERHAND)

Age Interval	Sex	Number	Range (In feet)	Mean	Median	S.D. of the Distribution
66 to 77	Boys	8	16.5-35.0	22.16	23.95	5.84
	Girls	3	14.5-29.0	20.83	19.00	6.06
78 to 89	Boys	12	26.7-59.3	38.08	36.20	8.54
	Girls	10	8.7-35.2	21.06	21.00	6.51
90 to 101	Boys	6	31.0-65.7	44.67	39.15	13.13
	Girls	7	21.7-35.7	30.97	32.20	4.74
102 to 113	Boys	12	29.7-67.8	47.14	45.65	11.54
	Girls	13	20.5-49.3	35.37	36.30	9.42
114 to 125	Boys	11	33.8-68.2	51.36	50.70	11.04
	Girls	6	32.2-59.2	46.70	48.80	8.53
126 to 137	Boys	7	48.8-67.8	59.68	59.00	7.19
	Girls	6	35.0-58.5	47.52	49.65	9.52

An examination of Table 6 showed that the mean performances on the ball throw for distance (underhand) increased

for each advancing age group studied. At every age level the boys were superior to the girls of comparable ages. The actual difference between the boys and girls 6, 7, 8, 9, 10 and 11 years of age was 1.33, 17.02, 13.70, 11.77, 4.66 and 12.16 feet respectively. For these groups of children, the seven, eight, nine and ten-year-old girls were more uniform in their performances in the ball throw for distance (underhand) than the boys of comparable ages. For the boys the greatest increase in achievement on the ball throw for distance (underhand) was shown between the six and seven-year-age levels (16 feet). The girls showed the greatest increase in achievement between the nine and ten-year-age levels, with no clear-cut increases between six and seven, and ten and eleven years. When the boys were combined, the range was found to be from 16.5 to 68.2 feet, and for the girls it was from 8.7 to 59.2 feet. The nine and eleven-year-old boys attained the same maximum distance of 67.8 feet on the ball throw for distance (underhand).

Table 7, which follows, presents the mean motor performances for those boys and girls measured on the ball throw for accuracy (overhand).

TABLE 7

MOTOR PERFORMANCES OF ELEMENTARY SCHOOL BOYS AND GIRLS CLASSIFIED IN TWELVE-MONTH-AGE INTERVALS ON THE BALL THROW FOR ACCURACY (OVERHAND)

Age Interval	Sex	Number	Range (In Points)	Mean	Median	S.D. of the Distribution
66 to 77	Boys	8	2-16	9.00	8.00	5.40
	Girls	3	0- 8	4.00	4.00	3.27
78 to 89	Boys	12	4-26	15.33	15.00	6.33
	Girls	10	0-16	5.80	4.00	5.33
90 to 101	Boys	6	8-26	18.67	21.00	5.96
	Girls	7	4-20	11.14	12.00	5.22
102 to 113	Boys	12	4-26	19.17	20.00	5.74
	Girls	13	2-22	13.92	14.00	6.30
114 to 125	Boys	11	14-26	19.27	18.00	3.64
	Girls	6	6-24	16.33	17.00	6.87
126 to 137	Boys	7	20-26	23.14	24.00	1.81
	Girls	6	10-22	17.00	18.00	4.12

As indicated in Table 7, there were differences in the mean performances of boys and girls of the same age levels in this study. The actual differences between the boys and girls 6, 7, 8, 9, 10 and 11-years of age was 5.0, 9.53, 7.53, 5.25, 2.94 and 6.14 points respectively. The actual difference

between the mean performances of each succeeding age level beginning with the youngest boys was 6.33, 3.34, 0.50, 0.10 and 3.87; and for the girls, 1.80, 5.34, 2.78, 2.41 and 0.67 points respectively. In this event the boys ranged from 2 to 26 points, while the range for the girls was from 0 to 24 points. One girl at the six-year-level and two girls at the seven-year-level failed to hit the target, whereas, all the boys tested were successful. Five of the six age groups of boys obtained maximum scores of 26 out of a possible 30 points.

Table 8, which follows, presents the mean motor performances of boys and girls tested at various age levels on the ball throw for accuracy (underhand).

TABLE 8

MOTOR PERFORMANCES OF ELEMENTARY SCHOOL BOYS AND GIRLS CLASSIFIED IN TWELVE-MONTH-AGE INTERVALS ON THE BALL THROW FOR ACCURACY (UNDERHAND)

Age Interval	Sex	Number	Range (In Points)	Mean	Median	S.D. of the Distribution
66 to 77	Boys	8	4-20	8.25	6.00	5.05
	Girls	3	2- 8	4.70	4.00	2.50
78 to 89	Boys	12	2-24	11.83	11.00	7.23
	Girls	10	0-16	7.00	7.00	4.75
90 to 101	Boys	6	14-26	18.00	17.00	4.16
	Girls	7	2-18	8.86	8.00	5.22
102 to 113	Boys	12	10-26	18.16	18.00	5.38
	Girls	13	2-26	11.69	12.00	6.22
114 to 125	Boys	11	10-26	18.91	20.00	4.62
	Girls	6	8-28	17.83	17.00	6.47
126 to 137	Boys	7	16-26	20.86	20.00	4.12
	Girls	6	14-26	19.67	20.00	4.68

In Table 8 there were marked differences in the mean performances of boys and girls of the same age levels tested on the ball throw for accuracy (underhand).

For the children studied the actual differences in mean performances between the boys and girls 6, 7, 8, 9, 10 and

11-years of age are listed as follows: 3.55, 4.83, 9.14, 6.47, 1.08 and 1.19 points respectively. The actual difference between the mean performances of each succeeding age level beginning with the youngest boys was 3.58, 6.17, 0.16, 0.75 and 1.95 points; and for the girls, 2.30, 1.86, 2.83 6.14 and 1.84 points respectively.

When the boys were combined into one larger group the range in performance was found to be from 2 to 26 points, and for the combined group of girls the range was from 0 to 28 points.

In Table 9 the mean height ages for these boys and girls are presented at various age levels.

TABLE 9

MEANS, MEDIANS AND STANDARD DEVIATIONS FOR HEIGHT AGES OF ELEMENTARY SCHOOL BOYS AND GIRLS CLASSIFIED IN TWELVE-MONTH-AGE INTERVALS

Age Interval	Sex	Number	Range (In Months)	Mean	Median	S.D. of the Distribution
66 to 77	Boys	8	70- 99	79.38	75.50	8.73
	Girls	3	68- 81	75.67	78.00	5.56
78 to 89	Boys	12	76-133	97.58	94.00	13.43
	Girls	10	72-105	85.70	84.50	8.33
90 to 101	Boys	6	74-126	98.33	97.50	18.54
	Girls	7	98-116	106.57	106.00	5.12
102 to 113	Boys	12	94-153	115.58	114.50	16.07
	Girls	13	98-143	116.46	114.00	12.35
114 to 125	Boys	11	83-150	127.00	133.00	20.73
	Girls	6	101-145	120.83	119.00	13.57
126 to 137	Boys	7	126-155	144.00	149.00	9.20
	Girls	6	127-172	142.50	136.50	14.95

In Table 9 a marked increase in the mean height ages for each succeeding age level was observed from the youngest to the oldest group. In this study the boys exceeded the girls in height ages at all intervals, except at the eight and nine-year-levels. The actual difference in the mean

height ages between boys and girls 6, 7, 8, 9, 10 and 11 years of age was 3.71, 11.88, 8.24, 0.88, 6.17 and 1.50 months respectively. The ten-year-old boys showed the greatest variability (S.D. 20.73) in height age, followed by the eight-year-olds with a sigma of 18.54. The eleven-year-old girls varied more in their height ages (S.D. 14.95) than any of the preceding younger groups of girls measured.

When the boys were combined into one larger grouping, their height ages ranged from 70 to 155 months, while the range for the girls was from 68 to 172 months.

Table 10, which follows, presents the mean weight ages for these boys and girls at various age levels.

TABLE 10

MEANS, MEDIANS AND STANDARD DEVIATIONS FOR WEIGHT AGES OF ELEMENTARY SCHOOL BOYS AND GIRLS CLASSIFIED IN TWELVE-MONTH-AGE INTERVALS

Age Interval	Sex	Number	Range (In Months)	Mean	Median	S.D. of the Distribution
66 to 77	Boys	8	69-139	88.13	75.50	26.45
	Girls	3	74- 84	78.33	77.00	4.19
78 to 89	Boys	12	83-146	107.42	107.00	19.10
	Girls	10	74-116	91.60	84.50	14.25
90 to 101	Boys	6	74-168	108.83	92.50	35.84
	Girls	7	85-120	107.29	115.00	12.17
102 to 113	Boys	12	95-165	119.17	112.50	22.03
	Girls	13	78-151	119.92	113.00	21.17
114 to 125	Boys	11	94-163	135.73	144.00	20.53
	Girls	6	89-147	118.33	115.50	19.59
126 to 137	Boys	7	127-192	154.14	149.00	18.36
	Girls	6	128-157	137.67	134.50	9.39

An examination of Table 10 revealed an increase in the mean weight ages for those boys measured from the six to the eleven-year-interval. The girls also showed a similar increase, except that the mean weight age for the nine-year-olds (119.17) was higher than that for the ten-year-olds.

