A Film Analysis of Motor Pattern Development of Educable Mentally Retarded Children.

Leonard Max Hill
Louisiana State University and Agricultural & Mechanical College

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The Louisiana State University and Agricultural and Mechanical Col.

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A Dissertation

Submitted to the Graduate Faculty of the Louisiana State University and Agricultural and Mechanical College in partial fulfillment of the requirements for the degree of Doctor of Education in The Department of Health, Physical, and Recreation Education

by

Leonard Max Hill
B.S., University of Wisconsin, Whitewater, 1967
M.S., Emporia Kansas State University, 1968
August 8, 1980
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ABSTRACT

The purpose of the study was to compare the standing long jump, place kick, overarm throw and striking patterns of educable mentally retarded children to the mature patterns of highly skilled individuals. It was also the purpose of this study to determine if these same motor patterns were inherent in educable mentally retarded subjects and to determine if these patterns would emerge naturally in a goal-centered teaching-learning environment.

Eleven educable mentally retarded children between the ages of five and eight years were selected to participate in the study. The children participated in a one week (fifteen minutes per day) orientation program so that they could become familiar with working with the investigator and his assistant, and accustomed to performing before the camera. During this time the children participated in motor activities not related to the motor patterns investigated.

The first filming session, during which the initial motor patterns were recorded, was held the first day of the treatment period. The second filming session was held on the twentieth and final day of the treatment period. During each day of the treatment period, each subject performed the standing long jump, overarm throw, place kick and striking patterns ten times.
Two university students were utilized to establish, on film, the mature patterns used in this study. One subject, a place kicker for the varsity football team, served as the model for the mature place kick pattern. The second subject, a member of the varsity baseball team, served as the model for the mature standing long jump, overarm throw and striking patterns.

Once the motor patterns of the mentally retarded subjects and the mature patterns were recorded on film, they were viewed and analyzed, and tracings were made. For each of the four motor patterns, the standing long jump, place kick, overarm throw and striking, the final motor patterns of the mentally retarded subjects were compared to the mature motor patterns. The initial motor patterns of the mentally retarded subjects were also compared to their final motor patterns in order to determine pattern changes. All comparisons were based on the involvement of body parts, the sequence of movements, the timing of movements and the range of movements during the various phases of each skill.

The findings of the study indicated that the standing long jump, overarm throw, place kick and striking patterns of the educable mentally retarded subjects between five and eight years old, to some extent, resemble the patterns of mature performers. However, in reference to the involvement of body parts, the sequence of movements, the timing of movements and the range of movements, the patterns of the mentally retarded subjects were immature and were
executed in an inefficient manner.

Although changes in the standing long jump, overarm throw, place kick and striking patterns of the mentally retarded subjects were noticeable, they were not perceived to be improvement. This is indicative that either the mentally retarded subjects were not aware of the changes they were making, or that they were unable to determine which of the changes would improve their skill performances.
Chapter 1

INTRODUCTION

The preschool and elementary school children are presently the focus of attention for motor development research. Understanding the ontogenetic changes that occur during these early years is paramount to understanding the maximum motor potential and the total development of the human organism. While the research to date has reported some interesting findings, it has not been adequate.

Much of the research has dealt with the natural emergence of motor patterns in preschool and elementary school children. One such study conducted by Flinchum¹ provides evidence that in children of preschool age the skills of kicking, throwing, striking and long jumping are inherent. It was found that basic motor patterns emerged naturally when the child had the opportunity to perform and practice each pattern. It was also found that improvement in skill development was made through repeated performances without the benefit of instruction or coaching.

Other investigators have researched the impact that the teaching-learning environment has upon the development

¹Betty M. Flinchum, "Selected Motor Patterns of Preschool Age Children," (Doctoral dissertation, Louisiana State University, 1971), pp. 6-228. (Microfiche.)
of motor patterns. The setting of goals appears to be an important facilitator in the emergence of basic motor patterns. Halverson\(^2\) states:

Two basic ideas in devising ways of eliciting patterns easily and naturally from young children with a minimum of direct teaching are as follows: setting goals so that desired movement patterns should emerge, and setting the situation or condition so that the desired movement response if present, must emerge.

It is known that genetic endowment and the environment play important roles in the development of basic motor patterns. Yet, very little is known about how genetic endowment and/or environment influence the natural emergence of these patterns. Flinchum\(^3\) and Halverson\(^4\) along with others have demonstrated that normal children can and do develop mature motor patterns in a goal-centered environment, thus indicating that the basis for these patterns must somehow be contained within the genetic make up of the human organism.

Rarick, Dobbins and Broadhead\(^5\) have through their research shown that "... mentally retarded children are more nearly normal in motoric functions than in conceptual

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\(^2\) Lolas E. Halverson, "Development of Motor Patterns in Young Children," \textit{Quest}, VI (May, 1966), 47.

\(^3\) Flinchum, loc. cit.

\(^4\) Halverson, op. cit., pp. 44-53.

development." It is concluded that motor retardation is substantial among educable mentally retarded children. However, the cause-effect relationship, if there is one, between mental capacity and motoric function is unknown. Once this relationship is confirmed and understood it will be possible for teachers and administrators to provide educable mentally retarded children with improved programs of instruction in physical education.

Statement of the Problem

The ability of educable mentally retarded subjects to develop mature motor patterns in the standing long jump, overarm throw, place kick, and striking a ball with a bat in a goal-centered teaching-learning environment were investigated. The investigator examined the following:

1. To what extent do the final standing long jump, overarm throw, place kick and striking patterns of mentally retarded subjects resemble mature patterns following a series of practice sessions that are held in a goal-centered teaching-learning environment?

2. To what degree do the initial and final standing long jump, overarm throw, place kick and striking patterns differ?

Purpose of the Study

The purpose of this study was to determine whether motor patterns of the standing long jump, overarm throw,
place kick and striking are inherent in educable mentally retarded subjects and to determine whether these patterns would emerge naturally in a goal-centered teaching-learning environment. It was also the purpose of this study to compare the initial and final motor patterns of mentally retarded subjects and to determine the changes in the motor patterns that resulted from the goal-centered teaching-learning environment.

**Need for the Study**

The development of certain basic motor patterns appears to be a natural occurrence in the normal child as the child experiences and participates in activities that utilize those patterns. Through studying the emergence of these basic patterns in the mentally retarded child it may be possible to determine the relationship between pattern emergence and the mental function that distinguishes the normal child from the mentally retarded child. For example, if the mentally retarded subjects in this study demonstrate a positive developmental change in their motor patterns then it can be concluded that pattern emergence is not dependent upon the level of mental functioning. However, if the patterns do not change, then it can be concluded that motor pattern development is linked to the level of mental functioning. The findings of this study may provide valuable information leading to a more complete understanding of basic human motor development.
Delimitations of the Study

The eleven subjects selected for this study represent the total population of educable mentally retarded children between the ages of five and eight enrolled in the Bushnell, Illinois Public School System. The eight boys and three girls were healthy individuals void of any physical handicap that could possibly influence the motor patterns being studied. The investigator, through consultations with the classroom teachers and through viewing school health records determined that none of the children needed to be excluded from the population of potential subjects.

The McCarthy Scales of Children's Abilities Test was administered to each subject on an individual basis and it was found that the General Cognitive Index for each subject fell within a range of fifty to seventy-five. This range is used by Bushnell Public Schools to identify a child as an Educable Mentally Retarded Child.

The investigation included four basic motor patterns, the standing long jump, place kick, overarm throw and striking a ball with a bat. All four patterns have been shown to emerge naturally with normal children in a goal-centered teaching-learning environment.6

Slow motion cinematography was used to analyze the motor patterns at the beginning and again at the end of the study. Super eight millimeter film was utilized at a

6Flinchum, loc. cit.
filming speed of forty frames per second.

Between the initial and final filming sessions there were twenty performance sessions in twenty consecutive school days. During each session each child performed the standing long jump, the place kick, the overarm throw and striking patterns. Each skill was performed ten times per session.

The environment in which the subjects performed these tasks was that of a goal-centered teaching-learning environment. The intent of such an environment was to have the child perform the skill with a maximum effort while the investigator provided encouragement but no instruction so that any change in the motor pattern was the result of natural emergence and development. This eliminated bias caused by teacher instruction.

**Limitations of the Study**

It was impossible to find subjects who had not performed these skills before or to be assured that the subjects had not had instruction in these skills prior to the beginning of this study. As a result, the subjects had varying degrees of experience and were at various levels of development in these motor patterns. It was also expected that the motor patterns would develop more readily in some subjects than in others. It was difficult to control the types of play experiences and physical activities in which the child participated during the period that the study was
being conducted. The classroom teachers and the physical education specialist avoided activities that involved the motor patterns being studied during the experimental period.

During the filming sessions and the performance sessions each child was asked to give his or her best effort. However, the investigator was not able to control the amount of effort exerted by the subjects on each trial.

The use of motion picture film for motor pattern analysis has many advantages and is the best means by which motor pattern data can be collected and stored. However, there are some limitations. One such limitation was the difficulty in selecting the frames that represented corresponding positions of the performers when comparing the motor patterns. Another limitation was that the motor pattern captured on film may be an erratic performance and may not be a true representation of that subject's ability.

**Definition of Terms Used**

The following terms are defined as they were used in this study.

**Educable Mentally Retarded**

Mentally retarded children with a General Cognitive Index between fifty and seventy-five are classified as educable mentally retarded. The McCarthy Scales of Children's Abilities Test was the instrument used to determine the General Cognitive Index. Educable mentally retarded children are potentially educable when placed in a special education
Goal-Centered Teaching-Learning Environment

The educational environment that was used in this investigation was one in which the subject performed without any assistance from the investigator. The investigator established goals and encouraged the subject to do his or her best but did not teach or give cues that would improve the performance. As the performance improved, new goals were established in order to encourage a maximum effort from the subject for each performance of the skill.

Mature Motor Pattern

A mature motor pattern is a motor pattern that utilizes the basic principles of body mechanics in order to accomplish a task in a most efficient manner.

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Chapter 2

REVIEW OF THE LITERATURE

A review of the literature as it relates to this study was divided into four main categories: (1) Motor Development; (2) Motor Pattern Development; (3) Cinematographic Techniques, and; (4) The Experimental Environment.

Motor Development

Many studies have been conducted and much has been written concerning the course of motor development in people of all ages. The relationships between motor development, the motor system and intellectual functioning have often been the focus of attention. However, the intricate workings of the motor system during physical activity are not totally understood.

The Motor System

Piaget\(^1\) states that "motor intelligence comes before logical intelligence and makes its discoveries independently of it." It is suggested that motor intelligence is the result of physical activity and muscle experience while

logical intelligence begins with a conscious realization of the results of each motor act. Hence, a child can execute a throw before he develops the concept of what a throw is. Later, as the result of throwing experiences the concept develops and even later a purpose for the throw is established.

A more complete description of the motor system is defined by Gardner, who maintains that many basic motor patterns are fully developed at birth. These patterns are the result of built-in nerve circuits designed to produce alternating or synchronous muscle activity. Other motor patterns emerge as a natural expansion and refinement of many of the more basic patterns as the neuromuscular system matures.

Performing a basic motor pattern involves both voluntary and involuntary movement.

The voluntary contribution to control is concerned primarily with initiation, regulation of speed, force, range, and direction, and termination of movement. Neural interregulation of participating muscles is mostly involuntary. Muscles are smoothly integrated by reflex mechanisms.

