ABSTRACT

JONES, Karen C. A comparison of the variation in the running patterns of individuals selected from various mental age categories. M.S. in Physical Education for the Handicapped, 1978. 52 p. (Dr. Lane Goodwin).

This study was designed to compare the variations in velocity, stride length, time of support, and time of non-support in the run. The subjects included 2 boys of normal intelligence, 2 EMR boys, and 2 TMR boys ranging in age from 126 months to 138 months. Subjects were filmed, through the use of cinematography, at 100 frames per second. The following frames were selected for analysis: foot-strike, mid-support (at the point when the tibia is perpendicular to the foot), heel rise, and toe off. These frames were traced onto graph paper and joints were marked. Treatment of data comprised descriptive statistics, utilizing the AAPHER Youth Fitness norms for normal populations and retarded populations as a standard of comparison. Analysis of data produced a significant relationship between IQ and running velocity, stride length, and time of support. The lower the IQ the slower the average velocity of the run. The slower the average velocity the shorter the stride length and the greater the time of support. There seemed to be no significant correlation between IQ and time of non-support.

A COMPARISON OF THE VARIATION IN THE RUNNING PATTERNS OF INDIVIDUALS SELECTED FROM VARIOUS MENTAL AGE CATEGORIES

A Seminar Paper Presented

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by

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CHAPTER I

INTRODUCTION

Research on mental retardation has until recently been under the domain of professions other than physical educators. A fear was associated with teaching these children, possibly due to a lack of knowledge about mental retardation and specifically, the motor proficiency of retarded children. Additional and improved research is currently ensuing superior methods of teaching exceptional children. Knowledge and understanding in this area is gradually expanding (Stein & Pangle, 1966).

Teaching any child efficiently depends upon two important factors: (1) the ability to communicate essential information to the performer and (2) the analytic ability of the instructor (Logan & McKinney, 1972). The latter has been improved upon in recent years through the use of cinematographical analysis. Through this procedure an event can be recorded for more careful and detailed study by slowing down and even freezing the action (Taylor, 1971). The filming and observational study can be followed by computer analysis which will supply information on velocities, center of gravity, joint angles, and much more pertinent information often necessary in research and accomplished rapidly by computer.

There has been insufficient biomechanical analysis on the average or below average individual and even less on the performance of the mentally retarded child (Purdy, 1974). With the knowledge afforded through cinematography and biomechanical analysis an understanding of the motor domain of the retarded child could be basic to all physical education teachers. Assessment, modification, and improvement in the physical education of mentally retarded children could be within the grasp of all physical education professionals.

Running is one of the most basic and earliest forms of locomotion available to children and therefore a vital part of the physical education curriculum. Although running is not a natural skill and must be learned, according to James & Brubaker (1972), there are certain anatomical characteristics which predispose an individual to be a more efficient runner. On the other hand, Jensen (1958) disagrees in stating that speed seems to be an element in which boys reach their maximum quite early in life and one which teaching input has limited influence on.

In this study the running pattern will be analysed in retarded boys and boys of normal intelligence. It is hoped that through this study more light will fall on the subject of motor performance and the retarded child.

Statement of the Problem

The problem will be to compare the variation in the running patterns of individuals selected from various mental age categories

The subproblems include:

1. To compare the difference in the average velocity in the run of individuals selected from various mental age categories.

2. To compare the difference in stride length in the run of individuals selected from various mental age categories.

3. To compare the difference in non-support time in the run of individuals selected from various mental age categories.

4. To compare the difference in time of support in the run of individuals of various mental age categories.

Need for the Study

A review of the literature reported that there is a lack of well controlled research in the area of motor ability and the retarded child (Sloan, 1951). Many of the studies completed have been descriptive rather than experimental and have involved institutionalized subjects as opposed to public school retardates.

Research is needed to increase available information concerning motor development and proficiency of retarded children. Cinematography and biomechanics has played an important role and has expanded potential for understanding human motion (Hoffman, 1974). The use of cinematography in the analysis of skills performed by exceptional children can assist in filling the void of information which has discouraged professionals in providing physical education for this segment of our population.

Definition of Terms

Biomechanics - A systematic application of the laws of mechanics and biological concepts - anatomical and physiological - to problems of human motion in a given situation in order to help man move more effectively within whatever environment he must function (Ariel, 1974).

Cinematography - "Cinematography involves the use of a camera to record motion for subsequent kinesiological analyses" (Logan & McKinney, 1970, p. 195).

Mental Age Categories - Educable mentally retarded (EMR) - The term EMR refers to the mild and borderline groups of retarded children who can achieve at approximately 1/2 to 3/4 the rate of average pupils who have a potential for independent social and vocational functioning at the adult level. Measured intelligence generally ranges from 55 to 85 IQ (Kahl, 1977).

Trainable mentally retarded (TMR) - The term TMR refers to the moderate and (upper) severe groups of retarded children who can achieve at approximately 1/3 to 1/2 the rate of average pupils and who have a potential for semi-dependent social and vocational functioning at the adult level. Measured intelligence generally ranges from 30 to 55 IQ (Kahl, 1977).

Normal - IQ is above 79 and has the ability to cope intellectually, socially, and emotionally in a regular school at their typical age (Moran & Kalakian, 1974). In this study normal will also refer to individuals who do not meet the criteria for placement in special education classes as determined by the Department of Public Instruction.

Stride Length - Time from the take-off of one foot until the touchdown of that same foot again (Nelson & Gregor, 1976).

Time of Non-Support - Time of touchdown until the time of take-off of the same foot (Nelson & Gregor, 1976).

Hypothesis

There will be no significant difference in the running patterns of individuals selected from various mental age categories.

Assumptions

1. All subjects ran at their maximum speed.
2. Filming at 100 frames per second provided sufficient speed for analysis.

Delimitations

1. The chronological age of the subjects ranged from 126 months to 138 months.
2. The subjects had no known physical handicaps.
3. The subjects were limited to individuals residing within the city of La Crosse.
4. Analysis of the running patterns involved only the lower limbs.

Limitations

1. The type or duration of involvement in physical education and/or athletic programs the subjects were previously involved in may have affected their performance.
2. A limited number of subjects within the appropriate chronological ages and IQ's were available.

CHAPTER II

REVIEW OF RELATED LITERATURE

The review of related literature is divided into four major sections: (a) biomechanical analysis, (b) motor proficiency of mentally retarded children, (c) running technique, and (d) running patterns of the mentally retarded.

Biomechanical Analysis

The study of human movement through biomechanical analysis is a time consuming task which includes obtaining cinematographic data, identifying the data to be analyzed, graphing, digitizing and measuring the data, utilizing a computer program to quantify the data, and interpreting results (Ariel, 1974; Hobart & Provenza, 1973).