The actual difference in the mean weight ages between the boys and girls 6, 7, 8, 9, 10 and 11-years was 9.80, 15.82, 1.54, 0.75, 17.40 and 16.47 months respectively. There was considerable variation in the weight ages of the eight-year-old boys when compared with boys of other age intervals in this study. The mean weight age for this group was 108.83 months with a standard deviation of 35.84. In terms of weight age, approximately 68 percent of the boys in this group ranged from 72.99 to 144.67 months. The girls were more uniform in weight than the boys at each age interval studied. The range in weight age for the combined boys was from 69 to 192 months, and from 74 to 157 months for the girls.

In the following table the mean grip ages are presented for the boys and girls tested at various age levels.

TABLE 11

MEANS, MEDIANS AND STANDARD DEVIATIONS FOR GRIP AGES OF ELEMENTARY SCHOOL BOYS AND GIRLS CLASSIFIED IN TWELVE-MONTH-AGE INTERVALS

Age Interval	Sex	Number	Range (In Months)	Mean	Median	S.D. of the Distribution
66 to 77	Boys	8	49- 94	69.38	64.00	16.08
	Girls	3	46- 84	71.33	84.00	17.91
78 to 89	Boys	12	64-102	89.25	93.00	10.79
	Girls	10	51- 96	76.10	76.00	12.41
90 to 101	Boys	6	58-111	90.83	96.50	20.38
	Girls	7	76-105	92.00	96.00	8.86
102 to 113	Boys	12	86-149	111.83	105.50	17.37
	Girls	13	68-153	105.62	109.00	22.18
114 to 125	Boys	11	97-140	117.55	116.00	14.49
	Girls	6	84-125	111.33	119.00	15.67
126 to 137	Boys	7	115-178	140.43	134.00	21.91
	Girls	6	101-161	124.83	121.50	20.48

As indicated in Table 11 the grip ages for boys and girls measured in this study increased with each advancing age interval. When considering the actual differences between these boys and girls in the same age intervals, it was noted that the boys were superior to the girls at the seven, nine, ten

and eleven-year-levels. The girls were superior to the boys of comparable ages at the six and eight-year-intervals. For the boys the grip ages range from 49 to 178 months, and from 46 to 161 months for the girls. The nine-year-old girls attained a maximum of 153 months in grip age as compared to 125 months for the ten-year-old girls measured in this study.

Table 12, which follows, presents the mean carpal ages for those elementary school boys and girls used in this study.

TABLE 12

MEANS, MEDIANS AND STANDARD DEVIATIONS FOR CARPAL AGES OF ELEMENTARY SCHOOL BOYS AND GIRLS CLASSIFIED IN TWELVE-MONTH-AGE INTERVALS

Age Interval	Sex	Number	Range (In Months)	Mean	Median	S.D. of the Distribution
66 to 77	Boys	8	48-126	82.25	79.00	21.54
	Girls	3	66- 79	72.00	71.00	5.35
78 to 89	Boys	12	85-101	93.42	93.00	4.99
	Girls	10	67-106	85.70	84.50	10.38
90 to 101	Boys	6	86-122	101.33	95.50	13.39
	Girls	7	88-108	99.14	102.00	6.77
102 to 113	Boys	12	84-128	110.17	116.50	15.73
	Girls	13	95-145	115.23	118.00	13.05
114 to 125	Boys	11	113-142	122.82	119.00	8.35
	Girls	6	103-128	116.67	120.50	9.43
126 to 137	Boys	7	126-151	140.14	143.00	8.82
	Girls	6	128-157	137.67	134.50	9.39

An examination of the carpal ages of the boys and girls in Table 12 revealed increases in the mean growth ages for each succeeding age group measured. Within each age interval the boys were superior to the girls in mean carpal development. The next older age interval of girls, however, was found to

be superior to the preceding age group of boys in the minimum range of carpal development. When considering the standard deviations of these children, the ten and eleven-year-old boys and girls were fairly uniform in carpal development. There was greater variability, however, among the boys of the six and eight-year-intervals than among the girls of comparable ages. At the seven-year-level the girls showed greater variability (S.D. 10.38) in carpal growth than the boys (S.D. 4.99) of the same ages.

When these boys were combined into one large group, their range in carpal growth was from 48 to 157 months, while the girls ranged from 66 to 157 months.

In the following table the mean dental ages expressed in months are presented for the boys and girls used in this study.

TABLE 13

MEANS, MEDIANS AND STANDARD DEVIATIONS FOR DENTAL AGES OF ELEMENTARY SCHOOL BOYS AND GIRLS CLASSIFIED IN TWELVE-MONTH-AGE INTERVALS

Age Interval	Sex	Number	Range (In Months)	Mean	Median	S.D. of the Distribution
66 to 77	Boys	8	64- 78	71.00	70.00	4.74
	Girls	3	75- 86	79.33	77.00	4.79
78 to 89	Boys	12	70-102	88.08	87.50	8.99
	Girls	10	77- 99	84.00	82.00	6.26
90 to 101	Boys	6	81-113	95.17	91.50	10.95
	Girls	7	77-109	96.43	97.00	9.94
102 to 113	Boys	12	96-112	105.33	106.50	6.82
	Girls	13	96-109	104.15	108.00	5.22
114 to 125	Boys	11	111-135	116.09	112.00	7.62
	Girls	6	102-132	110.67	107.50	9.76
126 to 137	Boys	7	111-151	127.29	119.00	15.22
	Girls	6	117-141	129.50	128.00	9.03

In the above table the mean dental ages for the boys and girls measured increased with each advancing age interval. The seven, nine and ten-year-old boys were found to be superior to the girls of the same ages in mean dental age. The girls in the six, eight and eleven-year-levels

surpassed the boys of comparable ages in mean dental development. The girls of the next older age group surpassed the boys of the preceding age interval in the minimum range of dental development.

At the eleven-year-interval the boys (S.D. 15.22) displayed greater variability than the girls (S.D. 9.03) in dental development. With the exception of the eleven-year-interval, the dental ages were quite uniform for both sexes at each age level.

The boys ranged from 64 to 151 months and the girls from 75 to 141 months in dental growth for the groups measured.

Table 14, which follows, presents the mean reading ages for these boys and girls at various age levels.

TABLE 14

MEANS, MEDIANS AND STANDARD DEVIATIONS FOR READING AGES OF ELEMENTARY SCHOOL BOYS AND GIRLS CLASSIFIED IN TWELVE-MONTH-AGE INTERVALS

Age Interval	Sex	Number	Range (In Months)	Mean	Median	S.D. of the Distribution
66 to 77	Boys	8	76- 96	79.13	77.00	6.41
	Girls	3	77- 78	77.67	78.00	0.47
78 to 89	Boys	12	76-114	92.58	86.50	13.51
	Girls	10	75-108	84.70	81.00	10.58
90 to 101	Boys	6	89-102	93.83	93.00	4.14
	Girls	7	88-121	104.57	104.00	9.82
102 to 113	Boys	12	81-139	98.00	92.00	16.11
	Girls	13	100-163	124.77	125.00	19.33
114 to 125	Boys	11	95-144	122.91	126.00	15.95
	Girls	6	99-154	122.67	122.00	16.66
126 to 137	Boys	7	99-166	124.29	107.00	25.94
	Girls	6	121-181	151.50	153.00	19.11

In this study the mean reading ages of the eight, nine and eleven-year-old girls were found (Table 14) to exceed those for boys of comparable ages. At the ten-year-level the mean reading ages for these boys and girls were found

to be the same. At the eleven-year-age interval the boys showed greater variability (S.D. 25.94) than the girls (S.D. 19.11) in ability to read. When each sex was combined into two larger groupings, the range in reading age was found to be 76 to 166 months for the boys, while for the girls, the range was from 75 to 181 months.

Table 15, which follows, presents the mean mental ages for these boys and girls measured at various age levels.

TABLE 15

MEANS, MEDIANS AND STANDARD DEVIATIONS FOR MENTAL AGES OF ELEMENTARY SCHOOL BOYS AND GIRLS CLASSIFIED IN TWELVE-MONTH-AGE INTERVALS

Age Interval	Sex	Number	Range (In Months)	Mean	Median	S.D. of the Distribution
66 to 77	Boys	8	73-111	89.00	89.00	11.55
	Girls	3	72-106	88.33	87.00	13.91
78 to 89	Boys	12	90-131	110.42	112.50	12.88
	Girls	10	85-126	98.90	94.50	12.79
90 to 101	Boys	6	110-147	122.50	119.50	12.20
	Girls	7	126-141	133.86	135.00	4.39
102 to 113	Boys	12	104-172	135.42	131.00	18.73
	Girls	13	129-200	154.23	150.00	18.88
114 to 125	Boys	11	118-196	156.27	158.00	21.84
	Girls	6	144-184	159.33	153.00	13.49
126 to 137	Boys	7	159-187	171.29	169.00	8.46
	Girls	6	138-207	181.33	180.50	23.00

In Table 15 the mean mental ages for the boys and girls measured in this study increased with each successive advance in age level. The girls were superior to the boys in mean mental development at the eight, nine, ten and eleven-year-age levels. The girls (S.D. 23.00) showed greater variability

in mental development than the boys (S.D. 8.46) at the eleven-year-age level. The boys (S.D. 12.20, 21.84) were less uniform in mental development than the girls (S.D. 4.39, 13.49) at the eight and ten-year-age levels respectively. The girls in each succeeding age interval were superior in the maximum range of mental development than the boys of each preceding age level.

The mental age range for the girls was from 72 to 207 months, and for the boys, it was from 73 to 196 months.

In the following table the mean organismic ages are presented for those boys and girls measured in this study.