It is the involuntary movement that is responsible for the control and coordination of each motor pattern. The smooth coordination of body segments in the motor pattern is the result of automatic muscle action which is controlled

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3Ibid., p. 1.
by the proprioceptive feedback system. Within this system each movement supplies the stimulus for the next part of the pattern. Hence, once the pattern has begun, the muscle action is automatic leaving the cortex free to direct strategy rather than movement.

Changes in the motor pattern may occur when there is a change in sensory input. Such input changes might result from different methods of instruction, explanation, demonstration, assistance, or from the modification of the environmental conditions.

The Council for Exceptional Children\(^4\) indicates that this same process is basic to motor pattern development in the mentally retarded. Throwing is taught through eye focus rather than through gross motor activity; that is, the child learns by looking at what he is throwing, rather than his own hand. In doing so his mental activity is concerned with the object, thus allowing the motor act to coordinate automatically. Eventually, as the throw becomes goal oriented, the eyes focus on the target and the mental activity on the task to be accomplished (i.e. hitting the target). Again, this keeps the voluntary mental activity from interfering with the involuntary and automatic processes of the motor pattern.

Much of the research related to motor development has utilized various measures of motor performance as criteria for motor development. Goodenough and Brian\(^5\) conducted a study to ascertain various factors related to motor skill acquisition by pre-school youngsters. A total of twenty-four and one-half year old children were trained for fifty days in throwing rings over a post set at a distance of four feet ten and one-half inches from a restraining line. Twenty trials were performed each day.

The subjects were divided into three groups. Group A included ten children who were given no instruction or criticism with regard to their method of throwing. Group B included six children who were given a brief preliminary demonstration and subsequent verbal criticism as to types of errors made, but were not required to adhere to a specific procedure in grasping and throwing the rings. Group C included four children who in addition to a preliminary demonstration and verbal criticism similar to that of Group B, were taught to follow a certain definite procedure in throwing and were not allowed to experiment with any other methods.

Only the children in Group C showed significant

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\(^5\) Florence Goodenough and Clara Brian, "Certain Factors Underlying the Acquisition of Motor Skills by Pre-School Youngsters," *Journal of Experimental Psychology*, (December, 1929), pp. 127-155. (Microfilm.)
improvement in ability to toss the ring over the post. Other findings of this study were that boys performed better than girls based on mean scores while boys and girls mean gains were the same. A small negative correlation was found between total score and I.Q.

The purpose of a study conducted by Dusenberry was to investigate the learning of ball throwing for distance by children due to specific training. Sub-problems investigated were the relationships of throwing ability to age, sex, standing long jump ability, and the manner of throwing. Fifty-six boys and girls three to seven years of age were divided into two groups. The groups were equated on the basis of age, sex, race, and the average distance of five throws. The experimental group received instructions in throwing twice per week for a period of three weeks. The control group received no practice. The pre-test and post-test data also included a visual examination of the throwing method used and the performance scores on three trials in the standing long jump.

It was found that while both groups demonstrated significant gains in the throw for distance, the experimental group had gains significantly higher than the control group. It was also found that the boy's throw for distance was significantly better than the girl's and that the child's

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6Lois Dusenberry, "A Study of the Effects of Training in Ball Throwing by Children Ages Three to Seven," Research Quarterly, XXIII (March, 1952), 9-14. (Microfilm.)
age correlated with the throwing distance ($r = .70$ for boys and $r = .62$ for girls). An increase in the average standing long jump performance was insignificant for both groups.

Hicks\(^7\) equated two groups of thirty children two and one-half to six and one-half years of age based on their initial performance of throwing a ball at a moving target. The practice group repeated the test once a week for eight weeks. At the end of this period both the practice group and the control group repeated the test twice on successive weeks.

From the analysis of these data Hicks found that both the practice and the control groups made significant gains in the average scores but that the difference between the gains of the two groups was not significant. Similar to the studies previously cited the boys had significantly greater average scores than the younger children.

Halverson and others\(^8\) presented a report on the effect that teaching kindergarten children the overarm throw has upon the children's final ball velocity. Three groups of children equated by sex were studied. The experimental

\(^7\)James Allen Hicks, "The Acquisitions of Motor Skill in Young Children," *Child Development* (June, 1930), pp. 90-105.

group received a six week movement program that included 120 minutes of guided practice in the overhand throw; one control group received a six week movement program; and a second control group received no movement experience. A Robert's Velocimeter was used to record ball velocities during pre-test and post-test performances.

No increase in ball velocity was reported for any of the groups. However, it was reported that the ball velocity for the boys was significantly greater than it was for the girls.

The Relationship Between Motor Development and Intelligence

Children from the second, fourth and sixth grades in public elementary schools in Lafayette, Indiana served as subjects in a study conducted by Thompson.\textsuperscript{9} The mental test data were collected via the Stanford Achievement Test Batteries while the motor tests included the beam walk, stepping stones, standing long jump, standing hurdle jump and agility run. There was little evidence that a relationship between motor performance and mental achievement existed as only 20 percent of the eighty correlations were significant. Of the significant correlations 82 percent were in a

negative direction, indicating that if there was a relationship it was an inverse relationship.

Clawson\(^{10}\) randomly selected 1020 educable mentally retarded children in the state of Missouri for investigation. The scores of a preliminary form of The Missouri Perceptual-Motor and Motor Performance Test Battery were correlated with I.Q. measures. It was found that the children with a higher I.Q. performed better than the children with a lower I.Q. on perceptual-motor and motor performance items, and that a significant straight line relationship existed between I.Q. and scores on The Missouri Perceptual-Motor and Motor Performance Test Battery.

Howe\(^{11}\) matched a group of forty-three mentally retarded children with a group of forty-three mentally normal children with respect to chronological age, socio-economic background and sex. He then administered a battery of eleven motor tasks including the Sargent jump, balancing on one foot, tracing speed, tapping speed, dotting speed, grip strength, zig-zag run, fifty yard dash, squat thrust, ball throw for accuracy and paper and pencil maze tracing. The normal boys were significantly (P = .05) better than the


mentally retarded boys on all skills. The normal girls were significantly ($P = .05$) better than the mentally retarded girls on all skills except for the ball throw for accuracy and grip strength tasks.

The Columbia Mental Maturity Scale was utilized by Hollingsworth\textsuperscript{12} to assess mental age and the Lincoln-Oseretsky Motor Development Scale was utilized to establish a motor performance score for mentally retarded and third, fourth and fifth grade children. It was found that when paired according to chronological age, the mentally retarded children were significantly below their intellectually normal peers in motor performance. However, when paired based on mental age, educable mentally retarded children were significantly superior to their intellectually normal peers in motor performance.

Widdop\textsuperscript{13} compared by age, sex and age/weight/height classification the physical performance of educable mentally retarded children with the performance of children of normal intelligence. The subjects included 2270 boys and 1965


girls from a nation-wide population of educable retardates between the ages of eight and eighteen. The physical test battery for the mentally retarded was a modified version of the AAHPER Youth Fitness Test. The scores for the normal children were taken from published data. Based on chronological age the retarded boys and girls had significantly lower scores on all physical test items when compared with scores from similar test items of normal boys and girls. The educable retardates of both sexes were generally two to four years behind the performance levels of normal children of similar age. With both sexes across all age groups, it was found that similar differences existed between the mean performance of the high I.Q. and low I.Q. mental retardates as that shown between normals and educables indicating that a positive relationship exists between I.Q. and motor performance.

One of the several purposes of a study conducted by Rarick, Dobbins and Broadhead\(^{14}\) was to compare the motor performances of educable mentally retarded children and normal children by age and sex. A battery of sixty-one tests were administered to 261 educable mentally retarded children and 145 normal children between the ages of six and thirteen years. The sixty-one scores collected for each subject included measures of static muscular strength, explosive muscular strength, muscular strength-endurance, 

gross body coordination, cardio-respiratory endurance, limb-eye coordination, manual dexterity, static balance, dynamic balance, kinesthesis, flexibility, speed and coordination of gross limb movements, body fat and body size. The findings demonstrated that the motor performances of the normal children were significantly better than the educable mentally retarded children. The findings also showed that older children performed better than younger children and that boys performed better than girls.

Motor Development in the Mentally Retarded

Rynders compared the motor patterns of seventy-one Down's Syndrome children against norms of the Gesell Developmental Scale to ascertain their developmental levels in crawling, standing and walking. It was found that Down's children are delayed in their development when compared to normal children's development and that the difference became greater with age.

A New York City summer enrichment program for 357 educable, trainable or brain damaged elementary and secondary school children were evaluated by Joiner, Lodato and

Stillman. The evaluation consisted of observation, interviews with teachers and objective pre-testing and post-testing. The curriculum for the program was designed to improve social and emotional development, cognitive development, hobby skill development and physical fitness. With six weeks between the pre-test and post-test the only motor activity measured, the standing long jump, showed a significant gain in performance at the .01 level of confidence.

Ross investigated the improvement of basic motor skills of educable mentally retarded children as the result of special training in sport and game situations. Twenty-one boys and nineteen girls were divided into an experimental and a control group, matched by chronological age, I.Q., sex and pre-test scores on the Basic Skills Test and the Brace Test Items. A third group of nine boys and eleven girls with an I.Q. range of 90 to 110 served as a second control group. The experimental group received twenty-five minutes of training three times per week for six months on the skills of hitting, catching, throwing, running, jumping, bouncing, kicking, hopping, skipping, balancing and target throwing.

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The two control groups participated in the regular physical education programs during this time.

A statistical analysis based on the pre-test data demonstrated that the two groups of mentally retarded children did not differ from each other and that they did differ significantly (P = .001) from the normal children. The analysis based on the post-test data from the Basic Skills Test found that the experimental group made significant gains (P = .001) over the mentally retarded control group and that the post-test scores of the experimental group did not differ significantly from the post-test scores of the normal children. An analysis of the data from the Brace Test did not show any significant changes in the relationships between the three groups.

It was also demonstrated by Rarick and Broadhead\(^\text{18}\) that mentally retarded individuals are capable of making significant improvements in motor development through participating in special programs. Forty-nine classes of educable mentally retarded children (n = 275) and minimally brain injured children (n = 206) were randomly assigned by disability and age to one of four treatments. Two of the treatments involved special educational physical activity

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programs, one being individually prescribed while the other was group oriented. A third treatment was an art program to determine the Hawthorne effect while the fourth was a control as the children participated in the usual instructional program. All four programs lasted twenty weeks. A battery of thirty-two tests was administered to the children prior to and at the conclusion of the treatments.

The children who participated in one of the three experimental groups demonstrated significantly ($P = .05$) greater positive changes in their motor, intellectual and emotional behavior than did the children in the control group. The two specially planned physical education programs proved to be superior in improving motor performance over the art program and the control group. The physical education program which was oriented toward the individual approach was significantly ($P = .05$) better than the group oriented physical education program in bringing about positive changes in the physical, mental and emotional growth of the children. It was also noted that positive changes occurred more frequently in the older children than the younger children and more frequently in the boys than the girls.

Scientific data obtained by Francis and Rarick\textsuperscript{19}

on the motor levels of attainment and/or potentials of the mentally retarded were utilized to provide a scientific base upon which teachers might prepare for future responsibilities. The major objective was to determine the motor characteristics of the mentally retarded. The 284 mentally retarded subjects were administered four measures of dynamic strength, one balance test and two measures of agility. The investigators clearly demonstrated that the mentally retarded boys and girls included in this study were well behind published standards of motor performance for normal children of their age and sex.