Observing skills by means of a film has a greater advantage in analysis than on the spot observation and analysis by the unaided eye. One prominent reason is due to the frame-by-frame analysis allowed by a stop-action projector. This enables the observer to critically evaluate and re-evaluate every movement the performer makes. Because of this factor and others, cinematography and biomechanical analysis are a definite teaching advantage to the physical educator (Logan & McKinney, 1972).

There are various types of cameras available for the purpose of producing research films. The three most common are the 35 millimeter, the 8 millimeter, and the 16 millimeter. The latter is most commonly used because it provides a larger image and greater detail. A motor driven camera with a variety of speeds is recommended for filming instead of a spring driven camera. A spring driven camera does not maintain a constant speed as the spring unwinds.

When photographing a subject several factors must be considered. These include the distance of the camera from the performer, the position of the camera in relation to the subject, and the time taken to perform the skill (Logan & McKinney, 1972; Taylor, 1971). Hobart and Provensa (1973) consider accurate measurement of time to be one of the most important parts of cinematography. Taylor (1971) suggests the use of a clock readable to .01 of a second, within view of the camera, as the most reliable and dependable method of recording time. Another frequently used method is the use of a timing light built into the camera mechanism. This is also very accurate in measuring time, although proper functioning during filming can be a limitation.

The position of the camera should be perpendicular to the plane of action explain Taylor (1971) and Logan & McKinney (1972). If more than one view of the performance is desired the lenses of all cameras must be aligned at perpendicular planes to each other.

The third factor to be considered when filming a subject is the distance of the camera from the performer. This is difficult to control when the subject's position is constantly changing, but it is essential to have at least one known distance for future reference when analyzing the film. It is also important to provide a reference scale in the film (Taylor, 1971; Logan & McKinney, 1972). Taylor (1971) recommends filming a yardstick in the same plane as the performance, for use as a reference scale.

Once the film has been processed, joint analysis can begin. This can be done in one of two ways: tracing, the most commonly used method, or point-and-line technique in which points are used to indicate body joints and lines are drawn to connect these points and denote body segments. This technique provides a less cluttered multi-image and more accurate joint angle measurement, but the image of the subject is lost.

It is unnecessary to do a joint analysis on all frames; therefore, the researcher must select desired frames for analysis. These frames can be chosen through fixed intervals or by determining crucial phases of the performance and recording these. The former method may result in the deletion of a crucial motion within the performance (Logan & McKinney, 1972).

There are many factors to be considered when using biomechanical analysis. If the filming is properly conducted and the analysis done accurately under well controlled conditions, data gained will be valuable.

<u>Motor Proficiency of Mentally Retarded Children</u>

Stein & Pangle (1966) in a review of the motor function of retarded children mention the following characteristics as basic to mentally retarded individuals. One such characteristic is that the physical abilities of the institutionalized retardate are significantly lower than those of the public school retardate. This may be due to a variety of reasons, such as limited opportunity to participate in physical activities, over-crowding, and insufficient staffing and facilities.

In a study using the Lincoln revision of the Oseretsky Motor Development Scale, Malpass (1960) compared the motor proficiency of institutionalized and non-institutionalized retardates. Public school retardates had a mean IQ significantly greater than the institutionalized retardates while both groups had comparable chronological ages. The results were that the public school retardates performed better (although not significantly) than the institutionalized retardates, as noted by Stein & Pangle (1966).

Another characteristic cited by Stein & Pangle (1966) emphasizes a higher correlation between motor proficiency and intelligence in the retarded as opposed to the normal child. This statement has been supported by Malpass (1960), who illustrated this through administration of the Lincoln revision of the Oseretsky Motor Development Scale to normal and retarded children. Such a correlation does exist for retarded children but not for normal children.

Results were also substantiated in a study by Kulcinski (1945). Kulcinski taught fundamental muscular skills to fifth and sixth grade children of various degrees of intelligence. These children were grouped by IQ as either normal, superior, or subnormal. The skills taught were divided into simple gymnastics movements and more advanced tumbling moves. Rated on their ability to learn new skills, the results indicated no significant difference between skill acquisition of normal and superior subjects. A significant difference was apparent between the normal and superior subjects and the subnormal subjects, with the latter group learning fewer skills in the simple or difficult batteries.

A third characteristic describes the mentally retarded as nearer the norm physically, than mentally. Stein & Pangle (1966) comment further saying that many studies have shown overlap between the retarded and normal populations on tests of physical abilities. Dobbins & Rarick (1976) offer an example in a study using a variety of motor tests to determine the percentage of educable retardates whose motor performance meet norm standards rather than standards set by their peers. Results determined that 32% of the educable mentally retarded fall within the motor performance standards of normal children.

An investigation by Howe (1959) declared normal children to be significantly superior to retarded children (according to calculated means) on each of eleven motor tasks. In addition, Howe (1959) discovered that the range of performance of some of the retarded subjects overlapped with the normal subjects, as suggested above by Stein & Pangle (1966).

In reviewing the related literature it is evident that when comparing mean motor performance scores the mentally retarded score significantly poorer than intellectually normal children. But in scanning the raw scores, frequent overlapping between the two groups is apparent (Sloan, 1951).

The general statement that at a specified age and sex normal children perform superior to retarded children on most measures of motor proficiency (Stein & Pangle, 1966) has been mentioned above. This is a commonly accepted fact due to an abundance of research supporting it.

Eggers (1967) conducted a study with EMR and normal children between the ages of 9 and 12. The subjects were given a battery of 10 tests taken from the Oseretsky Motor Development Scale and the Kephart Perceptual Motor Survey. Statistically significant results were found denoting the motor ability of normal children to be higher than that of retarded children. Differentiation of abilities between groups was less pronounced in throwing and catching skills, although the superior ability of the normal children was still apparent.

Data collected by Byrd (1969), using the Brace Motor Ability Test, indicated the motor performance of normal children to be significantly better than retarded children between 8 and 12 years of age. The normal children (12-13 year olds) also scored better than the retarded in the 25 yard dash, yet not significantly better.

Head (1963), using the Iowa Brace Test and tests of accuracy throwing and reaction time, found that normal children used as subjects between the ages of 8 and 15 were significantly superior to mentally retarded children on all tests. Auxter (1966) also found normal children to be superior to mentally retarded children on tests of strength and flexibility as opposed to motor proficiency.

Through the use of the stabilometer to measure dynamic balance and other aspects of motor learning, Eckert & Rarick (1976) supported the statement that individuals of normal intelligence demonstrate significantly better motor performance than the mentally retarded. Dobbins & Rarick (1976), Howe (1959), Malpass (1960), and Sloan (1951) also conducted research which gives clear evidence that IQ and motor ability are related i.e., normal children exhibit a greater level of motor proficiency than mentally retarded children.