TABLE 16

MEANS, MEDIANS AND STANDARD DEVIATIONS FOR ORGANISMIC AGES OF ELEMENTARY SCHOOL BOYS AND GIRLS CLASSIFIED IN TWELVE-MONTH-AGE INTERVALS

Age Interval	Sex	Number	Range (In Months)	Mean	Median	S.D. of the Distribution
66 to 77	Boys	8	67- 96	79.88	77.50	9.66
	Girls	3	75- 81	77.33	76.00	2.63
78 to 89	Boys	12	80-107	97.00	98.50	7.23
	Girls	10	76- 96	86.80	89.00	7.07
90 to 101	Boys	6	86-119	101.67	100.00	13.01
	Girls	7	93-111	105.86	109.00	6.29
102 to 113	Boys	12	97-128	113.67	112.50	8.75
	Girls	13	103-141	120.08	122.00	10.38
114 to 125	Boys	11	104-146	128.36	131.00	11.76
	Girls	6	107-138	122.83	121.50	11.19
126 to 137	Boys	7	135-156	143.29	141.00	7.32
	Girls	6	128-166	145.00	144.50	11.17

As indicated in Table 16, the mean organismic ages for these boys and girls increased with each advance in age interval. The boys were superior to the girls in mean organismic age at the six, seven and ten-year-age levels,

while the girls surpassed the boys at the eight, nine and eleven-year-age intervals. There was greater variability in organismic age between boys (S.D. 13.01) than among the girls (S.D. 6.29) at the eight-year-age level. For this group of children the organismic ages for the girls ranged from 75 to 166 months, and from 67 to 166 months for the boys.

The first hypothesis is restated and is followed by an analysis based on the results established in this study. The remaining hypotheses are considered in Chapter V. It should be noted in passing that all these hypotheses are tested in this study by measurements of the students in the available sample. It is possible that similar results might be found in other populations, however this study either establishes or fails to establish each hypothesis specifically for the parent population of this study.

Hypothesis I. - There are significant differences between boys and girls of the same chronological age groupings in some of the physical skills selected.

In order to test the above hypothesis Student-Fisher t values were computed for each age level according to the following formula (13).

$$t^2 = \frac{(N_2 \Sigma X_1 - N_1 \Sigma X_2)^2}{(N_2 L_1 \not{+} N_1 L_2)} \quad \frac{(N_1 \not{+} N_2 - 2)}{(N_1 \not{+} N_2)}$$

$$L = N \Sigma X^2 - (\Sigma X)^2$$

The following table presents t values for differences in the mean motor performances of elementary school children.

TABLE 17

STUDENT-FISHER t VALUES FOR DIFFERENCES IN THE MEAN PERFORMANCES OF CERTAIN PHYSICAL SKILLS FOR BOYS AND GIRLS CLASSIFIED IN TWELVE-MONTH-AGE INTERVALS

Age Interval	66-77		78-89		90-101		102-113		114-125		126-137	
Sex	Boys	Girls	Boys	Girls	Boys	Girls	Boys	Girls	Boys	Girls	Boys	Girls
Number	8	3	12	10	6	7	12	13	11	6	7	6
#1	∕0.40		∕0.41		-0.37		-1.16		∕0.54		∕0.67	
2	∕2.42*		-1.16		-0.20		-1.22		∕0.48		-0.92	
3	-0.52		-3.30**		-1.33		-1.93		-2.31*		-1.52	
4	∕1.20		∕0.06		-1.30		-0.71		∕0.65		-0.00	
5	-1.80		-4.61**		-2.54*		-0.40		-2.35*		-6.72**	
6	-0.87		-4.93**		-2.37*		-2.69*		-0.85		-2.41*	
7	-1.36		-3.61**		-2.23*		-2.11*		-1.08		-3.28**	
8	-1.06		-1.73		-3.17**		-2.66*		-0.14		-0.45	

Key: #1. Jump and Reach
2. Standing Broad Jump
3. Soccer Kick for Distance
4. Twenty-Five Yard Dash
5. Ball Throw for Distance (Overhand)
6. Ball Throw for Distance (Underhand)
7. Ball Throw for Accuracy (Overhand)
8. Ball Throw for Accuracy (Underhand)

*5% level
**1% level of significance

- Indicates a better mean performance for the boys
∕ Indicates a better mean performance for the girls

On examining Table 17 significant differences in the mean motor performances of boys and girls of the same chronological age groupings were noted at the five and one percent levels in this study.

For the six-year-olds the standing broad jump was found to be significant at the five percent level. As indicated by their mean performance on the standing broad jump the girls (3.2 feet) were superior to the boys (2.7 feet) of comparable ages.

At the seven-year-level, the soccer kick, over and underhand ball throw for distance and the overhand ball throw for accuracy were each significantly different at the one percent level. At each age interval expressing significant differences in the mean motor skills, with the exception of the six-year-age group, the boys were superior to the girls of the same ages.

At the eight-year-age level the following events were significantly different at the five percent level: over and underhand ball throw for distance and the overhand ball throw for accuracy, while the underhand ball throw for accuracy was significantly different at the one percent level. Again the boys excelled the girls of comparable ages in the mean performances of those physical skills which were significantly different between the sexes.

The underhand ball throw for distance and the over and underhand ball throw for accuracy were significantly differ-

ent at the five percent level for the nine-year-old group. The boys were superior to the girls in each of these events.

At the ten-year-age level, the soccer kick and the ball throw for distance (overhand) were significantly different for the boys and girls. In both events the boys surpassed the girls of comparable ages in the mean performances.

For the eleven-year-olds the overhand ball throw for distance and accuracy were significantly different at the one percent level, whereas, the ball throw for distance (underhand) showed a significance at the five percent level. The boys excelled the girls in each of these events.

On the basis of the findings established in Table 17 the first hypothesis has been verified.

Table 18 is presented along with the preceding table to show, in general, that the boys and girls selected for this study were not significantly different in most of the mean growth ages.

TABLE 18

STUDENT-FISHER t VALUES FOR DIFFERENCES IN THE MEAN GROWTH AGES OF BOYS AND GIRLS CLASSIFIED IN TWELVE-MONTH-AGE INTERVALS

Age Interval	66-77		78-89		90-101		102-113		114-125		126-137	
Sex	Boys	Girls	Boys	Girls	Boys	Girls	Boys	Girls	Boys	Girls	Boys	Girls
Number	8	3	12	10	6	7	12	13	11	6	7	6
Height Age	-0.62		-2.32*		/1.04		/0.15		-0.61		-0.20	
Weight Age	-0.58		-2.06		-0.10		/0.08		-1.59		-0.63	
Grip Age	/0.16		-0.80		/0.13		-0.74		-0.77		-1.21	
Carpal Age	-0.74		-2.17*		-0.35		/0.84		-1.30		-0.45	
Dental Age	/2.34*		-1.16		/0.20		-0.47		-1.19		/0.29	
Reading Age	-0.36		-1.43		/2.29*		/3.59**		-0.03		/1.95	
Mental Age	-0.07		-2.00		/2.11		/2.40*		/0.29		/0.99	
Organismic Age	-0.41		-3.17**		/0.69		/1.59		-0.89		/0.30	

- Indicates a higher mean growth age for the boys
/ Indicates a higher mean growth age for the girls
*Significant at 5 percent level
**Significant at 1 percent level

An examination of Table 18 reveals few significant differences between boys and girls of the same ages in the various age groups. Of the 48 differences between the growth factors and the various age levels, only 7 were statistically significant. Of these 7 significant differences the boys were ahead on three and the girls on four of the mean growth factors.

At the six-year-level the girls were superior to the boys in average dental development. The mean difference in dental age was significant at the five percent level. None of the other aspects of growth in this group were significantly different at the five percent level.

In the seven-year-group, height and carpal ages were significantly different at the five percent level, while organismic age had a one percent level of significance.

The difference in reading age was significant at the five percent level for the eight-year-group, whereas, none of the other aspects of growth were significant.

At the nine-year-interval reading age was significant at the one percent level, with the girls being superior to the boys. The girls were also superior to the boys of comparable ages in mean mental age, which was significant at the five percent level. There were no significant differences between boys and girls in each of the growth aspects at the ten and eleven-year-intervals.

CHAPTER V

CORRELATIONAL RELATIONSHIPS BETWEEN AGE, GROWTH AND SKILLS

For correlational analysis age groups were combined with separate treatment given to the boys and girls. In addition to these broader groupings, the raw physical skill scores were converted into age skill scores by establishing a regression line by the Least-Squares Method. This procedure was followed in order to interpret the physical skill data in the same light as the growth data which had been previously transformed into age-units. Furthermore, the age-scaling of the physical skills was necessary for the interpretation of some of the hypotheses.

The following regression equations were used in establishing the skill ages for each boy and girl used in this study.