While most of the correlations between I.Q. and motor performance are low, the fact that they are so consistently positive suggests that intelligence may play a role in the motor performance of the mentally retarded boys. With girls, the findings are less clear as many of the coefficients were negative and others close to zero. The size of the correlation coefficients for the mentally retarded were very similar to the coefficients reported in related studies with normal children.

Motor Pattern Development

The study of motor patterns is difficult due to the short time span and the magnitude of muscle activity involved with many patterns. However, the use of videotape and high speed motion picture cameras allows the investigator to record, replay at various speeds and to select
various stop-action segments for critical analysis.

**Motor Patterns of Normal Children**

The literature has been consistent in suggesting that the motor patterns of normal children follow a similar developmental pattern. Roberton utilized seventy-three first grade children to study the concept of developmental stages in the development of the overarm throwing pattern. One finding of the three year longitudinal study was that all the children passed through the same general stages of development (i.e. stage one followed by stage two followed by stage three, etc.) It was also found that individual component parts of the overarm throw patterns had their own series of developmental stages and that these component stage sequences develop independently of each other. It was noted that the children passed through the same developmental sequence for each individual component part.

Further investigation of this same data by Roberton and Halverson led to the conclusion that certain stages of one component part will occur only with certain stages of a second component part. For example, the trunk component

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stages one through four could accompany the first forearm component stage.

One study using a motion picture camera was conducted by Flinchum\textsuperscript{22} to compare the motor patterns of preschool age children with mature patterns and to determine the changes in those children's patterns after they were given the opportunity to practice them. Seventy preschool age children were filmed while performing motor patterns of kicking, throwing, striking a ball suspended from a rope, jumping from a height and long jumping. The children then participated in thirteen sessions during which each subject performed each of these skills a minimum of ten times. The children were simply told to kick, throw or strike as hard as they could or to long jump as far as possible. They were only instructed to jump from the box. At the completion of these thirteen periods the children were filmed again.

For the final analysis, three sixteen millimeter frames were selected of each motor pattern for eighteen of the subjects. These frames were compared to a similar photograph series of a mature performer in each skill pattern. A second comparison was made between each subject's initial and final performance to determine whether improvement had occurred. The findings of this study indicate that motor patterns resembling the mature motor patterns of kicking, throwing, striking, jumping from a height and long jumping

\textsuperscript{22}Flinchum, loc. cit.
are inherent in two to six year old children and that when given the opportunity to perform without instruction or coaching children can improve their motor patterns.

The standing long jump pattern. The take-off phase of the standing long jump was analyzed by Halverson. Thirty-two kindergarten subjects were divided into two groups equated on the basis of long jumping skill, age and sex. One group received five twenty-five minute special guided practice sessions while the other group served as a control. The children's long jump performances were filmed with a sixteen millimeter camera at sixty-four frames per second before and after the treatment.

Tracings and stick figures were made from the film in order to analyze the performances. The criteria used were total jumping distance, horizontal distance traveled by the center of gravity, the amount of body lean, velocity, angle of projection, range of movement and the speed of movement. It was found that there were no differences based on these criteria between the experimental and control groups, or between any of the sub-groups based on skill, age or sex.

Hellebrandt selected a sample of cinematographic


material from the film library of the Department of Physical Education for Women at the University of Wisconsin in order to study the standing long jump performances of forty-seven boys ranging in age from fourteen months to eleven years. Some of the observations made by Hellebrandt and others based on these films were:

1. The jumping pattern unfolds automatically progressing toward a mature pattern.
2. Stepping off and jumping off an elevation by extending one leg precedes the ability of jumping from an elevation while extending both legs simultaneously.
3. The ability to efficiently accept impact upon landing is present from the beginning.
4. The upper extremities serve first as brakes, then as stabilizers and finally as augmenters of the jump.
5. Movement of the head appears to be spontaneous in its role of maintaining balance.  

The kicking pattern. Poe conducted a study to determine the changes in movement characteristics in the punt of a young boy between the ages of two years, nine months and eleven years, four months. The data analyzed were from the Motor Development and Child Study Center at the University of Wisconsin, Madison. Film records were made at three month intervals at ages three through four; six month intervals at ages five through seven; and at yearly intervals at ages eight through eleven years. The fifteen different trials were recorded with a sixteen millimeter camera operating at sixty-four frames per second from a front view.

25Ibid.

26Alison Poe, "Developmental Changes in the Movement Characteristics of the Punt - A Case Study," (Madison: The University of Wisconsin), pp. 1-4. (Mimeographed.)
and a side view of separate performances. The final filming session at age eleven years, four months was a three-way filming situation in which simultaneous front, side and back views were filmed. Tracings were made of the key frames with which the researcher was concerned.

The movement characteristics that were studied included the approach to the ball, height and manner of ball release, time elapse between ball release and supporting foot contact, arm action throughout the kick and the height at which the ball was contacted. The major changes in the subject's punt pattern included a change from a one-step approach to a two-step approach in the kick with a period of flight occurring during the second step of the approach; a change from dropping the ball from a height between waist and shoulder level to a lift release which projected the ball upward and outward from the body at chest level; an increasing use of arm and leg opposition to improve stability; and, the velocity of knee extension progressively increased until it reached a level comparable to adult velocity.

The overarm throwing pattern. Gesell\textsuperscript{27} and Wild\textsuperscript{28}

\textsuperscript{27}Arnold Gesell, \textit{The First Five Years of Life} (New York: Harper and Brothers Publishers, 1940), pp. 86-88.

\textsuperscript{28}Monica Wild, "The Behavior Pattern of Throwing and Some Observations Concerning its Course of Development," (Doctoral dissertation, University of Wisconsin, 1937), pp. 148-935. (Microcard.)
conducted separate studies during the 1930's to investigate the development of throwing patterns in children. Gesell studied children from two and one-half through six years of age on a cross-sectional basis while Wild collected data from thirty-two children beginning at age two through age twelve on a longitudinal basis.

Both studies found that the motor pattern development of the overarm throw tends to follow a rather specific age related sequence. The age incidence of certain arm, body and whole throw movements suggests that a typical pattern can be identified for various age groups. These typical patterns also vary according to the sex of the individual as the throwing pattern appears to develop faster in boys. However, it is noted that boys and girls tend to follow the same developmental sequence.

An observation by Halverson, based on several studies suggests that motor pattern development is more related to experience and environment than it is to age. She has observed immature or beginning levels of pattern development in subjects well into late childhood and even into adult years. While throwing behavior begins early in life, immature patterns are often encountered well into adulthood. It cannot be assumed that motor patterns auto-

matically change with age past beginning developmental levels.

The striking pattern. The previously cited study by Flinchum\(^{30}\) included an investigation into the development of the two handed striking pattern used in softball and baseball. The analysis was based on a comparison of an initial and final filming of the striking patterns of eighteen subjects. There were thirteen performance sessions between the two filming sessions where each subject hit a suspended ball as hard as he could a minimum of ten times. The results indicated that changes representing a more mature pattern can and do occur without the benefit of instruction.

**Motor Patterns of Mentally Retarded Children**

A rather extensive search through the literature produced only one study concerned with the motor pattern development of the mentally retarded. An investigation into the throwing patterns among 110 educable mentally retarded children between the ages of seven and twelve years employed the use of cinematography. The findings of Auxter's\(^{31}\) cross-sectional study indicate that the mentally retarded,

\(^{30}\)Flinchum, loc. cit.

as do normal children, develop their throwing patterns through coordinating and integrating partial patterns in order to refine and improve the efficiency of the performance. There is a gradual fusion of new elements with those of the old established pattern as the throwing pattern progresses from its beginning level to that of a mature pattern. Some of the changes that evolved included the number of integrated joint actions, and length of the stride, the length of the throwing arc and the nature of the weight transfer.

**Cinematographic Techniques**

The Motor Development and Child Study Center in the Department of Physical Education for Women at the University of Wisconsin at Madison\(^{32}\) can be credited with much of the standardization and sophistication of the procedures utilized in cinematography studies of motor pattern development. Originally, one sixteen millimeter camera operating at sixty-four frames per second was utilized during filming sessions. Since 1971 two simultaneous camera views have been used, enabling more accurate measurement of the spatial displacement of body parts and more recently a third camera has been included allowing for even more sophistication in the analysis.

One advantage of cinematography, according to Northrip\textsuperscript{33} is that it is possible to record the synchronization of various body-segment movements much more accurately than is possible in a noncinematographic observation. However, the performance recorded on film may not be indicative of that subject's most commonly used performance style.

Noss\textsuperscript{34} indicates that films and even single photographs have helped to determine gross patterns of movement and characteristic dynamic body positions that would have otherwise been impossible. The limitations of the cinematographic technique begins when the analysis requires accurate measurements of specific movements. This is due to the photographic perspective and the linear correlations that result from recording three dimensional activity on a two dimensional plane.

The filming speed used to record the motor pattern may be a critical factor in cinematographic analysis. Northrip\textsuperscript{35} suggests that for the purposes of basic cinematographic analysis, filming speeds of thirty-two to sixty-four frames per second be used. The determining factor for filming speed is the nature of the skill being filmed. For


\textsuperscript{34}James Noss, "Control of Photographic Perspective in Motion Analysis," JOHPER, XXVIII (September, 1967), 81.

\textsuperscript{35}Northrip, loc. cit.
most gross body actions thirty-two frames per second is entirely adequate, and there may be times where sixteen frames per second would be adequate.

A clock is often placed in view of the cameras. This technique was employed by Victors enabling her to synchronize two films for the actual analysis. Two cameras, a lateral view and front view, were used to record the catching patterns of twenty boys seven and nine years old. The analysis of the catching patterns included two procedures, a direct film observation and film tracings.

Selected film trials can be viewed and studied repeatedly using a Lafayette Analyzer Projector which can slow or completely stop the action. Another technique utilized at the University of Wisconsin is that of tracing the image projected by a film reader or by photographing selected frames with a Testrite Cinelarger.

Once the data has been collected it is analyzed in terms of specific characteristics of the motor pattern. A list of the typical descriptive information taken from film has been compiled by Halverson and others:

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. . . (1) identification of the body parts moving, (2) identification of the planes in which the body parts move, (3) measurement of the displacement or range of angular and linear movement observed for each body part, (4) measurement of the time consumed by the movement of each body part, and (5) measurement of the temporal sequencing between body parts involved in the total movement.

**Experimental Environment**

The experimental environment in which the subject performs basic motor patterns before a camera may have some impact on the performance. In order to procure valid data the experimental environment must replicate the natural environment as much as possible. This can be a difficult task. However, a review of the literature does provide some insight into environment control.

Halverson, Roberton and Harper have researched the effect that various environments have upon motor responses by young children. They have found that young children have a variety of responses available to them. Children will initiate many of these responses without prompting when they are allowed to explore in a "normal" environment. However, some responses were not used often, or at all, by some children.

In the research environment they have had much success in eliciting motor patterns from children with a combination of goal setting and a simplification of the tasks.

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38 Halverson, Robteron and Harper, op. cit., p. 58.
39 Ibid., p. 63.
The goal setting encourages the young subject to put forth a good effort in the performance of a motor pattern while the task simplification increases the probability of a successful attempt. This in turn encourages the subject to utilize a good effort for subsequent performances.