Brace (1948) found a relationship between IQ and the ability to learn motor tasks. The Brace Motor Ability Test was administered to institutionalized girls between 13 and 18 years of age and representing a variety of mental ages. The subjects with the highest IQ's learned at the fastest rates.

Rabin's (1957) data collected on institutionalized EMR and TMR girls and boys indicated no relationship between motor proficiency and intelligence. According to Rabin (1957), this contradiction in results could be due to the effects of insufficiently controlled variables. This was the only study found revealing no relationship between motor proficiency and intelligence.

It is reported in the works of Stein & Pangle (1966) that the mentally retarded tend to perform 2 to 4 years behind normal children their age, this discrepancy increases with age and task complexity. This implies that normal and mentally retarded children are more nearly compared in motor ability on the basis of mental rather than chronological age. Francis & Rarick (1959) support these findings adding that mentally retarded children follow the same developmental pattern as normal children but at a slower rate.

Doorn (1966) discovered that the mentally retarded perform at a mental and motor level which is lower than their chronological age. This again supporting the statement that comparison is more realistic using mental age rather than chronological age. Sloan (1951), in an experiment with 40 subjects, using the Lincoln Adaptation of the Oseretsky Test of Motor Proficiency, attempted to measure the relationship between motor proficiency and intelligence. Six tests at each age level from 4 to 16 years were administered; the results indicated that the mentally deficient subjects scored significantly lower on the motor tests than the normal subjects did. With one exception, the trend appeared to be consistent with Stein & Pangle's finding (1966) that the more complex the task the more difficult it became for the retarded subjects to perform.

The last point mentioned by Stein & Pangle (1966) is that motor proficiency can be improved in the retarded if well-developed and organized programs are carried out. Research by Doorn (1966) supported this statement by recording improvement of motor proficiency following a remedial physical education program on EMR children. The Oseretsky Test of Motor Proficiency was used as the pre and post test. Corder (1966) and Chasey & Wyrick (1970) reported similar results also using EMR subjects in their studies.

Running Technique

Unfortunately, there is limited research involving biomechanical analysis of the run. This is surprising due to its early appearance in the milestones of locomotor skills (Clouse, 1959; Nelson & Gregor, 1976). According to James & Brubaker (1972) running is not a natural skill and must be learned. Certain anatomical characteristics predispose an individual to efficient running causing running patterns to vary from individual to individual, but despite those individual differences there are certain consistent characteristics required in order to run efficiently.

Developmental Trends in Running

The first developmental phase a child proceeds through on the developmental road to a mature run is a run with relatively straight legs, a short stride, and minimal non-support time. During this simple leg movement the arms also have a simple pattern. They are relatively straight and swing through a short arc. In the initial stages of learning to run the child runs in straight lines because they are the easiest. He also exhibits extensive movements around the long axis of the body. As balance, coordination, and speed increase, these rotary movements begin to disappear. Gradually, as the running pattern matures, the legs demonstrate more and more flexion, a longer stride, a longer time of non-support, less outward swing, and less toeing out of the foot during the swing phase (Wickstrom, 1970)

Characteristics of Efficient Running

All those sources researched agree that the trunk should remain in an erect position during running and sprinting (Bowerman & Brown, 1971; James & Brubaker, 1972; Slocum & James, 1968; Wilt, 1959, Sylvia, 1966). Bowerman & Brown (1971) feel this to be the most important factor for a smooth and efficient run.

Jensen (1958) explains that the head and trunk must maintain a straight alignment during running. Along with holding the head level and focusing directly forward, Wilt (1959), Sylvia (1966), and Bush & Weiskopf (1976) recommend a distance of thirty feet ahead to be the ideal focus point.

The arms complete a forward and backward pendular motion, rhythmically cooperating with the legs as they work (Bush & Weiskopf, 1976; Powell, 1960; Hopper, 1964), i.e., the speed and force of the arms determine the speed of the legs (Bush & Weiskopf, 1976; Cureton, 1935; Wilt, 1959; Powell, 1960; Bowerman & Brown, 1971). In his analysis of the sprint, Sylvia (1966) states that the arms contribute in preventing the torso from twisting, in balance, and in obtaining proper body lean. Bush & Weiskopf (1976) comment that the importance of the arms is to determine the length of the stride through their powerful and rhythmic action. They are in their most efficient position to fulfill the necessary responsibilities by forming a 90 degree angle at the elbow. Wilt (1959) holds a contrary belief, stating that the most important factor with the arms is that they are held comfortably, without tension, in whatever position they are in.

The placement of the foot is another matter of interest to researchers. Bowerman & Brown (1971), James & Brubaker (1972), and Slocum & James (1968) seem to agree that when running the foot usually contacts the surface in one of two methods, either completely flat or with the heel first and then continuing forward across the ball of the foot. When sprinting the contact is on the ball and toes of the foot initially, and in some cases followed by the lowering of the heel.

Nett (1964) analyses the foot contact more specifically. When running very slowly the outside edge of the foot close to the heel hits first, but as the speed of the run gradually increases the contact point remains on the outside edge, moving closer to the ball of the foot. When an individual is sprinting, the contact is on the outside edge of the foot high on the ball.

According to Bush & Weiskopf (1976) the key to good sprinting is relaxation. Jensen (1958) and Sylvia (1966) agree with this statement explaining that the body must function to relax the antagonist muscles as the agonist muscles contract to initiate the movement.

James & Brubaker (1972) and Slocum & James (1968) divide the run into two phases: support and recovery. The support phase consists of foot-strike when the foot first touches the ground, mid-support which begins when the foot is fixed until the heel starts to rise from the ground, and take-off which begins when the heel starts to rise and continues until the toes leave the surface. Recovery starts with the follow-through in which the trail foot leaves the surface and continues until the forward swing begins. Forward swing is next in which the thigh begins its movement forward until maximum hip flexion is reached. Foot descent is the final portion of the recovery phase extending from maximal hip flexion until foot-strike.

Stride Length

Almost without exception, researchers have found that with an increase in average velocity there is a corresponding increase in stride length (Osterhoudt, 1969; Cavagna, Margaria, & Arcelli, 1965; Cureton, 1935; Sylvia, 1966; Nelson & Osterhoudt, 1971; Hoshikawa, Matsui, & Miyashita, 1973; Sinning & Forsyth, 1970). Rapp (1963) studied the running of eighteen State University of Iowa men through the use of biomechanics. He found that as their speed increased so did their stride length with a correlation of .98 between the two variables. Nelson & Gregor (1976) used biomechanics to evaluate 10 Pennsylvania State University runners. A general pattern was seen. Nine of the ten runners increased their stride length curvilinearly with increased velocity, i.e., the stride length rose quickly at low speeds and tapered off as maximum speed was reached. The best performer did not exhibit the typical pattern demonstrated, but instead decreased the stride length as a result of increased velocity. Rompotti (1956) conducted the only study demonstrating a general exception to the relationship between velocity and stride length. He concluded that running velocity has no effect upon stride length.