$Y = a + bX$	X = skill	Y = skill age
Event	Boys	Girls
Jump and Reach	$Y = 60.49 + 6.5635X$	$Y = 60.07 + 6.8431X$
Standing Broad Jump	$Y = 37.62 + 15.992X$	$Y = 37.93 + 16.476X$
Soccer Kick for Distance	$Y = 75.36 + 1.0821X$	$Y = 83.67 + 1.1467X$
Twenty-Five Yard Dash	$Y = 225.41 - 23.580X$	$Y = 228.13 - 24.001X$
Ball Throw for Distance (Overhand)	$Y = 73.03 + 0.51519X$	$Y = 72.81 + 1.0115X$
Ball Throw for Distance (Underhand)	$Y = 60.36 + 0.93331X$	$Y = 65.31 + 1.1148X$

Event	Boys	Girl
Ball Throw for Accuracy (Overhand)	Y= 73.65/1.6068X	Y= 85.01/1.5196X
Ball Throw for Accuracy (Underhand)	Y= 75.53/1.6438X	Y= 83.56/1.6623X

The linearity of the relationship between the increase in skill and increase in age was tested and found to be linear. The formula $Y = a + bX$ is the equation of the line which expresses this relationship. In other words, Y is the Least-Squares estimate of the average chronological age of people having a given amount of skill. The b coefficient gives the slope of the regression line, and is dependent upon the coefficient of correlation and the two standard deviations as indicated in the following formula (25:398).

$$b_{yx} = r_{yx}\left(\frac{\sigma_y}{\sigma_x}\right)$$

The regression coefficient "a" is a constant which determines the general level of the line. In this study it is indicated by the following formula.

$$a_{yx} = M_y - (M_x)b_{yx}$$

The raw score for each skill was expressed in the following units: jump and reach in terms of inches; standing broad jump, soccer kick, over and underhand ball throw for distance in feet; twenty-five yard dash in seconds; and the over and underhand ball throw for accuracy in points.

In addition to the skill ages which were derived from the preceding regression equations, the raw skill scores

and growth ages for each boy and girl are presented in the appendix of this study.

The following table presents the correlations between chronological age and various physical skills expressed in age units for the boys and girls measured in this study.

TABLE 19

CORRELATIONS BETWEEN CHRONOLOGICAL AGE AND PHYSICAL SKILLS FOR BOYS AND GIRLS RANGING FROM SIX TO ELEVEN YEARS OF AGE

Physical Skill	Boys N-56	Girls N-45
Jump and Reach	.697	.706
Standing Broad Jump	.780	.741
Soccer Kick for Distance	.758	.712
Twenty-Five Yard Dash	.687	.623
Ball Throw for Distance (Overhand)	.762	.790
Ball Throw for Distance (Underhand)	.714	.793
Ball Throw for Accuracy (Overhand)	.567	.611
Ball Throw for Accuracy (Underhand)	.607	.676

As indicated in Table 19 the correlations between chronological age and the various physical skills appear to be high for the girls and boys measured in this study.

For the boys, chronological age correlates highest with the standing broad jump (.780) and lowest with the overhand ball throw for accuracy (.567). In the case of the girls, chronological age correlates highest with the underhand ball throw for distance (.793) and lowest in the overhand ball throw for accuracy (.611).

Table 20, which follows, presents the correlations for those boys and girls measured in this study.

TABLE 20

CORRELATIONS BETWEEN CHRONOLOGICAL AGE AND GROWTH ATTRIBUTES EXPRESSED IN AGE UNITS FOR BOYS AND GIRLS RANGING FROM SIX TO ELEVEN YEARS OF AGE

Growth Attribute	Boys N-56	Girls N-45
Height Age	.764	.853
Weight Age	.620	.732
Grip Age	.791	.709
Carpal Age	.799	.869
Dental Age	.893	.793
Reading Age	.657	.811
Mental Age	.845	.853
Organismic Age	.885	.905

An examination of table 20 revealed a high positive relationship between chronological age and various attributes of growth expressed in age units for the boys and girls studied.

When considering the individual aspects of growth, chronological age correlated highest with dental age (.893) for the boys measured, and carpal age (.869) for the girls. Weight age correlates lowest with chronological age for these boys and girls.

In terms of total growth, there was a higher relationship between organismic age and chronological age (.905) in girls, than in the latter's correlation with any of the growth attributes. For the boys studied, organismic age (.885) was second highest to dental age (.893) in its relationship with chronological age.

Table 21, which appears on the following page, presents correlations between various growth attributes and performances in certain physical skills for boys of elementary school age.

In observing Table 21 the relationships between various aspects of growth and performances in some of the physical skills were noted to be very high for the boys. In every case the correlations were positive.

On the whole, the jump and reach, twenty-five yard dash, and the ball throw for accuracy (over and underhand) correlate the least with the various aspects of growth.

TABLE 21

CORRELATIONS* BETWEEN PERFORMANCES IN PHYSICAL SKILLS AND VARIOUS ASPECTS OF GROWTH IN ELEMENTARY SCHOOL BOYS

Physical Skills	Aspects of Growth							Organismic Age
	Height	Weight	Grip	Carpal	Dental	Reading	Mental	
Jump and Reach	.546	.423	.631	.504	.625	.451	.660	.636
Standing Broad Jump	.599	.442	.705	.552	.703	.542	.706	.702
Soccer Kick for Distance	.695	.682	.751	.703	.800	.605	.657	.625
Twenty-Five Yard Dash	.527	.409	.587	.463	.572	.383	.609	.590
Ball Throw for Distance (Overhand)	.695	.638	.836	.659	.708	.545	.651	.786
Ball Throw for Distance (Underhand)	.674	.625	.768	.631	.701	.551	.638	.762
Ball Throw for Accuracy (Overhand)	.600	.535	.632	.473	.559	.404	.529	.621
Ball Throw for Accuracy (Underhand)	.573	.536	.579	.599	.614	.423	.553	.641

*Note: All the above correlations were significantly different from zero at the one percent level.

In general, dental, carpal and grip ages correlate the most with the various skills for the boys tested in this study.

Table 22, which appears on the following page, presents the relationship existing between various aspects of growth and performances in certain physical skills for the elementary school girls used in this study.

In Table 22 the correlations between performances in certain physical skills and various aspects of growth were positive and high for the girls studied.

For this group, carpal and dental age appeared to be more highly related with performances in the physical skills measured than any of the other growth attributes. Weight, reading and mental age correlate the least with these events.

Organismic age correlates most with the soccer kick for distance (.769) and least with the overhand ball throw for accuracy (.521) for the girls in this study.

The remaining hypotheses are restated, each followed by an analysis based on the results established in this study.

Hypothesis II. - The level of performance in certain physical skills is positively related to organismic age.

In order to test the above hypothesis, correlation coefficients were obtained between organismic age and the

TABLE 22

CORRELATIONS* BETWEEN PERFORMANCES IN CERTAIN PHYSICAL SKILLS AND VARIOUS ASPECTS OF GROWTH IN ELEMENTARY SCHOOL GIRLS

Physical Skills	Aspects of Growth							Organismic Age
	Height	Weight	Grip	Carpal	Dental	Reading	Mental	
Jump and Reach	.666	.532	.660	.702	.690	.543	.513	.668
Standing Broad Jump	.621	.510	.632	.691	.724	.654	.650	.705
Soccer Kick for Distance	.731	.643	.705	.779	.772	.633	.656	.769
Twenty-Five Yard Dash	.589	.410	.518	.615	.631	.503	.513	.587
Ball Throw for Distance (Overhand)	.675	.604	.713	.765	.774	.587	.600	.733
Ball Throw for Distance (Underhand)	.787	.683	.746	.773	.802	.569	.643	.693
Ball Throw for Accuracy (Overhand)	.476	.350	.458	.618	.510	.446	.463	.521
Ball Throw for Accuracy (Underhand)	.581	.515	.670	.633	.652	.528	.563	.697

*Note: All the above correlations were significantly different from zero at the one percent levels excepting ball throw for accuracy (overhand) with weight, which was significant at the two percent level.

physical skills measured. The results are set forth in Table 23 which follows.

TABLE 23

CORRELATIONS BETWEEN ORGANISMIC AGE AND PERFORMANCES IN PHYSICAL SKILLS FOR ELEMENTARY SCHOOL BOYS AND GIRLS

Physical Skills (In Age Units)	Organismic Age	
	Boys N=56	Girls N=45
Jump and Reach	.636	.668
Standing Broad Jump	.702	.705
Soccer Kick for Distance	.625	.769
Twenty-Five Yard Dash	.590	.587
Ball Throw for Distance (Overhand)	.786	.733
Ball Throw for Distance (Underhand)	.762	.693
Ball Throw for Accuracy (Overhand)	.621	.521
Ball Throw for Accuracy (Underhand)	.641	.697

In Table 23 the results showed that a positive relationship had been established between organismic age and the above physical skills measured. Therefore the second hypothesis has been verified for the children measured in this study.

Hypothesis III. - The mean motor performance of the combined physical skills measured is related more to organismic age than to chronological age.

In order to test the above hypothesis a mean motor skill was obtained for the physical measures used, by taking an average of the combined total skill score for each child. Correlations between the mean motor skill age and chronological age were then obtained separately for boys and girls. Similarly correlations were also obtained for organismic age and the mean motor skill age. The following results were established.

	Boys		Girls	
	C.A.	O.A.	C.A.	O.A.
Mean Motor Skill Age	.824	.816	.831	.795
t	.157		.500	

An examination of the above results revealed that the differences between the correlations were not found to be significant at the five percent level. Even when mental and reading age were omitted and a new mean age for the girls was computed with only the physical aspects of growth, its correlation with the mean motor skill was .803.

The following formula was used in computing significant differences between the correlations (15:203-204).

$$t = \frac{z_1 - z_2}{\sqrt{\frac{1}{N_1 - 3} + \frac{1}{N_2 - 3}}}$$

On the basis of the sample tested the correlations for organismic age and chronological age with the mean motor skill age may be considered identical. Therefore the above hypothesis has not been verified.