The scheduling of the filming sessions and practice sessions is important when conducting investigations of motor pattern development. Elementary school girls participated in a throwing velocity task to examine the effects of distributed and massed practice during a six week investigation conducted by Austin. Ten subjects in the massed group practiced fifty consecutive throws once each week during the six week period for a total of three hundred practice throws. Ten subjects in the distributed group practiced ten consecutive throws each school day of each week during the experiment for an identical total of three hundred practice throws. Nine members of the control group participated only during the testing sessions. The results of Austin's study revealed that the distributed practice improved with a continuous linear trend during the experiment while the massed and control groups had no such learning trend, but remained at approximately the same level of performance.

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A study conducted by Kozar\textsuperscript{41} investigated the effect of an overt level of aspiration on the standing long jump performance of thirty-three mentally retarded subjects. The subjects were randomly assigned to one of two groups, the overt level of aspiration group or the control group. After each trial the overt level of aspiration subjects were shown how far they had jumped and were asked to point to a line on the mat where they expected to be able to jump on the next trial. The control group subjects were shown how far they had jumped on the preceding trial. Each subject in each group was asked to do his best on each trial. No significant differences in long jump performances were found indicating that the overt level of aspiration does not appear to act as an effective motivating technique in increasing the performance of mentally retarded children.

Three reinforcements were used to determine their effect on the softball throw for distance of fifty-six educable mentally retarded boys. The reinforcements used by Morrison\textsuperscript{42} were a positive intangible reinforcement in the form of verbal praise, a negative intangible reinforcement consisting of verbal reproof, and a positive tangible


reinforcement (the choice of a nickel, a bar of candy, or a toy). The control group participated only during the pretest and post-test portion of the experiment. The experimental group post-test included one of the three reinforcements given in random order on three different days. The analysis of the data indicated that the three reinforcement conditions had no differential effects on the softball throw for distance of the mentally retarded boys.

Lamagna\textsuperscript{43} conducted a study to provide information concerning visual, tactual and motor performance in retarded children. A group of eight mongoloid trainable children and a group of eighty nonmongoloid children were equated for chronological age, sex and mental age. The findings demonstrated that improved motor functioning occurred between the ages of seven and nine years old with no further appreciable change noted between ten and eighteen years of age.

To the young subject the experimental environment may be an unfamiliar environment with an unfamiliar adult directing the activities. For many youngsters the performance filmed at such a session may be less than their potential or, at least, different from it. It has also been demonstrated that children's responses to the same task may

vary from one trial to the next. Halverson\textsuperscript{44} suggests that the subject be allowed to explore and get acquainted with this new environment before the actual recording of data begins.

Many of the basic procedures involved with cinemato graphical research may be a distraction when the subjects are young children. Roberton\textsuperscript{45} indicates that complicated body markings, artificial lights, and complex filming setups should be avoided with children.

**Summary**

A survey of the literature reveals that motor development and the development of motor patterns of normal children have been intensively investigated. It appears that basic motor patterns are inherent and will emerge naturally when cultivated in a nonrestrictive environment. Many of the studies indicated that while motor patterns and levels of development differ with sex and age, the pattern sequences were very similar for both sexes and across the various age groups. The motor patterns of the standing long jump, place kick, overarm throw and striking emerge more quickly in boys than girls and resemble the mature pattern more often in older than in younger age groups of children.

\textsuperscript{44}Lolas E. Halverson, "A Real Look at the Young Child," *JOHPER*, XLII (May, 1971), 32.

\textsuperscript{45}Mary Ann Roberton, "Developmental Kinesiology," *JOHPER*, XLIII (October, 1972), 65-66.
The relationship between motor development and I.Q. is difficult to comprehend. One study found little evidence of a relationship while eight studies found a significant positive relationship to exist between motor development and I.Q. Two of the seven studies found that when based on chronological age, normal children are superior to mentally retarded children and when based on mental age, the mentally retarded children performed better than normal children on selected motor tasks.

It has been found that while mentally retarded children develop at a slower rate than normal children they are capable of excellent performances and often demonstrate mature motor patterns. This is particularly true when the mentally retarded have had the opportunity to be involved in special programs designed to improve motor performance.

The studies concerned with motor pattern development have shown that each pattern evolves from a more basic pattern in approximately the same manner in most children. The patterns for the standing long jump, place kick, overarm throw and striking have been examined and developmental sequences have been recorded from the very first attempt by a young child through the highly skilled pattern of a mature performer.

Much of the research in motor development has utilized performance measures as the evaluation criteria. However, in the 1930's and more recently in the 1960's and 1970's a number of researchers have employed motion picture
cameras in an attempt to evaluate and analyze motor pattern development. It has provided an excellent means for establishing a permanent record from which to draw data for explicit analysis. Once recorded on film the performance can be viewed and reviewed in whole or in parts for a greater understanding of the mechanical techniques involved in motor patterns, and how these techniques change through maturation and experience.

The experimental environment in which the investigation of motor pattern development is conducted must be one in which the subject feels comfortable so that his performance can be typical and uninhibited. Many studies have indicated that this is not a difficult task when time and proper introductory activities have been employed.

While a review of the literature has demonstrated that there is a low but positive relationship between intelligence and motor development when based on performance measures very little has been done concerning the relationship between intelligence and the development of motor patterns. The review of the literature has shown that the use of cinematography for motor pattern analysis is the most popular method of gathering data and that tracing selected frames from the film is an accepted method of representing the various stages of motor patterns in the text of the dissertation. The use of the goal-centered teaching-learning environment has proven successful in bringing about motor pattern development without injecting bias caused by
the subject-investigator relationship. It is the intent of this investigator to utilize these methods, techniques and research designs that have proven to be successful in numerous studies involving motor pattern development in normal children in order to analyze motor patterns and motor pattern development in mentally retarded subjects.
Chapter 3

PROCEDURE FOR THE STUDY

It was the purpose of this study to compare the final standing long jump, place kick, overarm throw and striking patterns of educable mentally retarded children to the mature patterns of highly skilled individuals. The children's initial and final performances were also compared in order to determine the changes that resulted from the treatment. The data for the comparisons were collected before and after a treatment period during which the children were able to practice each of the skills.

Selection of Motor Patterns

The motor patterns investigated were the standing long jump, place kick, overarm throw and striking. Research has demonstrated that each of these is inherent in normal children and will emerge naturally when the individual has an opportunity to perform the skill.¹

It has been found that mentally retarded children can improve their performances in a manner similar to, but at a slower rate than normal children in the skills of standing long jump, place kick, overarm throw and striking.

¹Flinchum, loc. cit.
The developmental changes that occur in each of these motor patterns for the mentally retarded have not been researched.  

The motor patterns investigated are skills which require the use of the whole body when performed correctly. The skills also represented four different levels of functioning in relationship to apparatus. The standing long jump was a whole body skill that required the use of no apparatus. In the overarm throw the performer had apparatus (ball) under manipulative control as he/she prepared to execute the throw. The place kick required the performer to approach the apparatus (ball) as he/she prepared to execute a kick. The striking skill required the performer to utilize one piece of apparatus (bat) to manipulate a second piece of apparatus (ball).

Selection of Subjects

A group of educable mentally retarded subjects made up the experimental group. Two skilled adult performers were utilized to establish data to represent the mature patterns.

Educable Mentally Retarded Subjects

Eleven children representing the total population of physically able educable mentally retarded boys and girls between the ages of five and eight years of age enrolled in

Ross, loc. cit.
special education classes at Bushnell East Elementary School comprised the experimental group. The group consisted of eight boys and three girls. The youngest child was a five year eleven month old boy while the oldest child was a seven year ten month old boy. The subjects participated in the study from October 4, 1976 through November 10, 1976.

The McCarthy Scales of Children's Abilities Test that was administered individually indicated that the General Cognitive Index for each subject fell within a range of fifty to seventy-five. This is the range of scores that is generally accepted and utilized to identify children as Educable Mentally Retarded. One boy and one girl each scored fifty while the highest score was that of a boy at seventy-four. See Table 1 for personal data on each subject.

Table 1

Personal Data for Mentally Retarded Subjects

<table>
<thead>
<tr>
<th>Subject</th>
<th>Sex</th>
<th>Age</th>
<th>General Cognitive Index</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td></td>
<td>Years-Months</td>
<td></td>
</tr>
<tr>
<td>1</td>
<td>M</td>
<td>5-11</td>
<td>50</td>
</tr>
<tr>
<td>2</td>
<td>M</td>
<td>5-11</td>
<td>68</td>
</tr>
<tr>
<td>3</td>
<td>M</td>
<td>6- 1</td>
<td>74</td>
</tr>
<tr>
<td>4</td>
<td>F</td>
<td>6- 4</td>
<td>50</td>
</tr>
<tr>
<td>5</td>
<td>M</td>
<td>6- 6</td>
<td>67</td>
</tr>
<tr>
<td>6</td>
<td>F</td>
<td>6- 7</td>
<td>68</td>
</tr>
<tr>
<td>7</td>
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<td>F</td>
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<td>M</td>
<td>7- 1</td>
<td>68</td>
</tr>
<tr>
<td>10</td>
<td>M</td>
<td>7-10</td>
<td>69</td>
</tr>
<tr>
<td>11</td>
<td>M</td>
<td>7-10</td>
<td>66</td>
</tr>
</tbody>
</table>
It was necessary to acquire permission from the children's parents in order to conduct this study. The parents gave permission for the children to participate and to be photographed. The letter sent out asking for parental permission was signed jointly by Dr. Crowell, Superintendent of Bushnell Public Schools and the investigator. A copy of the letter can be found in Appendix A.

**Highly Skilled Subjects**

Two adult subjects were selected for their ability to demonstrate mature patterns in the standing long jump, place kick, overarm throw and striking. One subject, a member of the Western Illinois University varsity baseball team and a physical education major, demonstrated the mature patterns of standing long jump, overarm throw and striking. The second subject, a kicking specialist for the Western Illinois University varsity football team, demonstrated a mature place kick pattern.

**Equipment**

Three types of equipment were required to complete this investigation: (1) the equipment needed by the subjects in the performance of the motor patterns, (2) the photographic equipment needed to collect the data, and (3) the equipment needed to analyze and reproduce the data for the text of the dissertation.
Orientation Equipment

The equipment needed for the orientation activities included the following items: a ten foot long low balance beam, two bean bags, a balance board, a gym scooter, five frisbees and one pair of coffee can stilts.

Treatment Equipment

A mat marked with a restraining line was the only piece of equipment needed for the standing long jump. An inflated $8\frac{1}{2}$ inch diameter rubber utility ball was used for the place kick. A large folding mat standing on edge served as a target toward which the subjects kicked the ball. Ten tennis balls were used for the overarm throw. The target was the same mat as used in the place kick. The striking activity required a plastic bat, ten foam balls four inches in diameter and a batting tee.

Equipment for the Mature Patterns

The two adult subjects selected for their ability to perform with mature patterns utilized the same equipment as the mentally retarded subjects in the standing long jump, overarm throw and place kick. However, for the striking pattern a wooden bat and a whiffle ball with a twelve inch circumference were used in place of the plastic bat and foam balls. The same batting tee was used.

Filming Equipment

The equipment utilized for filming included a
Canon 814 E super eight millimeter movie camera, a tripod, one flood light and a supply of tri-x black and white movie film. Since exposing the film at a speed of forty frames per second required additional amounts of light a flood lamp was necessary.