Increased stride length and velocity according to Clouse (1959) can be attributed to increasing age and extremity length. Studies by Saito, Kobayashi, Miyashita, & Hoshikawa (1974), Wilt (1959), Powell (1960), and Hubbard (1939) yielded results demonstrating that sprinters and trained vs. untrained runners, have the longest stride lengths.

In 1971, Bowerman & Brown reported, as did Wilt (1959) and Slocum & James (1968) that a long stride is good but that overstriding can be detrimental. This is explained by Jensen (1958) who advocates the desirability of increasing the stride without losing leg speed or increasing the leg speed without shortening the stride.

According to Henry & Trafton (1951), 95% of the maximum running velocity is reached after 22 yards. In the 100 yard dash maximum velocity will be reached at 6 seconds. Upon reaching maximum velocity it is impossible to maintain this speed for more than 15 to 20 yards. In 50 yards 1% of the maximum speed is reached (Henry, 1952). Sigerseth & Grinaker (1962) believe that velocity does not accelerate after 50 yards.

Time of Support

Researchers concerned with the velocity and the support phase of the run generally agree that an inverse relationship exists between the two (Sinning & Forsyth, 1970; Osterhoudt, 1969; Nelson & Gregor, 1976; Tsujino, 1966; Nelson & Osterhoudt, 1971;

Hoshikawa et al., 1973; Brandell, 1973). Nelson & Gregor (1976), Osterhoudt (1969), and Hoshikawa et al. (1973) investigated the run from the biomechanical point of view on male adults. Besides discovering that increased velocity caused a decrease in support time, Osterhoudt (1969) stated that the ratio of non-support to support time also decreased with increased velocity.

The performance characteristics of the sprint run in competitive and non-competitive junior high school girls was surveyed by Tetreault (1973). Each subject, half from the track team and the other half from physical education classes, ran a 50 yard dash. Results indicated no significant difference between the length of the support phase and the velocity of the run in trained vs. untrained runners.

Time of Non-Support

The amount of training also seems to have no effect upon the relationship of velocity and time of non-support, as shown by Tetreault (1973). No significant results were found between these two variables.

Through research involving trained runners Osterhoudt (1969), Nelson & Gregor (1976), and Brandell (1973), demonstrated that an increase in velocity produces an increase in non-support time. Powell (1960) offered verbal opposition to the value of an extended time of non-support, based upon his opinion that time in the air is wasted time. The contact of the feet with the ground is the force needed to move the body faster.

Running Patterns of the Mentally Retarded

The only research found on the running pattern of mentally retarded children was by Adrian & Auxter (1967). Their subjects included 46 mentally retarded boys analysed through the use of biomechanics and then compared to findings on normal boys. Results indicated that the running speed of the retarded children was significantly slower than that of normal children. It was also evident that the stride length and support and non-support phases in retarded youngsters were different than in normal children.

Summary

From this review of literature the following observations and generalizations were made about the retarded child and motor proficiency:

1. With specified age and sex, normal children perform superior to mentally retarded children on most measures of motor proficiency. The mentally retarded perform 2 to 4 years behind normal children their age and are therefore more nearly compared on the basis of mental age rather than chronological age.

2. Physical abilities of institutionalized retardates are significantly lower than those of public school retardates.

3. There is a higher correlation between motor proficiency and IQ in mentally retarded as opposed to normal children.

4. Motor proficiency can be improved through well-developed physical education programs.

A section of the literature devoted to the run of normal children indicated that velocity along with stride length and non-support time share an inverse relationship, while the opposite is true of the relationship between velocity and the time of support. Similar patterns were found in the run of mentally retarded children.

CHAPTER III

METHODS

The purpose of this study was to compare the variation in the running pattern of individuals selected from various mental age categories. The data obtained in this study was recorded on film through the use of cinematography. The methods section was divided into the following sections: subject selection, film site and procedure, equipment and set up, subjects' dress and markings, film sequences, and analytical procedures.

Subject Selection

The six subjects selected for this study were all males with a mean age of 133 months and a range from 126 months to 138 months. All subjects were students in the La Crosse public school system. They were placed in the following mental age categories as determined by the school system. Subjects 1 and 2 were within the normal range of intelligence; subjects 3 and 4 were EMR students; and subjects 5 and 6 were TMR children.

The criteria utilized in the selection included the following: subjects devoid of physical handicaps, within the chronological age range of 120 months through 144 months; two subjects of normal intelligence; two EMR subjects; and two TMR subjects. Subjects received written permission from a parent/guardian to participate in the study (refer to appendix A). Subjects were chosen on recommendation from their physical education instructor.

Film Site and Procedure

Filming for this study was located outdoors on the west side of Mitchell Hall on the University of Wisconsin - La Crosse campus. A 50 yard area of sidewalk running parallel to the building was measured off. The starting line was taped and marked with cones, while the finish line was only taped. Cones were set up five yards beyond the finish as a point for subjects to run to, ensuring a full speed run over the 50 yard line.

Equipment Selection and Set Up

A Cine eight millimeter, high speed motion picture camera was used for filming. The camera was equiped with an Angineaux zoom lens set at an F-stop of 8.16. Filming was done at a rate of 100 frames per second with Tri-X-ASA 200 film.

The camera was positioned 64 feet 8 inches from and perpendicular to the plane of motion. The area filmed included the distance from the 45th yard to the 50th yard of the run. The camera was mounted on a tripod, so that the distance between the ground and the center of the lens equalled 35 inches. The natural lighting was sunny to overcast. Subject and trial identification numbers were placed within the five yard filming area, along with a clock accurate to 1/100th of a second. A starter stood at the starting line and a timer was positioned at the finish line. A university faculty member with expertise in cinematography filmed the runners.

Subjects' Dress and Markings

To facilitate observation of necessary anatomical areas, subjects wore shorts and tee-shirts during filming. Joint areas marked for film analysis included the medial and lateral malleoli, knees, and greater trochanters. Two small pieces of electrician tape perpendicular to one another marked each of these joints.

Film Sequence

All subjects were given three warm-up runs before the actual filming began. This was to assure their understanding of where to run and to accustom them to the starting signal. The children of normal intelligence ran first, starting with subject number one. The two educable retarded children ran next, beginning with subject three. Subjects five and six ran last, respectively. All subjects used a standing start and were started by the words "on your mark, get set," and followed by the firing of a starting gun. Each subject ran in order, from numbers one through six and then the sequence started over. The boys were given a 5 minute rest period after the warm-up runs. The procedure just described was used for the actual filming with three trials filmed per subject. A yardstick was filmed to be used as a reference measure.