Hypothesis IV. - The degree of homogeneity between the selected aspects of growth will determine the consistency and level of performance of children as measured by the arithmetic average of the combined physical skills. Conversely, the degree of heterogeneity between the selected growth measures will determine the variability and level of performance of the children.

In order to test the above hypothesis it was necessary to obtain the following variables: a mean motor skill age, standard deviation of the motor skill age, and the standard deviation of the organismic age for each girl and boy.

Product-moment and partial correlations were then computed between pairs of these variables for the boys and girls separately. Since there was a wide range in the ages (six to eleven years) of the children tested, it was necessary to partial out the effects of chronological age.

The following results were obtained:

	Boys	
	Product-moment r	Partial r
S.D. of Mean Skill Age with S.D. of O.A.	.203	.150
Mean Skill Age with S.D. of O.A.	.376	.024
	Girls	
S.D. of Mean Skill Age with S.D. of O.A.	-.009	-.289
Mean Skill Age with S.D. of O.A.	.341	-.277

An examination of the above partial correlations revealed the presence of a small positive correlation (.150) for the boys and a negative correlation (-.289) for girls, between consistency in mean skill performance and homogeneity in total growth. Likewise there was also a slight positive correlation (.024) for the boys and a negative correlation (-.277) for the

girls between the mean skill age and the standard deviation of the organismic age.

The partial correlations were not statistically significant at the five percent level. Therefore the writer was unable to demonstrate any statistically significant correlations between homogeneity and heterogeneity of the growth attributes and consistency as well as level of performance in the subjects tested.

Table 24, which appears on the following page, presents correlations between various growth attributes and physical skills performed by elementary school boys selected for this study.

As indicated in Table 24, many of the relationships between various aspects of growth and performance in physical skills were significant but not highly so for boys.

When chronological age was kept constant, the soccer kick for distance was found to be significant at the one percent level with weight, grip and dental ages, and with height age at the five percent level.

The ball throw for distance (over and underhand) and the ball throw for accuracy (overhand) were significant with grip age at the one percent level, and with height and weight age at the five percent level.

Weight and carpal age correlated low and negatively with the jump and reach and the standing broad jump.

The mean partial correlations were obtained by transforming the partial correlations into z scores found in

TABLE 24

PARTIAL CORRELATIONS BETWEEN VARIOUS ASPECTS OF GROWTH AND CERTAIN PHYSICAL SKILLS HOLDING CHRONOLOGICAL AGE CONSTANT FOR BOYS RANGING FROM SIX TO ELEVEN YEARS OF AGE

Physical Skills	Aspects of Growth							Mean Partial r
	Height	Weight	Grip	Carpal	Dental	Reading	Mental	
Jump and Reach	.028	-.016	.182	-.123	.009	-.013	.185	.036
Standing Broad Jump	.007	-.085	.230	-.189	.021	.064	.140	.027
Soccer Kick for Distance	.276*	.414**	.378**	.248	.419**	.218	.046	.290**
Twenty-Five Yard Dash	.004	-.030	.099	-.197	-.125	-.124	.072	-.044
Ball Throw for Distance (Overhand)	.270*	.326*	.588**	.128	.096	.090	.020	.228**
Ball Throw for Distance (Underhand)	.286*	.331*	.474**	.145	.200	.155	.093	.245**
Ball Throw for Accuracy (Overhand)	.314*	.283*	.365**	.040	.143	.050	.113	.190**
Ball Throw for Accuracy (Underhand)	.213	.256	.203	.239	.201	.040	.094	.179**
Mean Partial r	.177**	.191**	.325**	.037	.124**	.060	.096*	

*Significantly different from zero at the five percent level
**Significantly different from zero at the one percent level

Table V. B. in Fisher's Statistical Methods for Research Workers. The z scores were then combined for each physical skill and aspect of growth. A mean z score was obtained for each growth attribute and skill by taking an average of the combined z scores. With the use of Table V.B. mentioned above, the mean z scores were transformed into mean partial correlations.

In order to test whether the mean partial correlations were significantly different from zero the following formula was used.

$$t = \frac{r\sqrt{N - 3}}{\sqrt{1 - r^2}}$$

In Table 24 the mean partial correlations for the soccer kick for distance, over and underhand ball throw for distance, and the over and underhand ball throw for accuracy were all significant at the one percent level for the boys tested in this sample.

Table 25, which appears on the following page, presents partial correlations between aspects of growth and physical skills for the girls measured in this study.

An examination of Table 25 revealed the existence of many significant correlations even though they were small. For example, grip, carpal and dental age were more significantly related with most of the physical skills than any of the other growth attributes. None of the aspects of growth were significantly related to the twenty-five yard dash and the ball throw for accuracy (overhand). The relationship

PARTIAL CORRELATIONS BETWEEN VARIOUS ASPECTS OF GROWTH AND CERTAIN PHYSICAL SKILLS HOLDING CHRONOLOGICAL AGE CONSTANT FOR GIRLS RANGING FROM SIX TO ELEVEN YEARS OF AGE

Physical Skills	Aspects of Growth							Mean Partial r
	Height	Weight	Grip	Carpal	Dental	Reading	Mental	
Jump and Reach	.173	.031	.319*	.251	.301*	-.072	-.241	.112
Standing Broad Jump	-.031	-.072	.226	.142	.333*	.135	.051	.115*
Soccer Kick for Distance	.339*	.255	.404**	.460**	.484**	.136	.134	.323**
Twenty-Five Yard Dash	.142	-.086	.138	.191	.287	-.004	-.047	.091
Ball Throw for Distance (Overhand)	.003	.062	.354*	.257	.397**	-.150	-.231	.105
Ball Throw for Distance (Underhand)	.349*	.248	.429**	.279	.466**	-.208	-.107	.217**
Ball Throw for Accuracy (Overhand)	-.109	-.180	.045	.222	.052	-.108	-.140	-.031
Ball Throw for Accuracy (Underhand)	.010	.040	.367*	.126	.258	-.046	-.036	.106
Mean Partial r	.113*	.038	.290**	.244**	.328**	-.040	-.078	

*Significantly different from zero at the five percent level
**Significantly different from zero at the one percent level

between mental age and most of the physical skills was negative, and the correlations ranged from -.036 to .134.

The mean partial correlations for the soccer kick for distance and the ball throw for distance (underhand) were significant at the one percent level for the girls tested, while the standing broad jump was significant at the five percent level.

Hypothesis V. - Selected aspects of growth, taken independently, will be related to performance in some of the physical skills more than to others.

The following formula was used to test whether one mean partial correlation was significantly different from another.

$$t = \frac{z_1 - z_2}{\sqrt{\frac{1}{N_1 - 3} + \frac{1}{N_2 - 3}}}$$

In Table 24 the mean partial correlation for grip age with the physical skills was significantly higher than all other aspects of growth at the five percent level for the boys. The mean partial correlation for carpal age was significantly lower than either height, weight or grip with the physical skills, but not significantly lower than dental, reading or mental age at the five percent level.

For the boys the mean partial correlations for jump and reach, standing broad jump and the twenty-five yard dash with all of the aspects of growth were not significantly different from each other at the five percent level. However each of the above skills was significantly lower than any of the mean partial correlations for the soccer kick,

over and underhand ball throw for distance, and over and underhand ball throw for accuracy at the five percent level. In the last mentioned group of skills, each was not significantly different from others in that group.

In Table 25 the mean partial correlation for dental age with the physical skills was significantly higher than corresponding correlations for all other growth aspects except grip and carpal age at the five percent level for the girls. With the exception of carpal and dental age the mean partial correlation for grip age with the physical skills was significantly higher than all other aspects of growth at the five percent level. For the girls the mean partial correlation for the soccer kick was significantly higher than the mean partial correlations for all other skills with growth aspects, excepting the underhand ball throw for distance at the five percent level. The overhand ball throw for accuracy was lower than the soccer kick and the underhand ball throw for distance, but not significantly lower than the other skills with the growth aspects at the five percent level. Therefore the fifth hypothesis has been established by this sample.

Table 26, which is on the following page, presents partial correlations between organismic age and the physical skills for the boys and girls studied.

In Table 26 many of the relationships between organismic age and the physical skills were more significant for the

TABLE 26

PARTIAL CORRELATIONS BETWEEN ORGANISMIC AGE AND PHYSICAL SKILLS HOLDING CHRONOLOGICAL AGE CONSTANT FOR BOYS AND GIRLS RANGING FROM SIX TO ELEVEN YEARS OF AGE

Physical Skills	Organismic Age	
	Boys	Girls
Jump and Reach	.057	.096
Standing Broad Jump	.041	.119
Soccer Kick for Distance	-.151	.418**
Twenty-Five Yard Dash	-.053	.069
Ball Throw for Distance (Overhand)	.371**	.069
Ball Throw for Distance (Underhand)	.399**	-.097
Ball Throw for Accuracy (Overhand)	.310*	-.095
Ball Throw for Accuracy (Underhand)	.281*	.271

*Significantly different from zero at the five percent level.

**Significantly different from zero at the one percent level.

boys than the girls. For the boys organismic age was significant at the one percent level with ball throw for distance (over and underhand), and with ball throw for accuracy (over and underhand) at the five percent level. For the girls only the soccer kick for distance was significant

at the one percent level, while none of the other relationships were proved significant.

CHAPTER VI

SUMMARY AND CONCLUSIONS

A study of the relationship between performance in certain physical skills and various aspects of growth was made on a total of 56 boys and 45 girls in grades one through six in the University Elementary School of the University of Michigan. From a total of 137 students enrolled, 101 boys and girls were selected for this study. The selection was made on the basis of availability of complete physical and mental growth data for each child.