**Equipment Needed for the Analysis**

The film was viewed at normal projection speed (eighteen frames per second), in slow motion and in stop action for the analysis of the motor patterns. This was accomplished with a Kodak Ecktographic MFS-8 super eight analyzer. A Craig super eight film editor was utilized to edit the films. The tracings included in the text of the dissertation were made by tracing the images projected onto a piece of paper.

**Procedure for Filming and Treatment**

The experiment began with a one week orientation period during which time the investigator worked with the mentally retarded subjects in order to establish a relaxed and comfortable environment. Three balance activities and a gym scooter skill that were not related to the motor patterns being investigated were utilized during this period.

The investigator procured the aid of an assistant so that two activity stations could be utilized. The two stations, in the gymnasium at Bushnell East Elementary School, were divided by portable folding lunch tables so
that the subjects could not see each other perform. The subjects reported to the gymnasium two at a time.

At station one, one subject walked the length of a ten foot balance beam forward and backward. This was repeated with a bean bag balanced on the subject's head. Another activity at station one included walking forward and backward on coffee can stilts.

A second subject at station two participated in balance board activities of rocking forward and backward and from side to side. It also included some twisting and turning activities while the subject balanced on the board. The gym scooter activity at station two required the subject to sit on a gym scooter and race across the floor weaving in and out of frisbees placed on the floor. The two subjects changed stations after completing the required tasks at their initial stations.

The camera was set up on the tripod and was operated without film during the orientation period so that the subjects could become familiar with the sights and sounds of the experimental environment.

During the twenty day treatment period the subjects reported to the gymnasium one at a time on days one and twenty for filming and two at a time on days two through nineteen for practice. The folding tables were again utilized in order to maintain two activity stations. It was important that each subject not be allowed to observe the other subjects perform as they might imitate each other and
hence, bias the results of the study. For each of the four motor patterns ten trials were attempted by the subjects each of the twenty days of the treatment period.

The first filming session, during which the initial motor patterns were recorded was held the first day of the treatment period. The second filming session was held on the twentieth and final day of the treatment period. The third trial of each motor pattern, the standing long jump, place kick, overarm throw and striking were filmed. For the initial filming it was felt that by the third trial each subject understood the concept of the task and exerted a maximum effort. During the final filming session it was felt that the first two trials served as a warm up and that by the third trial the effort was again at a maximum level. On occasion, when the investigator felt that the third performance was not a representative performance, the fourth performance was also filmed.

The camera was placed so that lateral views of the motor patterns were filmed. The camera was also in place and operated without film periodically throughout the treatment so that the subjects remained familiar with the experimental environment.

For the standing long jump each subject was shown where to stand behind a restraining line and asked to "jump as far as you can". A piece of tape was used to mark the best performance. The subject was then encouraged to jump beyond this best performance thus providing a realistic and
challenging goal.

In the place kick, a rubber utility ball was placed on the floor at an appropriate distance from a folding mat target. The subject was instructed to kick the ball as hard as possible toward the target. As the subject's skill and kicking distance improved the ball was placed farther from the target.

In the overarm throw, each subject was shown where to stand and instructed to throw a ball as hard as possible at a folding mat target. Again, as the subject's skill improved the subject stood farther from the target in order to keep the task challenging.

For the striking pattern a batting tee was adjusted so that the ball could be placed at waist level. The subject was shown where to stand and was instructed to "hit the ball as hard as you can".

Filming the Mature Motor Patterns

Filming the standing long jump, place kick, overarm throw and striking patterns of the two adults selected for their ability to perform these skills with a mature pattern was completed under identical circumstances as for the filming of the other subjects. Each adult was given several practice trials and instructed to perform the skill with maximum effort. Three trials were allowed and each of the three trials were filmed. The one trial that best represented a mature pattern was selected as the control pattern.
Procedures for the Analysis

Once the motor patterns of the mentally retarded subjects and the mature patterns were recorded on film they were viewed, analyzed and compared at normal speed, in slow motion and with stop action. For each of the four motor patterns, the standing long jump, place kick, overarm throw and striking, the following comparisons were made:

1. The final motor patterns of the mentally retarded subjects were compared to the mature motor patterns.

2. The initial motor patterns of the mentally retarded subjects were compared to their final motor patterns.

The Criteria for Analysis and Comparison

The analysis and stated comparison of the standing long jump, place kick, overarm throw and striking patterns were based on the following criteria:

1. The involvement of body parts.
2. The sequences of movements.
3. The timing of movements.
4. The range of movements.

Presenting the Data

The written analysis of the standing long jump, place kick, overarm throw and striking patterns were based on the observations made through viewing the films. Tracings made from the films are included in the text to provide reference points for the reader.
Four tracings were made to represent each performance in the standing long jump. The first tracing was selected from the frame in the film showing the performer at the height of readiness. This was the last frame before the subject initiated the movements that continued into the jump. The second frame from which a tracing was made was at a point where the subject began a forward and upward movement. This was the frame during which knee flexion was at its greatest. The third frame traced was the point of maximum total body extension and the fourth position selected was on landing at first contact with the mat.

The overarm throwing pattern required four tracings. The first tracing was the ready position prior to the preparatory movements. The second tracing, at the completion of the preparatory movements, was at the instant when the throwing hand was cocked behind the head just prior to any forward movement of the ball. The third tracing was at the point at which the ball was released and the fourth tracing was at the end of the follow-through. An additional tracing was indicated for one of the overarm throwing patterns as it did not conform to the expected sequence.

Each place kick pattern required three tracings to represent the total pattern. The first tracing represented that part of the pattern where the kicking foot initiated its forward movement to meet the ball. In the mature pattern, with a running approach, this was the same point at which the support foot first made contact with the ground. The
second tracing represented that point at which the kicking foot contacted the ball while the third tracing presented the pattern at that point where the forward and upward movement of the kicking foot ceased during the follow-through.

The striking pattern required four tracings. The first was done as the subject addressed the ball just before initiating the backswing. The second tracing was at the height of the backswing just prior to any forward movement of the bat. The third tracing represented the point where the bat contacted the ball or passed by the ball. The fourth tracing represented the follow-through.

The Statistical Procedure

A two-tailed sign test as described by Siegel was utilized to test the null hypothesis that the standing long jump, overarm throw, place kick and striking patterns of the educable mentally retarded subjects did not change from their initial to final performances. The significance level for rejecting the null hypothesis was established at the 5 percent level.

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Chapter 4

ANALYSIS OF THE DATA

The mature patterns as well as the initial and final performances of the mentally retarded subjects were viewed at normal projection speed (eighteen frames per second), in slow motion and by single frame. Selected frames were traced and are included in the text of this thesis. The criteria on which the analyses are based include the involvement of body parts, the sequence of movements, the timing of movements, and the range of movements.

The personal data for the mentally retarded subjects including sex, age and General Cognitive Index scores on the McCarthy Scales of Children's Abilities can be found in Table 1, page 44.

Analysis of the Standing Long Jump

A physical education major who was a member of the varsity baseball team at Western Illinois University was selected for filming in order to establish a model for the mature standing long jump pattern. This model was utilized as a reference against which the initial and final standing long jump patterns of the mentally retarded subjects were analyzed.
Mature Standing Long Jump Pattern

The subject assumed a ready position with the feet parallel, a comfortable distance apart, knees slightly flexed, hips flexed so that the back was in a horizontal position, head up, and the arms passively swinging backward and forward. The jump was initiated with shoulder flexion, followed by forceful shoulder extension and hyperextension until the arms were in a vertical position (Figure 1-1). As shoulder flexion drove the arms downward, the body leaned forward bringing the heels off the floor, while knee flexion increased (Figure 1-2). This was the point at which all the joints involved began movement in the direction of the jump.

Shoulder flexion, which brought the arms forward and upward was initiated at the same time as hip and knee extension, followed by plantar flexion, until the total body was extended from toe to hand (Figure 1-3). As the body became airborne, the hips hyperextended, the knees flexed, while shoulder extension dropped the arms downward. Flight continued with hip flexion bringing the knees forward, the knees extended in preparation for landing, and the arms swung forward to maintain balance upon landing (Figure 1-4). As contact with the floor was made, knee and hip flexion allowed the body to continue in a downward and forward direction, until the center of gravity was over the feet so that the subject maintained a balanced position at the point of landing.
Figure 1

Standing Long Jump
Mature Pattern
Subject 1 - Initial Pattern

The starting position was from an upright position, the feet a comfortable distance apart and with the subject looking down at the mat (Figure 2-1I). The initial movement involved knee and hip flexion with the subject placing his hands on his knees. Flexion continued until the back was almost horizontal (Figure 2-2I). The body leaned forward bringing the heels slightly off the mat. The hands pushed on the knees, accompanied by plantar flexion, knee extension and hip extension. As the body extended forward and upward, plantar flexion was nearly complete. However, knee and hip extension were incomplete as compared to the mature pattern. The hands and arms were raised to approximately shoulder height (Figure 2-3I). As flight continued, the arms dropped downward and hip flexion raised the knees in preparation for landing. As contact with the mat was made, increased hip and knee flexion allowed the body to continue in a forward and downward direction so that balance was maintained with the center of gravity over the feet (Figure 2-4I).

Subject 1 - Final Pattern

The starting position was with the feet a comfortable distance apart, knees and hips slightly flexed with the hands resting on the knees (Figure 2-1F). Motion was initiated with knee and hip flexion until the back reached a horizontal position (Figure 2-2F). A forward lean of the body was followed by the hands pushing on the knees, knee and hip
Figure 2

Standing Long Jump
Subject 1

Initial Performance

Final Performance
extension and plantar flexion. As in the initial pattern, total body extension was incomplete. However, the arms remained in a down position with the hands near the knees (Figure 2-3F). As flight continued, hip flexion lifted the knees in preparation for landing. Upon contact with the mat, hip and knee flexion allowed the body to continue in a downward and forward direction (Figure 2-4F).

Subject 1 - Pattern

Changes

The changes between the initial and final motor patterns included a more complete knee and hip extension during the final performance. The upward arm lift during the initial performance was indicative of a more mature standing long jump pattern, while during the final performance the arms were rather useless.

Subject 2 - Initial Pattern

The starting position was with the feet parallel, a comfortable distance apart, while the body was erect with a slight arm swing backward and forward. The jump was initiated with shoulder hyperextension, knee flexion and hip flexion. The arms continued in an upward and backward swing until they reached a horizontal position (Figure 3-11). As shoulder flexion moved the arms downward, knee and hip flexion continued until the back assumed a horizontal position (Figure 3-21). As shoulder flexion swung the arms forward and upward, the body leaned forward, the knees and
Figure 3

Standing Long Jump
Subject 2

Initial Performance

Final Performance
hips extended, accompanied by plantar flexion, until the total body reached a nearly complete extension from toe to hand (Figure 3-3I). As the body became airborne, the arms began to drop while the knees and hips began to flex in order to lift the feet forward in preparation for landing. Knee extension brought the legs forward as contact with the mat was made (Figure 3-4I). The body weight continued in a downward and forward direction with increased knee and hip flexion so that body balance was maintained over the landing point.

Subject 2 - Final Pattern

The starting position was again in a vertical position. However, the arm swing was vigorous from a forward vertical position to a backward horizontal position. The jump was initiated with a backward arm swing half way between horizontal and vertical, accompanied by slight knee and hip flexion (Figure 3-1F). As shoulder flexion drove the arms downward, knee and hip flexion increased. The back was approximately half way between vertical and horizontal (Figure 3-2F). The body leaned forward, shoulder flexion drove the arms forward and upward, plantar flexion and hip extension were nearly complete, while the knees remained slightly flexed (Figure 3-3F). As the subject became airborne, the arms dropped, followed by hip flexion in order to raise the knees and feet for landing. The knees extended so that the feet contacted the mat well ahead of the body
(Figure 3-4F). As landing continued, the knees and hips flexed, but the feet slid forward so that the subject landed in a sitting position rather than on his feet.