Analytical Procedures

A Kodak eight millimeter projector was used to project the film onto graph paper with 20 squares per inch for film analysis. Total body tracings were then completed with joint markings. Each subject had their fastest run selected for analysis. The following frames were chosen to be analyzed from these runs: (1) foot-strike, (2) mid-support (at the point when the tibia is perpendicular to the foot), (3) heel rise, and (4) toe off. These frames were selected because they are critical in computing the desired data necessary in completing the study. The following data was calculated from the analysis of this film: average velocity, the length of the stride, time of support, and time of non-support.

Average velocity. Through the use of a stop watch, the speed of each subject running the 50 yard dash was recorded. Displacement divided by time was the formula used to calculate the average velocity (Hay, 1973).

$$\text{average velocity} = \frac{\text{displacement}}{\text{time}}$$

Stride length. Stride length was computed by applying the multiplier to the difference between the X-coordinates of the toes, from toe off of one foot until toe off of the same foot again (Osterhoudt, 1969).

$$\text{stride length} = X\,(X-X_1)$$

X = multiplier (1 graph unit as figured by the reference measure i.e., .917 inch)

$(X-X_1)$ = toe off of one foot minus toe off of same foot again

Support time. This time is figured in terms of seconds or part of a second by determining the following formula: number of frames per support phase divided by frames per second (Osterhoudt, 1969).

Non-support time. Non-support time is also figured in terms of partial seconds of time spent airborne. The formula used is: number of frames per non-support phase divided by frames per second (Osterhoudt, 1969).

CHAPTER IV

RESULTS AND DISCUSSION

The problem of the study was to compare the variation in the running patterns of individuals selected from various mental age categories. Three different mental age categories were used; children of normal intelligence (IQ's above 79), educable mentally retarded children (IQ's between 85 and 55), and trainable mentally retarded children (IQ's between 55 and 30). The aspects of the running patterns which were analyzed included the average velocity, stride length, support time, and non-support time.

Average Velocity

Table 1 reveals the speed of each subject running the 50 yard dash. Speed was recorded by a stop watch accurate to a tenth of a second. From these figures an average velocity was calculated for all subjects. These statistics are available on table 1.

Table 1

Relationship Between Average Velocity and Subjects of Various Mental Ages

Subject	Age	Height	Weight	Speed	Average Velocity
1	127 mo.	54"	73 3/4#	7.3 sec.	20.54 '/sec.
2	126 mo.	54 1/4"	70 1/4#	9.2 sec.	16.30 '/sec.
3 (EMR)	138 mo.	54"	82#	10.7 sec.	14.01 '/sec.
4 (EMR)	132 mo.	58"	90#	8.9 sec.	16.85 '/sec.
5 (TMR)	133 mo.	54 1/8"	109 1/2#	11.8 sec.	12.66 '/sec.
6 (TMR)	133 mo.	56 1/4"	82#	15.9 sec.	9.43 '/sec.

After observing table 1, it is clear that subject 1, a boy of normal intelligence, accomplished the fastest run. Using table 2, the AAPHER Youth Fitness Test norms for the 50 yard dash as a standard of comparison, subject 1 placed in the 86th percentile for his age.

The AAPHER norms are based on adequate and representative samples, including data collected on 9,000 boys, 8 to 18 years of age, plus 2,200 college men. Information on reliability or validity of the AAPHER test is not available at this time (Lockhart, 1972).

The boy with the second fastest time was subject 4. This individual, classified as EMR, ran faster than subject 2, a boy of normal intelligence. Based on the AAPHER Youth Fitness norms, subject 4 ranked in the 16th percentile in the 50 yard dash.

Using the AAPHER Youth Fitness norms for the mentally retarded, subject 4 ranked in the 50th percentile. This table more accurately explains his ability as compared to other boys of similar IQ's. These norms were developed as a part of a national study using a random sample of 4,200 boys with IQ's between 50 and 80 and between the ages of 8 and 18 (Lockhart, 1972). The correlation between IQ and performance in the 50 yard dash is .29 for 10 year olds and .28 for 11 year old boys (Rarick, Widdop, & Broadhead, 1969). Despite the low correlation of this test, no other test exists which highly correlates IQ and motor proficiency.

Subject 2 came in with the third fastest time ranking him in the 14th percentile on the AAPHER norms. This boy of normal intelligence fell into a lower percentile ranking for his age and ran a slower pace than the retarded subject. These results conflict with general research correlating IQ and running speed or motor proficiency (Stein & Pangle, 1966; Eggers, 1967; Byrd, 1969; Adrian & Auxter, 1967).

Table 2

AAPHER Youth Fitness Norms

50 yard Dash for Boys

Percentile	Normal Population Age 10	Normal Population Age 11	Retarded Population Age 10	Retarded Population Age 11	Percentile
100	6.0	6.0	7.0	6.3	100
95	7.0	7.0	7.8	7.3	95
90	7.1	7.2	8.0	7.8	90
85	7.4	7.4	8.2	8.0	85
80	7.5	7.5	8.3	8.1	80
75	7.6	7.6	8.5	8.2	75
70	7.8	7.7	8.7	8.3	70
65	8.0	7.8	8.9	8.4	65
60	8.0	7.8	8.9	8.5	60
55	8.1	8.0	9.1	8.8	55
50	8.2	8.0	9.2	8.9	50
45	8.3	8.0	9.4	9.0	45
40	8.5	8.1	9.5	9.1	40
35	8.5	8.3	9.6	9.2	35
30	8.7	8.4	9.8	9.4	30
25	8.8	8.5	10.0	9.6	25
20	9.0	8.7	10.2	10.0	20
15	9.1	9.0	10.5	10.3	15
10	9.5	9.1	11.2	10.5	10
5	10.0	9.5	12.1	11.1	5
0	12.0	11.9	16.0	13.8	0

Note. From *Practical Measurements for Evaluation in Physical Education*, by Johnson & Nelson, 1969, p. 223.

There is research stating that a proportion of the retarded used as subjects within these studies (comparing IQ and motor proficiency) perform at a level equivalent to children of normal intelligence and that the reverse is also true on occasion (Stein & Pangle, 1966; Howe, 1959; Dobbins & Rarick, 1976). The fact that the EMR boy is 3 3/4 inches taller than subject 2 could have been a factor in his faster speed. In any case subject 2 still ran slower than 86% of the normal population in his age group.

Subject 3, another EMR child, had the fourth fastest run of the group. He ranked in the second percentile of the AAPHER norms and in the ninth percentile of the AAPHER norms for the retarded. Subjects 5 and 6, both trainable mentally retarded boys, finished fifth and sixth respectively, as previous research would predict, based on their lower IQ's. Both boys, based upon the AAPHER norms for boys of normal intelligence, performed in the zero percentile. Based on the norms for retarded children, subject five ranked in the seventh percentile and subject six fell into the zero percentile.