Summary. - Eight test items consisting of the jump and reach, standing broad jump, soccer kick for distance, twenty-five yard dash, ball throw for distance (overhand and underhand), and the ball throw for accuracy (overhand and underhand) were treated statistically by means, medians and standard deviations for boys and girls at various age levels. The same treatment was also given to the following growth attributes: height, weight, grip, carpal, dental, reading and mental ages, which have been previously age scaled by Olson and Hughes (49).

Tables 1 through 8 show the mean motor performances of boys and girls from six through eleven years of age. Increases in the mean motor performances for boys and girls were observable at each advancing age level in this study.

Increase in mean motor performance were more evident, however, at various age levels for some of the physical skills measured. For example, there was more increase in performance on the jump and reach for boys between eight and nine years of age, and for girls between nine and ten.

There were marked increases on the overhand ball throw for distance for boys from six to seven and between the ten and eleven-year-age levels, and likewise for the girls from nine to the ten-year-interval.

On the ball throw for distance (underhand), the boys showed the greatest increase in achievement between the six and seven-year-age levels, and the girls from nine to the ten-year-interval.

There was also evidence of sex differences in the mean motor performances and also in the mean growth attributes by age intervals. The six, seven, ten and eleven-year-old girls were superior to the boys of comparable ages on the jump and reach. The boys surpassed the girls at the seven, eight, nine and eleven-year levels on the standing broad jump. At each age interval the boys were superior to the girls on the soccer kick, over and underhand ball throw for distance, and the over and underhand ball throw for accuracy. However, the girls displayed superiority in the twenty-five yard dash at the six, seven and ten-year-age level.

Tables 9 through 16 present the mean growth attributes of boys and girls at various age levels. On examining the

table the following observations were made. The boys exceeded the girls in mean height and carpal age development at all levels. The girls surpassed the boys in mean weight age at the nine-year-level, and also in mean grip age at the six and eight-year-intervals. The seven, nine and ten-year-old boys were superior to the girls of the same ages in mean dental age. The boys also surpassed the girls of comparable ages in mean reading age at the six, seven and nine-year-levels. The girls, however, were superior to the boys of the same ages in average mental age development at the eight, nine, ten and eleven-year-intervals.

When the total growth of the child was considered, the boys were found to be superior to the girls of comparable ages in mean organismic age at the six, seven and ten-year-levels, while the girls surpassed the boys at the eight, nine and eleven-year-intervals.

High and positive correlation coefficients were obtained between chronological age and each of the various physical skills measured. In the case of the boys the three highest correlations obtained were the standing broad jump (.780), overhand ball throw for distance (.762) and the soccer kick for distance (.758). The three lowest correlations for the boys were found to be the twenty-five yard dash (.687) and the over- and underhand ball throw for accuracy (.567, .607). For the girls, the three highest correlations between chronological age and the physical skills measured were obtained

on the following: under- and overhand ball throw for distance (.793, .790) and the standing broad jump (.741). The three lowest relationships were on the over- and underhand ball throw for accuracy (.611, .676) and the twenty-five yard dash (.623).

This study further revealed a high positive relationship existing between chronological age and the various aspects of growth for both boys and girls. For the boys, dental age (.893) correlated higher than any other aspect of growth with chronological age. Whereas carpal age (.869) correlated highest with chronological age in girls. Weight age correlated the least with chronological age for both boys and girls.

In terms of total growth, a higher relationship existed between organismic age and chronological age in girls (.905) than in boys (.885). The sex difference was not significant.

When the individual aspects of growth were correlated with each physical skill the resultant relationships were found to be high and positive for both boys and girls in this study. However, when chronological age was held constand the resulting relationships between each growth attribute and the individual physical skill was found to be low and in some cases negative. In terms of total growth, the relationship between organismic age and the physical skills varied from -.151 on the soccer kick to .399 for the underhand ball throw for distance for the boys. The partial

correlations between organismic age and the gross motor skills ranged from -.097 for the underhand ball throw for distance to .418 on the soccer kick for the girls.

Conclusions. - There is reason to believe that if successive samples of similar children were tested, they would provide somewhat the same results as the initial group in their performances on the physical skills measured.

Superior mean motor performances were noted for each succeeding older age group. However, the superiority of the eleven-year-old girls over the ten-year-old girls in mean motor performances appeared to be slight. There seemed to be no significant differences between the boys and girls in their performances on the jump and reach, standing broad jump and the twenty-five-yard dash at various age levels. However, the difference that did exist in the mean performance of the six-year-olds on the standing broad jump may have been due in part to the size and selection of the sample.

The results obtained on the over and underhand ball throw for distance and accuracy gave evidence of significant differences between boys and girls of the same age level.

A subsidiary finding in this study revealed a difference in the ability and manner of throwing a ball for distance. Out of a total of fifty-six boys, thirty-eight or approximately sixty-eight percent threw the ball further overhand than underhand. Thirty-two girls out of a total of forty-five, or approximately seventy-one percent, threw the ball further underhand than overhand. These results

suggest a preference in the manner of throwing a ball by boys and girls of elementary school age. This difference in ability to throw over and underhand was significant at the one percent level for the children measured in this study.

When chronological age was held constant for the boys, the relationships between height, weight or grip age with the soccer kick, over and underhand ball throw for distance, and the overhand ball throw for accuracy appeared to be higher than other growth measures used. These relationships were significant at the one and five percent level. Grip, dental and carpal age showed significant relationships to some of the motor skills for the girls studied in this sample.

For the boys the mean partial correlation for grip age and the physical skills was found to be significantly higher than any other aspect of growth at the five percent level. Dental, reading and mental age were found to be significantly lower than other growth measures with the physical skills in general.

For the girls the mean partial correlations for dental, grip and carpal age with the physical skills were found to be significantly higher than other growth measures.

The results obtained in this study suggested that some of the growth aspects were more related to the physical skills than were other measures of maturity.

It is recommended that further study be made on the motor performances of elementary school children in relation to their various aspects of growth. It is also recommended that some of the physical skills used in this study be combined with other events and be made applicable to elementary school children. In addition to the growth measures the physical events should be given at yearly intervals to each child. This longitudinal approach would give a more accurate measure of the child's development in motor ability.

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APPENDIX

RAW PHYSICAL SKILL SCORES FOR EACH BOY FROM SIX TO ELEVEN YEARS OF AGE

Key

I. Jump and Reach
II. Standing Broad Jump
III. Soccer Kick
IV. Twenty-Five Yard Dash
V. Ball Throw for Distance-Overhand
VI. Ball Throw for Distance-Underhand
VII. Ball Throw for Accuracy-Overhand
VIII. Ball Throw for Accuracy-Underhand

Physical Skills

O.A. (Mo.)	I (In.)	II (Ft.)	III (Ft.)	IV (Sec.)	V (Ft.)	VI (Ft.)	VII (Pts.)	VIII (Pts.)
72	4.5	3.1	5.0	6.0	21.0	23.2	14	6
72	4.8	2.9	8.8	6.1	29.0	19.3	6	12
74	2.7	2.7	8.3	6.0	15.3	16.5	2	6
74	4.5	2.8	8.7	6.7	24.8	32.3	10	8
76	6.2	2.8	8.2	5.5	19.3	24.8	4	4
76	3.3	2.1	16.5	5.8	25.2	35.0	16	20
77	3.8	2.8	4.0	5.9	24.3	21.5	4	4
77	5.7	2.7	8.0	5.5	35.8	24.7	16	6
78	3.7	2.5	14.8	6.0	43.3	28.3	12	6
78	4.4	3.4	10.8	5.8	22.7	26.7	8	8
80	3.8	3.5	9.5	6.1	27.3	32.8	14	4
83	7.0	4.3	33.3	4.8	63.3	59.3	26	22
84	4.7	3.2	21.5	5.8	47.2	37.2	14	14
84	5.9	4.7	20.8	4.7	40.7	44.7	18	14
86	4.7	2.4	7.3	7.0	16.2	35.2	10	2
88	6.0	4.2	9.5	5.0	47.8	45.7	18	24
88	4.2	4.5	22.8	5.2	56.0	34.2	18	8
88	3.9	3.9	15.2	5.3	30.7	32.2	16	4
88	4.8	2.9	9.5	5.5	60.2	40.0	26	20
89	4.3	3.8	16.7	5.7	37.7	40.7	4	16
90	3.1	2.5	10.6	5.7	17.8	31.0	14	20
95	3.0	3.3	42.7	5.1	66.3	59.3	20	16
95	6.8	3.9	21.0	5.1	53.0	41.3	26	14
95	8.8	4.1	18.3	4.9	48.0	37.0	22	14
101	5.8	4.8	48.3	4.9	78.7	65.7	22	26
101	5.3	3.3	12.7	5.3	23.8	33.7	8	18
103	5.4	3.5	23.1	5.2	67.2	51.7	22	20
103	6.3	4.5	17.6	4.9	55.0	40.3	22	14
105	4.0	3.4	11.0	5.6	24.8	29.7	4	10

RAW PHYSICAL SKILL SCORES FOR EACH BOY FROM SIX TO ELEVEN YEARS OF AGE (Continued)