**Subject 2 - Pattern Changes**

One change in the standing long jump technique of subject 2 was the more forceful arm swing prior to the jump demonstrated in the final pattern. However, the initial pattern demonstrated a more complete hip and knee flexion in preparation for the jump. In the initial pattern the subject kept his weight over his feet upon landing while in the final performance the subject's feet were placed far enough ahead of the subject that he fell backward instead of maintaining a balanced landing.

**Subject 3 - Initial Pattern**

The pattern was initiated from an upright standing position with slight hip and knee flexion (Figure 4-1I). As the body leaned forward, the shoulders hyperextended until the arms reached a horizontal position, while knee and hip extension began (Figure 4-2I). Plantar flexion and knee and hip extension were completed while the arms remained in a horizontal position behind the subject (Figure 4-3I). As the subject became airborne, shoulder flexion swung the arms downward and forward, while knee and hip flexion raised the feet and swung them forward for landing. Knee flexion in the right knee was complete while the left knee only slightly
Figure 4

Standing Long Jump
Subject 3

Initial Performance

Final Performance
flexed. As knee and hip extension prepared the subject for landing, shoulder flexion continued to extend the arms forward and upward (Figure 4-4I). The subject's momentum carried the center of gravity forward so that the subject maintained his balance over his feet.

Subject 3 - Final Pattern

The jump was initiated from a vertical standing position (Figure 4-1F) with knee and hip flexion (Figure 4-2F). As the body leaned forward, the shoulders hyperextended, followed by knee and hip extension and plantar flexion. While plantar flexion was complete, the knees and hips remained flexed and the arms maintained the winged position behind the subject (Figure 4-3F). As the subject became airborne, shoulder flexion swung the arms downward and forward while the knees and hips flexed and then extended in preparation for landing. As contact with the mat was made, the subject continued in a forward and downward direction to maintain a balanced landing (Figure 4-4F).

Subject 3 - Pattern Changes

The initial pattern showed only slight knee and hip flexion in preparation for the jump while the final pattern demonstrated extensive knee and hip flexion during this phase of the jump. The amount of total body extension at the point of take-off was more complete in the initial performance than in the final performance.
Subject 4 - Initial Pattern

The subject initiated the standing long jump from an upright position by swinging the arms backward. This was followed by knee and hip flexion as the shoulders hyperextended until the arms reached a horizontal position (Figure 5-1I). Knee and hip flexion continued until the back reached a nearly horizontal position, while the body leaned forward and shoulder flexion began to swing the arms downward and forward (Figure 5-2I). The forward and upward drive of the arms was followed by plantar flexion, knee extension and hip extension. At the point of take-off, plantar flexion was complete while the knees and hips remained slightly flexed and the arms reached their maximum height at about shoulder level (Figure 5-3I). As the subject became airborne, the arms began to drop downward, followed by knee and hip flexion. As the feet swung forward, the knees extended to prepare for landing, while the shoulders continued to extend (Figure 5-4I). Contact with the mat was made as the knees and hips flexed, the shoulders flexed and the subject continued in a downward and forward direction so that balance was maintained. The center of gravity shifted forward over the feet while the knees and hips extended so that the subject assumed a standing position.

Subject 4 - Final Pattern

The pattern began with the subject in an upright
Figure 5

Standing Long Jump
Subject 4

Initial Performance

Final Performance
standing position (Figure 5-1F). Movement began with knee and hip flexion with the arms hanging downward. This movement continued until the back was in a horizontal position (Figure 5-2F). The shoulders flexed, swinging the arms forward and upward, followed by knee and hip extension and plantar flexion. At the point of take-off, plantar flexion was complete, the knees and hips remained slightly flexed, the right arm was head high while the left arm was only shoulder high (Figure 5-3F). As the knees and hips flexed in order to bring the feet forward for landing, the right foot was forward of the left foot. However, as the knees extended to make contact with the mat, the left foot caught up to the right foot so that both feet contacted the mat at the same time (Figure 5-4F). Upon landing, the body continued in a forward and downward direction, while the knees and hips flexed until the subject assumed a squat position. As the arms swung forward to maintain balance, knee and hip extension brought the subject to a stand.

**Subject 4 - Pattern Changes**

The major change in the standing long jump pattern of subject 4 was in the preparation for the jump as the initial pattern represented a more mature performance than did the final pattern. The initial pattern demonstrated a backward and forward swing of the arms with a continuous flow of movement into the jump. The final pattern lacked the backward arm swing with a separation of movement between
the knee and hip flexion and the knee and hip extension.

**Subject 5 - Initial Pattern**

The pattern began from an upright position with knee and hip flexion and with a slight hyperextension of the shoulders (Figure 6-1I). While the shoulders began to flex and as the body began to lean forward, knee and hip flexion continued until the back was in a horizontal position (Figure 6-2I). Plantar flexion, knee and hip extension and an upward swing of the arms brought the body close to total body extension at the point of take-off with only the knees and hips slightly flexed (Figure 6-3I). Once airborne, the shoulders began to extend while the knees and hips flexed. Knee extension then helped lift the feet forward of the body for landing (Figure 6-4I). As the left foot slipped on the mat, the body continued forward and downward so the subject sat on the mat to the left side of the right foot.

**Subject 5 - Final Pattern**

For the final pattern, subject 5 initiated movement from a standing position with a great degree of hip flexion and only a minimal amount of knee flexion, so that the back was only slightly beyond a horizontal position. At the same time, the arms dropped downward with no backward swing (Figure 6-1F). As the body leaned forward (Figure 6-2F), plantar flexion and hip extension followed by knee extension and an upward, but not forward lift of the arms brought the
Figure 6

Standing Long Jump
Subject 5

Initial Performance

Final Performance
subject to the point of take-off (Figure 6-3F). At this point, plantar flexion was complete, while the knees and hips remained slightly flexed with the arms in a winged position. As the body became airborne, the arms swung forward while knee and hip flexion lifted the feet from the mat. As the subject began a downward flight path, the knees extended to place the feet on the mat (Figure 6-4F). Once contact with the mat was made, the subject continued in a forward and downward direction placing the hands forward on the mat in order to refrain from rolling forward.

Subject 5 - Pattern

Changes

The change that took place between the initial and final performances was mainly in the utilization of the arms with the initial pattern more closely representing the mature pattern. In the initial pattern the arms swung backward in preparation for the jump and extended above the head at the point of take-off. Neither movement occurred during the final performance.

Subject 6 - Initial Pattern

The subject began in a standing position, arms hanging at the sides, and initiated movement with knee and hip flexion (Figure 7-11). The degree of hip flexion was minimal as the body leaned forward and the shoulders began to flex (Figure 7-21). At the point of take-off, the subject demonstrated a nearly mature body position as plantar
Figure 7

Standing Long Jump
Subject 6

Initial Performance

Final Performance
flexion was complete and the arms were extended well above the head while the knees and hips were only slightly flexed (Figure 7-3I). As the subject became airborne, the knees and hips flexed and the arms dropped. This was followed by knee extension as the feet contacted the mat well ahead of the subject (Figure 7-4I). As contact with the mat was made, the momentum carried the body downward and forward while the knees and hips flexed and the arms reached forward for a balanced landing.

Subject 6 - Final Pattern

The subject began in a standing position with the knees and hips slightly flexed (Figure 7-1F). Movement began with extensive hip flexion followed by a slight increase in knee flexion and a forward swing of the arms (Figure 7-2F). As the body leaned forward, the shoulders flexed driving the arms upward as the hips began to extend. This was followed by knee extension. At the point of take-off, plantar flexion was complete. However, the knees and hips remained flexed and the shoulders were flexed so that only the hands were above the head (Figure 7-3F). Once airborne, the shoulders extended while the knees and hips flexed. This was followed by knee extension in preparation for landing. As contact with the mat was made, the arms were forward and the knees and hips flexed so that a balanced landing completed the skill (Figure 7-4F).
Subject 6 - Pattern Changes

The major change in the long jump patterns for subject 6 involved the use of the arms. In the initial pattern, the subject timed the forward and upward movement of the arms to correspond with the knee and hip extension and continued the upward arm movement to complete extension. For the final pattern, the forward and upward movement of the arms began while the knees and hips were still flexing in preparation for the jump so that the hands were already shoulder high and well forward of the shoulders by the time knee and hip extension began. It was also noted that the elbows remained flexed for the final performance while they were well extended with the arms high above the head for the initial performance at the point of take-off.

Subject 7 - Initial Pattern

Subject 7 demonstrated a rather immature pattern as movement began from a standing position with extensive hip flexion and only slight knee flexion (Figure 8-11). As the back assumed a horizontal position, the subject leaned forward, placed his hands on his knees and increased the amount of knee flexion (Figure 8-21). To initiate the jump, the knees and hips extended while the hand pushed against the knees. Plantar flexion along with knee and hip extension raised the body to a nearly vertical position while shoulder hyperextension raised the upper arms behind the body with the elbows flexed (Figure 8-31). With the body airborne,
Figure 8

Standing Long Jump
Subject 7

Initial Performance

Final Performance
the elbows extended so that the arms were in a low winged position. This was accompanied by hip flexion so that the lower half of the body was vertical while the upper portion leaned slightly forward. As the hips continued to flex, the feet swung forward. The landing was made with only a small amount of hip flexion while knee flexion was almost absent (Figure 8-4I). As contact with the mat was made, the knees flexed and then extended causing the subject to over balance forward so that a step forward was required to maintain balance. The arms swung forward only after the forward movement of the body had stopped.

Subject 7 - Final Pattern

Movement was initiated from a standing position with hip flexion and a small amount of knee flexion (Figure 8-1F). This continued until the back assumed a horizontal position with the arms hanging beside the knees (Figure 8-2F). As the body leaned forward, the hips extended, followed by knee extension and plantar flexion. Shoulder hyperextension drove the arms upward so that the left arm was in a winged position while the right elbow flexed at the point of take-off. Once airborne, a minimal amount of knee and hip flexion followed by knee extension swung the legs forward for landing (Figure 8-4F). As contact with the mat was made, the arms dropped downward and slightly forward while the knees flexed and extended. Balance was maintained as the subject stopped in a standing position.
Subject 7 - Pattern Changes

To initiate the jump for the initial pattern, subject 7 utilized his arms by pushing on his knees in order to aid hip extension. For the final performance, the arms hung beside and did not push on the knees. During the final performance, the subject demonstrated a greater degree of knee and hip flexion and knee extension while airborne as well as an increase in the amount of knee and hip flexion upon landing than in the initial performance.