Stride Length

According to figures available in table 3, the four fastest runners demonstrated the longest strides, as research suggests. The runner with the fastest velocity, subject 1, had the second longest, as opposed to the longest stride, and vise versa. Although research suggests (Osterhoudt, 1969; Cavagna et al., 1965; Cureton, 1935; Sylvia, 1966) that velocity and stride length are directly proportional, subject 1 had a shorter stride time (approximately .13 second shorter per stride) than subject 4. This same relationship was found between subjects 5 and 6. Although subject six had a greater stride length his speed was slower. This may have occurred due to excessive knee flexion during the support phase of the run causing a longer period of time in the support phase to develop enough power to lengthen the stride. Subject six's stride lasted 30% longer than subject five's stride, compensating for the difference in speed. Figure 1 depicts these results in graph form. Table 3 also provides information on the length of one step within the stride and the time necessary to take that step. Figure 1 graphs the relationship between the velocity and the stride length of each subject. Figure 2 uses stick figures to show the differences in stride length of all subjects, from the same toe off point until toe off of the same foot again. As seen from the various graphs, the boys with the lowest IQ's demonstrated the slowest average velocities and the shortest stride lengths.

Figure 1

Relationship Between Average Velocity, Stride Length, Support Time, and Non-Support Time

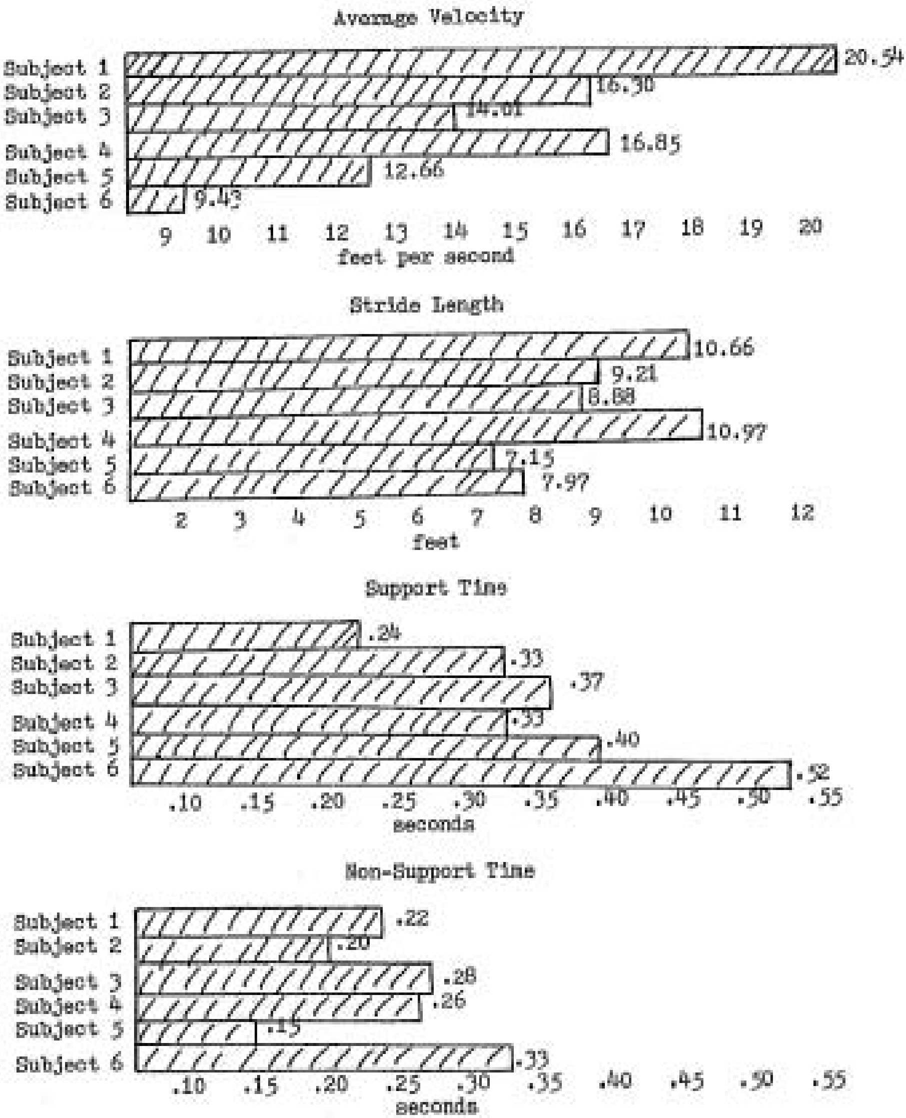


Figure 2

A Comparison of the Stride Lengths of the Subjects

Subject 1 XXXX

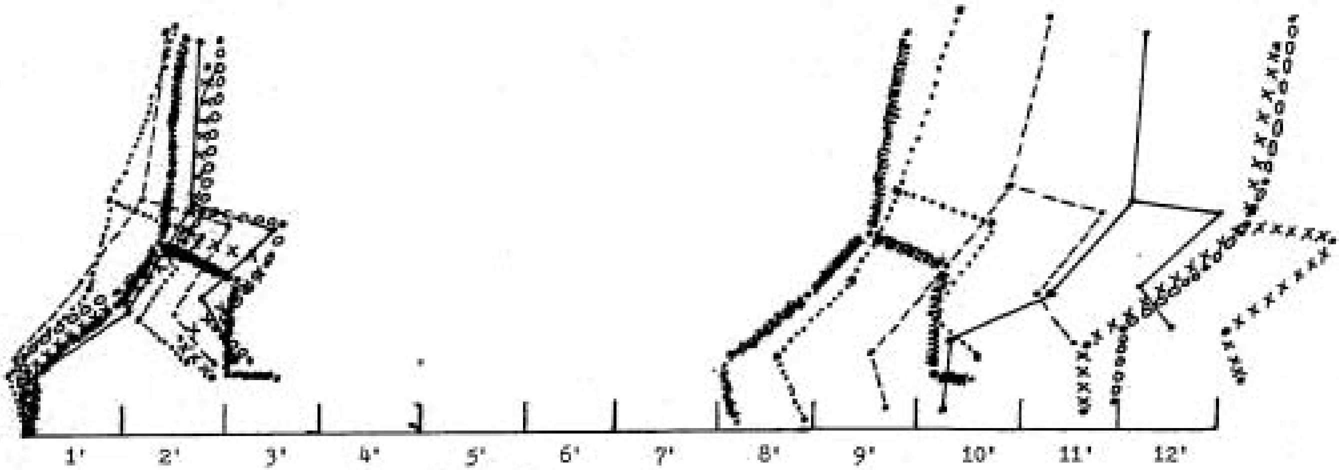
Subject 2 ————

Subject 3 — — — —

Subject 4 oooo

Subject 5

Subject 6 ......