C.A. (Mo.)	I (In.)	II (Ft.)	III (Ft.)	IV (Sec.)	V (Ft.)	VI (Ft.)	VII (Pts.)	VIII (Pts.)
105	7.0	4.1	23.2	5.3	42.2	41.2	18	18
106	6.1	4.3	22.5	4.9	44.0	47.7	12	14
106	6.0	4.5	29.0	5.5	58.3	46.0	26	26
107	10.7	4.8	23.7	4.3	44.5	55.0	24	10
108	7.5	3.8	16.2	5.1	40.0	31.0	20	16
109	6.8	4.9	32.7	5.1	65.0	42.5	18	24
111	10.6	4.6	36.3	4.7	93.0	67.8	20	20
112	9.2	5.2	41.7	4.6	98.5	67.5	20	26
113	6.1	4.7	36.7	4.9	62.0	45.3	24	18
114	8.9	4.8	37.5	5.0	80.8	66.0	24	20
114	8.8	4.9	26.7	5.1	60.8	57.2	16	24
115	6.3	3.7	14.4	5.5	39.0	42.0	22	22
115	7.7	3.6	30.5	5.0	79.3	49.2	22	10
116	5.8	3.5	21.0	5.5	53.8	35.5	14	14
116	6.3	4.7	36.3	5.2	53.7	50.7	18	16
117	9.1	4.9	49.8	4.7	108.0	61.2	20	26
117	7.6	4.1	35.0	4.8	96.8	68.2	26	20
118	6.4	4.1	28.7	5.0	32.8	33.8	16	14
120	6.4	5.3	34.2	4.5	74.5	56.0	18	22
124	9.1	5.1	25.8	4.7	67.7	45.2	16	20
129	7.2	4.8	40.2	4.8	125.7	67.8	26	16
129	9.5	5.1	48.8	4.7	107.3	48.8	24	26
131	8.0	5.5	33.2	4.7	93.5	59.0	24	16
131	7.2	4.6	46.2	5.0	77.0	56.3	20	20
132	7.8	4.9	28.5	5.0	90.2	67.7	22	26
134	7.7	5.0	45.3	4.8	79.2	52.0	22	24
137	9.0	5.8	45.5	4.7	108.7	66.2	24	18

RAW PHYSICAL SKILL SCORES FOR EACH GIRL FROM SIX TO ELEVEN YEARS OF AGE

Key

I. Jump and Reach
II. Standing Broad Jump
III. Soccer Kick
IV. Twenty-Five Yard Dash
V. Ball Throw for Distance-Overhand
VI. Ball Throw for Distance-Underhand
VII. Ball Throw for Accuracy-Overhand
VIII. Ball Throw for Accuracy-Underhand

Physical Skills

C.A. (Mo.)	I (In.)	II (Ft.)	III (Ft.)	IV (Sec.)	V (Ft.)	VI (Ft.)	VII (Pts.)	VIII (Pts.)
73	7.4	3.3	6.7	5.3	25.5	29.0	8	8
74	3.6	2.9	6.8	6.2	13.3	14.5	4	4
76	3.5	3.4	8.3	5.3	8.8	19.0	00	2
79	6.9	3.9	6.2	5.2	27.5	26.2	16	6
79	3.5	2.6	6.2	5.3	12.8	8.7	0	0
79	3.5	2.8	5.7	5.6	13.2	16.3	0	0
82	4.9	2.7	4.3	5.8	15.7	19.7	4	6
84	6.0	3.6	12.0	5.9	13.5	22.0	6	12
84	4.3	2.6	6.0	6.1	10.8	21.2	2	10
85	4.8	3.2	7.7	5.4	24.8	35.2	12	8
85	3.7	3.9	11.5	5.9	23.5	20.8	12	4
88	6.3	4.0	11.7	5.1	21.3	23.3	4	16
89	5.9	3.4	4.2	5.4	16.7	17.2	2	8
91	3.3	3.1	17.2	5.5	11.5	35.7	6	2
93	6.4	3.8	17.2	5.6	19.7	21.7	4	8
93	6.1	3.6	10.7	5.4	18.0	28.8	20	6
96	5.8	3.9	13.3	5.0	31.0	34.5	12	18
98	4.6	3.7	11.5	5.2	22.7	32.2	16	14
100	4.1	3.2	10.8	6.3	26.7	28.2	12	4
101	5.5	3.8	17.5	5.1	36.7	35.7	8	10
103	5.8	4.0	15.3	4.9	22.8	36.3	18	18
103	5.2	3.5	15.0	5.3	18.7	21.7	14	4
103	7.0	4.2	13.3	5.1	27.0	20.5	20	14
103	6.8	3.8	31.8	5.0	38.2	44.3	18	12
104	6.7	4.3	22.0	4.9	20.8	40.2	4	10
106	4.7	3.6	6.0	5.3	21.6	26.6	2	8
107	6.0	4.5	17.2	4.9	27.0	24.3	22	14
107	6.7	3.5	15.2	5.1	37.7	46.0	8	12
108	7.2	4.3	17.8	5.2	36.3	38.8	10	12
110	6.1	4.7	45.8	4.8	46.2	49.3	14	16
110	5.3	3.6	6.0	5.9	31.0	36.0	10	2
113	8.8	5.1	22.3	4.8	48.7	45.3	20	26
113	6.8	4.2	11.3	5.0	35.2	30.5	20	4
116	7.7	3.3	19.0	5.5	17.2	32.2	6	14
117	7.0	4.9	14.7	5.0	41.3	40.2	20	20
118	5.3	3.8	14.3	5.2	25.5	48.3	14	8

RAW PHYSICAL SKILL SCORES FOR EACH GIRL FROM SIX TO ELEVEN YEARS OF AGE (Continued)

C.A. (Mo.)	I (In.)	II (Ft.)	III (Ft.)	IV (Sec.)	V (Ft.)	VI (Ft.)	VII (Pts.)	VIII (Pts.)
119	8.2	4.7	10.3	4.5	60.5	51.0	24	22
120	7.5	4.8	28.5	5.0	57.0	49.3	24	14
122	12.0	6.2	33.5	4.0	52.8	59.2	10	28
126	8.2	4.7	25.7	4.9	36.3	35.0	14	14
129	6.7	4.6	20.2	5.0	41.8	36.0	10	22
133	9.2	4.9	50.3	4.4	49.7	58.5	16	26
136	9.4	5.3	39.3	4.6	51.3	54.5	20	14
136	8.2	5.7	38.7	4.8	53.8	56.3	22	24
137	8.7	3.7	23.5	5.2	44.3	44.8	20	18

PHYSICAL SKILL SCORES EXPRESSED IN AGE UNITS (MONTHS) FOR EACH BOY FROM SIX TO ELEVEN YEARS OF AGE

Key

I. Jump and Reach
II. Standing Broad Jump
III. Soccer Kick
IV. Twenty-Five Yard Dash
V. Ball Throw for Distance-Overhand
VI. Ball Throw for Distance-Underhand
VII. Ball Throw for Accuracy-Overhand
VIII. Ball Throw for Accuracy-Underhand

Physical Skills

C.A.	I	II	III	IV	V	VI	VII	VIII
72	90	87	81	84	84	82	96	85
72	92	84	85	82	88	78	83	95
74	78	81	84	84	81	76	77	85
74	90	82	85	67	86	91	90	89
76	101	82	84	96	83	84	80	82
76	82	71	93	89	86	93	99	108
77	85	82	80	86	86	80	80	86
77	98	81	84	96	92	83	99	85
78	85	78	91	84	95	87	93	85
78	89	92	87	89	85	85	87	89
80	85	94	86	82	87	91	96	82
83	106	106	111	112	106	116	115	112
84	91	89	99	89	97	95	96	99
84	99	113	98	115	94	102	103	99
86	91	76	83	60	81	93	90	79
88	100	105	86	108	98	103	103	115
88	88	110	100	103	102	92	103	89
88	86	100	92	100	89	90	99	82
88	92	84	86	96	104	98	115	108
89	89	98	93	91	93	98	80	102
90	81	78	87	91	82	89	96	108
95	80	90	122	105	107	116	106	102
95	105	100	98	105	100	99	115	99
95	118	103	95	110	98	95	109	99
101	99	114	128	110	114	122	109	118
101	95	90	89	100	85	92	87	105
103	96	94	100	103	108	109	109	108
103	102	110	94	110	101	98	109	99
105	87	92	87	93	86	88	80	92
105	106	103	101	100	95	99	103	105
106	101	106	100	110	96	105	93	99
106	100	110	107	96	103	103	115	118
107	131	114	101	124	96	112	112	92
108	110	98	93	105	94	89	106	102
109	105	116	111	105	107	100	103	115

PHYSICAL SKILL SCORES EXPRESSED IN AGE UNITS (MONTHS)
FOR EACH BOY FROM SIX TO ELEVEN YEARS OF AGE
(Continued)

C.A.	I	II	III	IV	V	VI	VII	VIII
111	130	111	115	115	121	124	106	108
112	121	121	121	117	124	123	106	118
113	101	113	115	110	105	103	112	105
114	119	114	116	108	115	122	112	108
114	118	116	104	105	104	114	99	115
115	102	97	91	96	93	100	109	112
115	111	95	108	108	114	106	109	92
116	99	94	98	96	101	94	96	99
116	102	113	115	103	101	108	103	102
117	120	116	129	115	129	118	106	118
117	110	103	113	112	123	124	115	108
118	103	103	106	108	90	92	99	99
120	103	122	112	119	111	113	103	112
124	120	119	103	115	108	103	99	108
129	108	114	119	112	138	124	115	102
129	123	119	128	115	128	106	112	118
131	113	126	111	151	121	115	112	102
131	108	111	125	108	113	113	106	108
132	112	116	106	108	120	124	109	118
134	111	118	124	112	114	109	109	115
137	120	130	125	115	129	122	112	105