Subject 8 - Initial Pattern

The preliminary movements began from a standing position with the arms swinging backward and forward several times. With the arms moving in a backward and upward direction, the knees and hips began to flex slightly. While hip flexion was very incomplete, the arms did swing backward to a point somewhat above horizontal (Figure 9-11). At this point, the arms would have been vertical had hip flexion been complete. As the arms drove downward, the knees and hips continued to flex and the body leaned forward, but not enough to bring the heels off the mat (Figure 9-21). Complete hip flexion was lacking during this phase of the jump. As shoulder flexion drove the arms upward, knee and hip extension followed by plantar flexion brought the subject to the point of take-off (Figure 9-31). Note that plantar flexion and knee and hip extension were incomplete while the hands were extended to just above the head. Once airborne,
Figure 9

Standing Long Jump
Subject 8

Initial Performance

1I 2I 3I 4I

Final Performance

1F 2F 3F 4F
the arms dropped downward and forward, the knees and hips flexed, followed by slight knee extension (Figure 9-4I). As the feet contacted the mat, the body continued in a downward and forward direction. Knee and hip flexion along with limited dorsiflexion allowed the subject to roll forward on the balls of the feet. The hands were placed forward on the mat in order to maintain balance.

Subject 8 - Final Pattern

Movement began with the subject in a standing position with shoulder flexion, followed by shoulder extension and hyperextension. As the shoulders hyperextended, the knees and hips began to flex. With the backward swing of the arms completed, the hips were only slightly flexed so that the back was half way between vertical and horizontal and the arms were slightly above horizontal (Figure 9-1F). The shoulders flexed forcibly while the knees and hips flexed and the body began a slight forward lean to bring the heels slightly off the mat (Figure 9-2F). A forward and upward swing of the arms accompanied plantar flexion and knee and hip extension. At the point of take-off, plantar flexion and knee and hip extension were complete, while the hands only reached head high (Figure 9-3F). Once airborne, the arms began to drop and the knees and hips flexed extensively. This was followed by slight shoulder flexion and knee extension in preparation for landing (Figure 9-4F). As contact with the mat was made, the subject continued in a forward
and downward direction while the knees and hips flexed. Again, the hands were placed forward on the mat to prevent the subject from rolling forward.

**Subject 8 - Pattern Changes**

The changes in the long jump pattern from the initial to the final performance for subject 8 were minimal. A greater degree of knee and hip flexion, followed by knee extension, were demonstrated in the final performance than in the initial performance during the flight phase of the jump.

**Subject 9 - Initial Pattern**

Subject 9 began the initial standing long jump pattern from a standing position, with hip flexion, followed by knee flexion and a backward swing of the arms. As the backward and upward swing of the arms reached their peak, well above horizontal, hip flexion was still incomplete (Figure 10-1I). With a downward and forward swing of the arms, the body leaned forward bringing the heels off the mat, while knee and hip flexion continued (Figure 10-2I). As the arms began to drive upward, plantar flexion along with knee and hip extension were seen. At the point of take-off, plantar flexion was complete, while knee and hip extension were very near complete. However, the arms were already beginning to drop after having reached only shoulder height (Figure 10-3I). As the subject became airborne, the arms continued to drop while the knees and hips flexed slightly. In preparation
Figure 10

Standing Long Jump
Subject 9

Initial Performance

Final Performance
for landing, the left knee extended before the right knee, as the right arm swung backward to a near horizontal position. The right knee then extended so that both feet touch the mat at the same time (Figure 10-4I). Knee and hip flexion allowed the subject to continue in a forward and downward direction. Shoulder flexion brought the arms forward so that the center of gravity was over the feet for a balanced landing. The subject immediately extended the knees and hips in order to come to a standing position.

Subject 9 - Final Pattern

The final pattern was initiated with a backward and upward arm swing, accompanied by minimal knee and hip flexion. At the height of the arm swing, the arms approached a vertical position while the small amount of hip flexion maintained the back in a relatively vertical position (Figure 10-1F). The arms remained in this position for a short time, while the knees and hips continued to flex. As the body leaned forward and the heels left the mat, the arms began a downward and forward swing (Figure 10-2F). The upward swing of the arms was followed by plantar flexion and knee and hip extension. At the point of take-off, plantar flexion was complete while the knees and hips remained slightly flexed. The arms were extended well above the head (Figure 10-3F). Once airborne, the arms began to drop as the knees flexed. This was followed by hip flexion as both knee and hip flexion were rather extensive. The knees
extended while the hips continued to flex as the arms swung forward in preparation for landing (Figure 10-4F). As contact with the mat was made, the right knee flexed while the left knee remained relatively extended. This caused the subject to rotate counter clockwise for one quarter turn around the left foot. Motion ended with the subject kneeling on the right knee with his back to the camera.

Subject 9 - Pattern Changes

One change from the initial to final performance for subject 9 involved the use of the arms. While the subject demonstrated a forceful arm swing in both patterns, the arms extended well above the head in the final pattern at the point of take-off while in the initial pattern the arms had already begun to drop and were below shoulder height at this phase of the pattern.

A second change in the pattern can be seen during the flight phase of the performance. The final pattern demonstrated a more mature performance, with a greater degree of knee and hip flexion, followed by increased knee extension. During the landing phase the right knee flexed for a well executed landing. However, in that the left knee failed to flex and give as the weight of the body moved forward and downward, the landing was uncoordinated and off balance.
Subject 10 - Initial Pattern

The subject began in a standing position and initiated movement with hip flexion. This was followed by knee flexion, as the arms remained parallel to the trunk until the arms and trunk were near a horizontal position (Figure 11-11). The arms began to swing downward and forward as the body leaned slightly forward (Figure 11-21). As the arms began to drive upward, a more pronounced forward lean pulled the heels off the mat. Plantar flexion and hip extension accompanied by a small amount of knee extension brought the subject to the point of take-off (Figure 11-31). Note that plantar flexion and knee extension were far from complete while the hips were only slightly flexed. The arms were only chest high in the "on-guard" position. Once airborne, the arms dropped and the knees flexed, followed by hip flexion so that the subject was in a nearly completed squat position in mid-air. The arms moved forward and raised to about shoulder height as the knees extended to make contact with the mat (Figure 11-41). Once contact with the mat was completed, the arms remained at shoulder height, while the knees and hips flexed as the body moved downward and forward to a balanced squat position on the mat.

Subject 10 - Final Pattern

Subject 10 began the final pattern with a preliminary forward arm swing accompanied by some knee flexion
Figure 11

Standing Long Jump
Subject 10

Initial Performance

Final Performance
and considerable hip flexion. As the arms swung backward and then forward, the knees and hips extended to a nearly vertical standing position. Next, the arms swung downward while the knees and hips flexed again, this time with a greater degree of flexion. As the arms reached the end of the backward swing, they were near a horizontal position, while the knees and hips were flexed so that the back assumed a horizontal position (Figure 11-1F). As the arms began to swing forward and upward, the body leaned forward considerably bringing the heels off the mat (Figure 11-2F). Plantar flexion and knee and hip extension were incomplete, and the hands were only head high at the point of take-off (Figure 11-3F). As the subject became airborne, the arms began to drop and the knees began to flex, followed by flexion of the hips. Hip flexion became extensive as the knees extended and the arms reached forward toward the mat for landing (Figure 11-4F). When contact with the mat was made, the body continued in a downward and forward direction, while the knees flexed to a full squat position. The right hand was placed forward on the mat to help maintain a balanced landing. Knee and hip extension immediately brought the subject to a stand.

**Subject 10 - Pattern Changes**

The main change in the pattern, was the addition of a preliminary forward and backward arm swing and knee and hip flexion and extension, before going into the crouch,
during the final performance. While in the crouch position, knee and hip flexion were greater for the final pattern than for the initial pattern. Also, at the point of take-off, the final performance demonstrated a more mature pattern, as the forward lean of the body was greater and the arms extended higher than in the initial performance.

Subject 11 - Initial Pattern

The pattern began from a standing position with the arms swinging backward and upward. This was followed by a minimal amount of knee and hip flexion. The trunk remained in a nearly vertical position while the arms swung upward beyond a horizontal position (Figure 12-11). Knee and hip flexion became more extensive as the arms began to drive downward and forward (Figure 12-21). Note that the degree of hip flexion was minimal. As the arms began to drive upward, there was a slight forward lean of the body. This was accompanied by plantar flexion and knee and hip extension. At the point of take-off, plantar flexion was incomplete, while knee and hip extension were nearly complete. The right arm was shoulder high while the left arm was slightly lower (Figure 12-31). During flight, knee and hip flexion were minimal and the arms dropped downward. Knee extension brought the subject into contact with the mat with the body high over the point of landing (Figure 12-41). As the body continued forward, the knees flexed only a little and then extended while the arms swung forward causing the subject
Figure 12
Standing Long Jump
Subject 11

Initial Performance

Final Performance
to over balance so that a forward step was required to keep the subject from falling forward.

**Subject 11 - Final Pattern**

Subject 11 began his final performance of the standing long jump from an upright position with a backward and upward swing of the arms, accompanied by some knee and hip flexion. When the arms reached the highest point, the body remained in a relatively upright position (Figure 12-1F). As the arms began to swing downward and as the subject leaned forward, a slight increase in knee and hip flexion were observed (Figure 12-2F). The upward drive of the arms was accompanied by plantar flexion and knee and hip extension. At the point of take-off, the arms were only about shoulder height while plantar flexion and knee and hip extension were complete (Figure 12-3F). Once airborne, the right arm began to drop while the left arm swung backward. At the same time, knee and hip flexion followed by knee extension prepared the subject for landing (Figure 12-4F). When contact with the mat was made, the center of gravity was high and forward. Hence, as the knees and hips flexed upon landing and as the weight continued in a downward and forward direction, the subject overbalanced forward in a full squat position. In order to prevent falling, the subject stood up while stepping forward.
Subject 11 - Pattern Changes

The pattern changes for subject 11 came during the flight and landing phases of the jump. During flight, the final pattern was more mature as it demonstrated greater knee and hip flexion in order to bring the legs forward for landing. Also, during landing, the final pattern demonstrated a greater degree of knee and hip flexion to absorb the downward and forward momentum of the body. Even though the subject lacked balance upon landing, a more controlled landing was demonstrated in the final than in the initial pattern.

The Final and Mature Standing Long Jump Patterns Compared

The final standing long jump patterns of the educable mentally retarded subjects were analyzed and compared to the mature standing long jump performance. While there were many characteristics of the final patterns of the educable mentally retarded subjects which resembled the mature pattern, none of the patterns could be classified as mature. One of the main differences was that the mature performer utilized more body parts in the execution of the skill.

The sequence of movements was different in that the mature performer included more movements in his sequence than did the mentally retarded subjects. However, the movements that were similar between the mature performer and the performances of the mentally retarded subjects did appear in
basically the same sequence.

The timing of the movements was difficult to compare in that when different body parts were involved, the timing changed. When the body parts utilized and the sequence of movements were similar to the mature patterns, the mentally retarded subjects demonstrated timing that was also similar to the mature pattern. However, when the involvement of body parts and the sequence of movements were different from the mature pattern, the mentally retarded subjects demonstrated timing that was best for the style of jump utilized.

The range of motion was where the most obvious difference between the mature pattern and the standing long jump patterns of the experimental group existed. The mature performer demonstrated a much greater range of movement throughout the performance than did the mentally retarded subjects.

The Initial and Final Standing Long Jump Patterns Compared

The sign test, as described by Siegel,¹ was utilized to determine whether or not the changes from the initial to final standing long jump patterns for the educable mentally retarded subjects were significant. The data in Table 2 indicate that two subjects had the same number of positive changes and negative changes, four subjects had more negative changes than positive changes, while five subjects had more

¹Siegel, loc. cit.
### Table 2
Changes in the Standing Long Jump Pattern

<table>
<thead>
<tr>
<th>Subject</th>
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<th>Negative Changes</th>
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$N = 9, x = 4, p = 1.00 = \text{N.S. at .05 confidence level}$
positive changes than negative changes. An N of nine and 
x of four yields a p value of 1.00.\textsuperscript{2} A p value of .05 or 
less was needed in order for the changes in the patterns to 
be significant.