Scale: |____| equals one foot

Table 3

The Relationship Between Stride Length and Stride Time

Subject	Stride Length	Stride Time	Step Length (first step)	Step Time (first step)
1	10.66'	.46 sec.	5.16'	.21 sec.
2	9.21'	.53 sec.	4.85'	.26 sec.
3	8.88'	.65 sec.	4.62'	.35 sec.
4	10.97'	.59 sec.	5.46'	.29 sec.
5	7.15'	.55 sec.	3.44'	.27 sec.
6	7.95'	.85 sec.	4.18'	.46 sec.

Support Time

This study finds results similar to those of previous researchers, supporting the inverse relationship of velocity and support time (Osterhoudt, 1969; Nelson & Gregor, 1976; Sinning & Forsyth, 1970). This relationship is shown in figure 3. As the average velocity of the runner increases the time of support decreases. The variations in times of support are drawn in figure 1. It is clearly seen that subject 1 has the shortest support time and greatest velocity while subject six has the longest time of support and the slowest average velocity. Table 4 indicates numerically the differences in support times.

Figure 3

Relationship Between Average Velocity and Time of Support

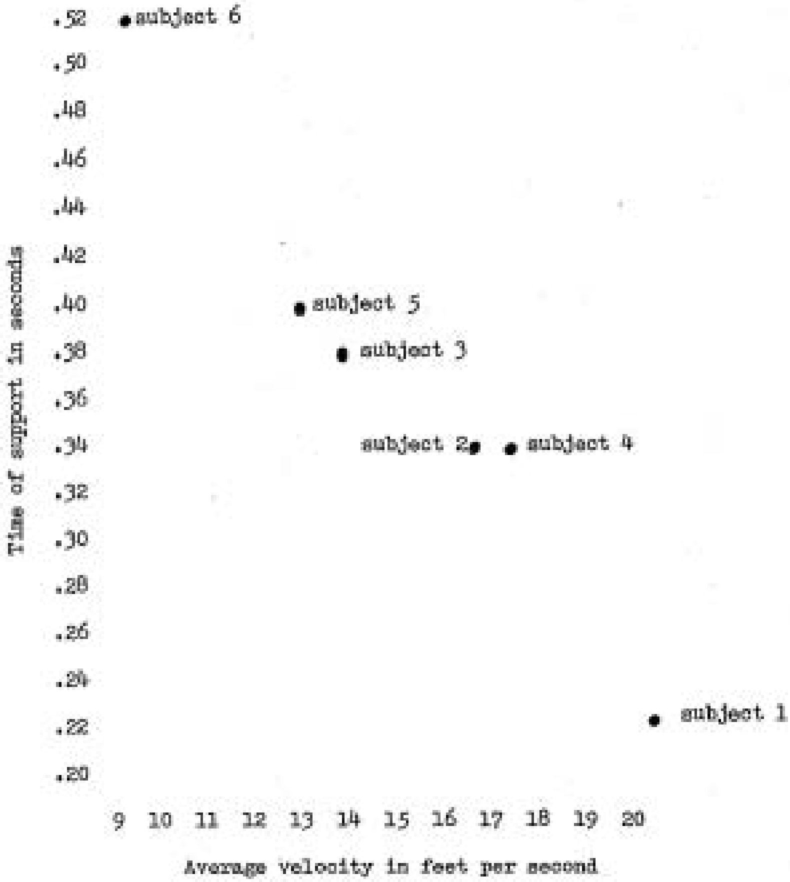


Table 4

Relationship Between Mental Age and Time of Support

Subjects	Total Support Time	Support Time (for first step)	Support Time (for second step)
1	.24 sec.	.11 sec.	.13 sec.
2	.33 sec.	.16 sec.	.17 sec.
3	.37 sec.	.19 sec.	.18 sec.
4	.33 sec.	.16 sec.	.17 sec.
5	.40 sec.	.20 sec.	.20 sec.
6	.52 sec.	.27 sec.	.25 sec.

Non-Support Time

There is general concensus throughout research that as running velocity increases the time of non-support also increases (Osterhoudt, 1969; Nelson & Gregor, 1976; Brandell, 1973). There was no such correlation notable in this study, as exemplified in figure 4. Results were variable. As an example table 5 reports that the runner with the slowest velocity was in the non-support phase longer than any other subject. No deduction can be made about the relationship between velocity and non-support time in this study.

Figure 4

Relationship Between Average Velocity and Time of Non-Support

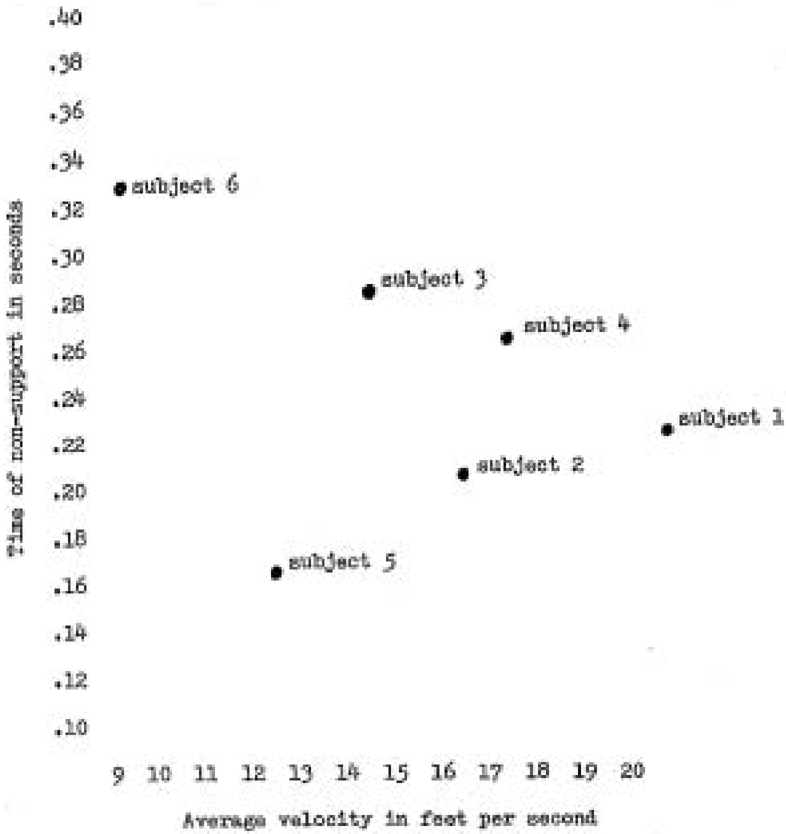


Table 5

Relationship Between Mental Age and Non-Support Time

Subject	Total Non-Support Time	Non-Support Time (for first step)	Non-Support Time (for second step)
1	.22 sec.	.10 sec.	.12 sec.
2	.20 sec.	.10 sec.	.10 sec.
3	.28 sec.	.16 sec.	.12 sec.
4	.26 sec.	.13 sec.	.13 sec.
5	.15 sec.	.07 sec.	.08 sec.
6	.33 sec.	.19 sec.	.14 sec.