PHYSICAL SKILL SCORES EXPRESSED IN AGE UNITS (MONTHS) FOR EACH GIRL FROM SIX TO ELEVEN YEARS OF AGE

Key

I. Jump and Reach
II. Standing Broad Jump
III. Soccer Kick
IV. Twenty-Five Yard Dash
V. Ball Throw for Distance-Overhand
VI. Ball Throw for Distance-Underhand
VII. Ball Throw for Accuracy-Overhand
VIII. Ball Throw for Accuracy-Underhand

Physical Skills

C.A.	I	II	III	IV	V	VI	VII	VIII
73	111	92	91	101	99	98	97	97
74	85	86	92	79	86	82	91	90
76	84	94	93	101	82	87	85	87
79	107	102	91	103	101	95	109	94
79	84	81	91	101	86	75	85	84
79	84	84	90	94	86	84	85	84
82	94	82	89	89	89	87	91	94
84	101	97	97	87	87	90	94	104
84	90	81	91	82	84	89	88	100
85	93	91	93	99	98	105	103	97
85	85	102	97	87	97	89	103	90
88	103	104	97	106	94	91	91	110
89	100	94	89	99	90	85	88	97
91	83	89	103	96	84	105	94	87
93	104	101	103	94	93	90	91	97
93	102	97	96	99	91	97	115	94
96	100	102	99	108	104	104	103	114
98	92	99	97	103	96	101	109	107
100	88	91	96	77	100	97	103	90
101	98	101	104	106	110	105	97	100
103	100	104	101	111	96	106	112	114
103	96	96	101	101	92	90	106	90
103	108	107	99	106	100	88	115	107
103	107	101	120	108	111	115	112	104
104	106	109	109	111	94	110	91	100
106	92	97	91	101	95	95	88	97
107	101	112	103	111	100	92	118	107
107	106	96	101	106	111	117	97	104
108	109	109	104	103	110	109	100	104
110	102	115	136	113	120	120	106	110
110	96	97	91	87	104	105	100	87
113	120	122	109	112	120	116	115	127
113	107	107	97	108	109	99	115	90
116	113	92	106	96	90	101	94	107
117	108	119	101	108	115	110	115	117
118	96	101	100	103	99	119	106	97

PHYSICAL SKILL SCORES EXPRESSED IN AGE UNITS (MONTHS)
FOR EACH GIRL FROM SIX TO ELEVEN YEARS OF AGE
(Continued)

C.A.	I	II	III	IV	V	VI	VII	VIII
119	116	115	96	120	134	122	122	120
120	111	117	116	108	131	120	122	107
122	142	140	122	132	126	131	100	130
126	116	115	113	111	110	104	106	107
129	106	114	107	108	115	105	100	120
133	123	119	141	123	123	131	109	127
136	124	125	129	118	125	126	115	107
136	116	132	128	113	127	128	118	124
137	120	99	111	103	118	115	115	114

GROWTH AGES EXPRESSED IN MONTHS FOR EACH BOY FROM SIX TO ELEVEN YEARS OF AGE

O.A.	Height	Weight	Grip	Carpal	Dental	Reading	Mental	O.A.
72	70	70	49	48	71	77	82	67
72	87	139	94	97	68	76	95	94
74	75	69	54	66	69	96	96	75
74	74	72	64	89	67	76	73	74
76	76	76	92	81	73	77	94	81
76	99	128	80	126	78	77	84	96
77	75	75	64	77	78	78	111	80
77	79	76	58	74	64	76	77	72
78	92	90	80	97	81	76	95	87
78	76	83	64	98	70	79	90	80
80	99	102	80	101	86	106	100	96
83	108	117	98	89	98	106	120	105
84	133	146	93	90	79	80	98	103
84	86	90	98	85	83	107	113	95
86	92	128	87	101	102	107	131	107
88	94	128	98	96	84	83	124	101
88	93	87	93	89	89	114	125	99
88	107	114	98	94	94	80	100	98
88	97	112	102	89	92	89	112	99
89	94	92	80	92	99	84	117	94
90	87	79	58	86	81	95	114	86
95	108	147	111	117	113	91	124	116
95	82	85	87	92	88	92	125	93
95	113	100	111	98	93	89	147	107
101	126	168	106	122	106	94	110	119
101	74	74	72	93	90	102	115	89
103	130	165	123	122	112	88	135	125
103	105	100	106	84	97	81	104	97
105	101	95	98	101	101	95	130	103
105	94	99	93	103	97	109	172	110
106	120	123	102	125	96	87	122	111
106	115	107	105	119	112	139	167	123
107	96	104	102	92	112	100	141	107
108	153	161	86	126	100	83	124	119
109	130	128	149	128	112	98	150	128
111	114	117	122	123	112	89	120	114
112	108	108	128	85	101	118	132	111
113	121	123	128	114	112	89	128	116
114	150	147	111	115	113	140	171	135
114	145	144	122	133	112	135	196	141
115	146	148	128	129	112	95	132	127
115	133	151	128	124	112	116	160	132
116	83	94	97	119	111	103	118	104
116	120	133	116	116	118	104	131	120

GROWTH AGES EXPRESSED IN MONTHS FOR EACH BOY FROM SIX TO ELEVEN YEARS OF AGE (Continued)

O.A.	Height	Weight	Grip	Carpal	Dental	Reading	Mental	O.A.
117	145	163	140	142	135	138	158	146
117	137	156	140	123	112	132	171	139
118	130	133	102	119	112	144	178	131
120	104	109	102	118	112	119	149	116
124	104	115	107	113	128	126	155	121
129	155	159	178	126	111	157	164	150
129	126	159	122	148	137	102	169	138
131	144	146	115	135	111	105	187	135
131	149	192	122	147	144	166	169	156
132	147	127	149	143	119	107	159	136
134	151	149	134	131	151	134	177	147
137	136	147	163	151	118	99	174	141

GROWTH AGES EXPRESSED IN MONTHS FOR EACH GIRL FROM SIX TO ELEVEN YEARS OF AGE

O.A.	Height	Weight	Grip	Carpal	Dental	Reading	Mental	O.A.
73	68	74	84	71	86	78	72	76
74	81	84	84	79	75	78	87	81
76	78	77	46	66	77	77	106	75
79	82	84	84	106	85	85	99	89
79	80	80	51	73	81	78	89	76
79	72	74	68	84	77	76	90	77
82	86	77	68	67	79	75	85	77
84	94	85	76	96	88	80	87	87
84	82	104	84	84	80	81	107	89
85	105	111	96	85	89	81	88	94
85	84	116	68	86	99	108	109	96
88	87	101	90	92	83	81	109	92
89	85	84	76	84	79	102	126	91
91	116	120	90	102	97	108	141	111
93	103	85	96	92	92	97	135	100
93	98	97	76	88	77	88	126	93
96	109	118	97	96	95	112	136	109
98	108	101	84	103	109	121	135	109
100	106	115	96	105	97	102	134	108
101	106	115	105	108	108	104	130	111
103	98	110	96	105	97	107	150	109
103	106	78	68	102	97	125	148	103
103	114	102	76	103	96	114	148	108
103	143	147	153	145	109	127	163	141
104	115	113	105	103	97	107	129	110
106	115	113	75	95	108	154	200	123
107	106	103	105	126	108	127	148	118
117	135	140	119	124	109	100	129	122
108	110	150	119	121	108	163	164	134
110	109	110	109	121	108	121	151	118
110	119	151	109	112	108	101	168	124
113	112	112	125	118	107	149	173	128
113	132	130	114	123	102	127	134	123
116	128	147	119	123	108	154	184	138
117	113	105	125	103	102	119	152	117
118	101	89	84	105	107	113	153	107
119	117	111	96	123	107	99	144	114
120	121	120	119	118	108	126	170	126
122	145	138	125	128	132	125	153	135
126	150	146	118	132	117	147	176	141
129	133	140	139	128	126	163	181	144
133	172	188	161	157	141	138	206	166
136	139	129	105	140	141	181	180	145
136	127	146	125	133	122	159	207	146
137	134	133	101	136	130	121	138	128

University of Michigan
University Elementary School
Ann Arbor, Michigan

Name: Date: Grade:
Date of Birth:

EVENT	TRIAL
1. Jump and Reach	1. _____ 2. _____ Average_____ 3. _____
2. Standing Broad Jump	1. _____ 2. _____ Average_____ 3. _____
3. Soccer Kick for Distance	1. _____ 2. _____ Average_____ 3. _____
4. 25-Yard Dash	1. _____ 2. _____ Average _____ 3. _____
5. Soft-ball Throw for Distance	Arm preference: Right___Left___Overhand____ 1. _____ 2. _____ Average_____ 3. _____
	Arm preference: Right____Left____Underhand____ 1. _____ 2. _____ Average_____ 3. _____
6. Soft-ball Throw for Accuracy	Arm preference: Right____Left____Overhand____ 1. _____ 2. _____ Total points_____ 3. _____
	Arm preference: Right____Left____Underhand____ 1. _____ Total points_____ 2. _____ 3. _____

GROWTH VALUES	O.A. (Months)	Growth Age (Months)	Quotient	Present C.A. (Months)	Estimated Growth Age (At time of Performance)
Height.....					
Weight.....					
Grip.....					
Carpal.....					
Dental.....					
Reading.....					
Mental.....					

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