Summary

The hypothesis for this study was stated in the null form: There will be no significant difference in the running patterns of individuals selected from various mental age categories. The aspects of the run which were analyzed included average velocity, stride length, time of support, and time of non-support. The subjects with the fastest average velocities were recorded as having the longest strides and the shortest support times, as characterized by efficient running. The subjects of normal intelligence or with IQ's closest to normal ran the fastest. The two TMR subjects therefore ran the slowest and also had shorter strides and longer support times. Generally, these findings correlated with those of previous researchers in the field i.e., IQ and motor proficiency are directly proportional. The differences in all but one analyzed phase of the run were apparent between subjects of various IQ's. No significant difference was found in the time of non-support between the three different mental age categories. Therefore the hypothesis was rejected in all areas except time of non-support. Table A in Appendix B summarizes in numerical form the relationship of IQ, running speed and average velocity, stride length, time of support, and time of non-support.

Chapter V

SUMMARY AND CONCLUSIONS

Summary

The problem of the study was to compare the variation in the running patterns of individuals of various mental age categories. The study included six children ranging in age from 126 months to 138 months. Two of the subjects were of normal intelligence, two were educably mentally retarded, and two were trainable retardates. Biomechanical analysis was the method used to gather data for this study. The subjects were filmed at a rate of 100 frames per second while running the 50 yard dash.

The aspects of the run determined as critical were the velocity, stride length, time of support, and time of non-support. The frames which were vital in supplying the above information were traced onto graph paper and then analyzed. Statistical treatment of data involved descriptive statistics. Due to the fact that this is a case study, there is no justification in concluding that IQ has an effect on running pattern.

Conclusions

IQ did seem to have an effect on the running efficiency of the subject; however, there were exceptions in certain cases. The null hypothesis of this study was subdivided into four parts with no significant difference in (a) the average velocity, (b) the stride length, (c) the time of support, and (d) the time of non-support of individuals selected from various mental age categories. Hypotheses a, b, and c were rejected while hypothesis d was accepted. The following conclusions have been formulated but should not be inferred beyond the parameters of this study:

1. Increased velocity yields increased stride length.

2. Increased velocity yields a decrease in the time of support.

3. Velocity seems to have no significant correlation to time of non-support.

4. IQ has significant effects on running velocity, stride length, and time of support. The lower the IQ the slower the average velocity of the run, which in turn decreases the stride length and increases the time of support.

The study lacked external validity because the population selected for study was too small to relate to the general population and was not randomly picked. Inferences will therefore not be made beyond the parameters of the study.

Other factors which may have had an effect on the outcome of this study include reaction time to the gun firing, past experience in running, and the ability to comprehend the concept of speed. It also appears as though the height of the individual may be a determining factor in the velocity and stride length of the run.

Recommendations

The following are recommendations for further study:

1. Conduct a similar study using larger samples.

2. Conduct a similar study using different age groups and different skills.

3. Conduct a similar study comparing institutionalized and non-institutionalized retardates.

4. Conduct a study analyzing additional aspects of the run with retarded children.

5. Conduct a study analyzing distance running and the relationship between endurance and running form in retarded children.

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APPENDIX A

April 10, 1978

Dear

I am Karen Jones, a graduate student in physical education for the handicapped. Part of the requirement necessary for graduation is to write a seminar paper. The study I will be doing consists of filming and analysing the running of the 50 yard dash by six boys of various mental age groups. ____________________ has been identified as a candidate to participate in the study. This would involve written permission by the parent/guardian. Your permission and cooperation will be greatly appreciated as the results of the study will hopefully aid teachers in evaluation and teaching of basic skills.

The study is under the direct supervision of Dr. Lane Goodwin and Mr. Keith French. All information obtained from the study will be kept confidential. Names of participants will not be released.

If there are any questions, please contact Karen Jones at 784-2409. Please return the permission slip at the bottom of the letter as soon as possible. Thank you for your time.

Sincerely,

Karen C. Jones

Karen C. Jones
Graduate Student

- -

I allow my son, ______________________, to participate in the study analysing the running pattern in the 50 yard dash.

____
Signature of parent/guardian

APPENDIX B

Table A

Summary of Relationships Between Subjects of Various Mental Ages and Running Pattern

	Subject 1	2	3	4	5	6
Age	127 mo.	126 mo.	138 mo.	132 mo.	133 mo.	133 mo.
Weight	73 3/4#	70 1/4#	82#	90#	109 1/2#	82#
Height	54"	54 1/4"	54"	58"	54 1/8"	56 1/4"
Time for 1st step	.21 sec.	.26 sec.	.35 sec.	.29 sec.	.27 sec.	.46 sec.
Time for 2 steps	.46 sec.	.53 sec.	.65 sec.	.59 sec.	.55 sec.	.85 sec.
Time of non-support 1 step	.10 sec.	.10 sec.	.16 sec.	.13 sec.	.07 sec.	.19 sec.
Time of non-support 2nd step	.12 sec.	.10 sec.	.12 sec.	.13 sec.	.08 sec.	.14 sec.
Total time of non-support	.22 sec.	.20 sec.	.28 sec.	.26 sec.	.15 sec.	.33 sec.
Time of support 1 step	.11 sec.	.16 sec.	.19 sec.	.16 sec.	.20 sec.	.27 sec.
Time of support 2nd step	.13 sec.	.17 sec.	.18 sec.	.17 sec.	.20 sec.	.25 sec.
Total time support	.24 sec.	.33 sec.	.37 sec.	.33 sec.	.40 sec.	.52 sec.
Speed	7.3 sec.	9.20 sec.	10.7 sec.	8.9 sec.	11.85sec.	15.9sec.
Average velocity	20.54 '/sec	16.30 '/sec	14.01 '/sec	16.85 '/sec	12.66 '/sec	9.43 '/sec
Length 1 step	5.16'	4.85'	4.62'	5.46'	3.44'	4.18'
Length 2 step	10.66'	9.21'	8.88'	10.97'	7.15'	7.97'
Length 2nd step	5.50'	4.36'	4.26'	5.5'	3.71'	3.78'