Analysis of the Overarm Throw

The same adult that was utilized to establish the 
model for the standing long jump was utilized to establish 
the model for the overarm throw pattern. The mentally re-
tarded subjects were also the same subjects utilized in the 
standing long jump portion of the study.

**Mature Overarm Throw**

**Pattern**

The subject assumed a ready position facing the tar-
get with the ball held in the right hand in front of the 
body. The left hand supported the ball and the right hand 
(Figure 13-1). Movement was initiated with a short step 
forward on the right foot with the right thigh rotated out-
ward so that the foot was placed on the floor almost per-
pendicular to the intended line of flight of the ball. As 
the foot made contact with the floor, the body began to 
rotate to the right, while the weight was shifted to the 
right foot. At the same time, the hands brought the ball up 
to just below the chin.

With all the weight on the right foot, the left leg

\textsuperscript{2}Ibid., p. 250.
Figure 13

Overarm Throw
Mature Pattern
began to stride toward the target thus allowing the body to complete its rotation so that the shoulders and hips were parallel to the intended line of flight of the ball. During the long stride motion of the left leg, the right arm, with the ball in hand, began to first drop downward and then circle upward to behind the head with the elbow flexed to about ninety degrees. The left elbow extended pointing the left arm toward the target (Figure 13-2). At this point the entire body was cocked ready to begin a summation of forces in order to produce the most forceful throw mechanically possible.

As soon as the left foot was firmly in contact with the floor, the hips began to rotate to the left, followed immediately by shoulder rotation to the left. The beginning of the shoulder rotation was accompanied by lateral rotation of the right arm and a slight increase in right elbow flexion. The left arm began to drop forcefully while the left elbow flexed. As the hips and shoulder rotated to a position perpendicular to the intended line of flight, medial rotation of the right arm was accompanied by elbow extension. A small amount of hip flexion was noted when the ball was released from a point above the front of the head (Figure 13-3).

During the follow through, hip flexion continued while the body continued to rotate to the left pivoting around the left hip as all the weight was supported by the left leg. The right arm continued in a forward and downward
direction crossing over to the left side of the body, while the right leg swung out and forward in order to maintain balance (Figure 13-4).

**Subject 1 - Initial Pattern**

Subject 1 began the initial overarm throw pattern with the left foot slightly forward of the right foot causing the hips to be rotated to the right of perpendicular to the intended line of flight. The shoulders however, were perpendicular to the line of flight. The hands were in front of the body with the ball in the right hand and with the left hand helping to support the ball (Figure 14-11).

Motion began with both hands pushing the ball slightly forward. This was followed by a shift of weight to the right leg while the body rotated to the right, until the hips and shoulders were parallel to the line of flight. At the same time, the right arm with the ball in hand began to circle downward, backward and upward until the ball was positioned behind the head. The left arm dropped downward (Figure 14-21).

The actions that initiated the actual throw began with the left foot contacting the floor as the weight began to shift to the left leg. This caused the hips and shoulders to rotate to the left. As the shoulders came to a point perpendicular to the line of flight, medial rotation of the right arm began. The ball was released at about eye level forward of the head. The left arm hanging at the side flexed
Figure 14

Overarm Throw
Subject 1

Initial Performance

Final Performance
at the elbow during this phase of the throw (Figure 14-3I).

During the follow through, the hips remained nearly perpendicular to the line of flight while the shoulders continued to rotate to the left. The right elbow extended as the ball left the hand. The right arm then moved forward, downward and finally backward to the left side of the body. The left shoulder rotation caused the left arm to swing behind the body, while the right leg swung slightly forward taking some body weight in order to maintain balance (Figure 14-4I).

**Subject 1 - Final Pattern**

The final overarm throw pattern for subject 1 began with the subject facing the target, feet parallel a comfortable distance apart, left arm hanging at the side and with the ball in the right hand held below and forward of the hips (Figure 14-1F).

Motion began with the hips and shoulders rotating to the right while the weight was being shifted to the right foot. The right shoulder abducted and hyperextended, followed by the right elbow flexion bringing the ball to a position immediately behind the head (Figure 14-2F).

Forward motion began with hip and shoulder rotation to the left while the weight was being shifted to the left foot. This was followed by medial rotation of the right arm and right elbow extension. The ball was released at a height level with and forward of the top of the head.
The hips and shoulders continued with a slight rotation to the left, while the right elbow extended as both arms swung backward to the left side of the body. While most of the weight was supported by the left foot, the right foot continued to support some of the body weight (Figure 14-4F). Note that throughout the throw, during the final performance, both feet remained in contact with the floor at the same location as where the pattern began.

**Subject 1 - Pattern Changes**

The initial performance for subject 1 demonstrated a more mature pattern than did the final performance. For the initial pattern, the ball was supported by both hands in front of the body while for the final pattern the ball was held by the right hand only with the arms hanging at the sides. The initial pattern also demonstrated a greater degree of weight transfer as the left foot stepped slightly forward prior to the throw and the right foot moved forward during the follow through. For the final pattern the weight shifted, however, the feet remained in contact with the floor with no forward step on either the left or right foot.

While the body remained in an upright position throughout the throw, a greater degree of hip and shoulder rotation was demonstrated in the initial pattern accompanied by only a small amount of hip flexion as the ball was released. For the final performance, the hips were slightly
flexed throughout the pattern with no increase in hip flexion anywhere during the throw.

**Subject 2 - Initial Pattern**

Subject 2 began the initial throwing pattern while walking toward the target. The right foot was in a forward stride position, the ball in the right hand held forward at about waist level, while the shoulders and hips were perpendicular to the intended line of flight (Figure 15-1I).

When the left foot began to leave the floor, the ball was drawn upward and backward with elbow flexion to place the ball in a position slightly above and behind the right shoulder (Figure 15-2I). At the same time, the hips, trunk and shoulders rotated to the right while the left arm was raised and extended forward pointing toward the target.

Next, as the left leg completed its forward stride with the foot pointing slightly to the right of the intended line of flight, the hips, trunk and shoulders began to rotate left. At the same time, the left elbow was drawn back to the side of the body with some force, while the right elbow lead the throw causing only a slight amount of upper arm lateral rotation. There was a considerable amount of elbow flexion followed immediately by forceful elbow extension. At the point of release, the ball was at eye level and forward of the head (Figure 15-3I). Most of the weight was supported on the left leg while the hips and trunk were perpendicular to the line of flight. The shoulders had
Figure 15

Overarm Throw
Subject 2

Initial Performance

Final Performance
rotated only slightly to the left.

In the follow through, complete elbow extension was reached as the throwing arm pointed toward the target. As the arm continued in a downward direction, the hips flexed while the right leg remained behind the subject for balance (Figure 15-4I).

Subject 2 - Final Pattern

Subject 2 began the final pattern from a standing position with the throwing arm raised high behind the head. The body was turned to a position almost parallel to the intended line of flight (Figure 15-1F). The left arm was raised to shoulder height in front of the body.

The body was brought to a cocked position with a stride forward on the left foot, an increase in elbow flexion of the right arm, a lowering of the left arm and a slight increase in rotation so that the shoulders were parallel to the line of flight (Figure 15-2F).

As the left foot contacted the floor, the hips, trunk and shoulders rotated left, while the upper arm demonstrated a degree of lateral rotation accompanied by elbow extension bringing the elbow near a ninety degree angle. At the point of release, the pattern looked very much like the mature pattern (Figure 15-3F). The ball was released above and slightly forward of the head while the hips, trunk and shoulders were perpendicular to the line of flight. Much of the force generated was the result of medial rotation of the
upper right arm. Note also that the left arm was drawn in to the side.

In the follow through, the right arm extended toward the target and then continued in a downward direction. The right arm did not cross the body but ended up near the right hip (Figure 15-4F). Weight was supported on the left leg while the hips flexed and the trunk leaned to the left. The right leg remained in a stride position to the right side to help maintain balance.

Subject 2 - Pattern Changes

Subject 2 demonstrated three very important changes in the overarm throwing pattern. Each of these changes represent a change toward a more mature pattern. The first change was seen in the starting position with the shoulders perpendicular to the line of flight in the initial pattern and parallel to the line of flight in the final pattern. The second change was represented by very little medial rotation of the upper arm during the effort phase of the pattern in the initial performance, while the final performance demonstrated a great deal of medial rotation of the upper arm. The third change, also taking place during the effort phase of the throw, was the increased utilization of hip, trunk and shoulder rotation as part of the total force production in the final pattern.
Subject 3 - Initial Pattern

The starting position for subject 3 was with the subject facing the target, the ball held in the left hand, forward and above the waist (Figure 16-1I).

Action began with a sideward stride to the left while moving the ball first forward and upward and then backward and upward. The left elbow flexed to bring the ball behind the left shoulder. The right arm extended up to the right while the left foot began a forward stride (Figure 16-2I). At this point, the shoulders were rotated slightly to the left.

As the left foot strode forward, increased elbow flexion followed by elbow extension accompanied by only a slight degree of shoulder rotation provided the force for the throw. The ball was released at eye level well in front of the left shoulder (Figure 16-3I).

Very little motion could be seen during the follow through. The left leg was lifted and took a second stride forward, the left arm extended and continued in a downward direction while the right arm extended behind the body for balance (Figure 16-4I).

Subject 3 - Final Pattern

The subject again began by facing the target with the ball extended forward in the left hand (Figure 16-1F).

Motion began by raising the ball overhead and by drawing it to the rear. The shoulders and hips rotated
Figure 16

Overarm Throw
Subject 3

Initial Performance

Final Performance
slightly to the left while the elbow flexed bringing the ball to a position behind the neck (Figure 16-2F).

The throwing motion began with shoulder rotation to the right. Elbow extension followed by shoulder extension raised the ball high above and slightly forward of the head at the point of release (Figure 16-3F).

During the follow through, the left arm extended forward and downward, while the right foot took a small step backward in order to maintain balance (Figure 16-4F). The right arm remained at the subject's right side throughout the performance.

**Subject 3 - Pattern Changes**

During the initial performance, subject 3 demonstrated an ipsilateral throwing pattern by stepping forward with the left foot and throwing with the left hand. For the final performance, the subject's feet remained in contact with the floor except for a small step backward with the right foot in order to maintain balance during the follow through.

A second change concerns the utilization of the throwing arm during the effort phase of the throw. For the initial pattern, the effort was mainly that of elbow extension causing the ball to be released at about eye level. During the final pattern, the effort was a combination of shoulder and elbow extension causing the ball to be released high above the head.
Subject 4 - Initial Pattern

Subject 4 assumed a starting position facing the target with the right foot slightly forward, the right shoulder and elbow flexed so that the ball was located above and behind the right shoulder (Figure 17-1I).

Motion began with a slight increase in shoulder flexion and with a considerable increase in elbow flexion placing the ball immediately behind the right shoulder (Figure 17-2I). At the same time, the right foot began a small stride forward.

As the right foot continued to stride forward, the hips began to flex. Shoulder and elbow extension provided the force for the throw. The ball was released from a point above the forehead (Figure 17-3I).

During the follow through, the right arm continued in a forward and downward direction while the hips continued to flex (Figure 17-4I).

Subject 4 - Final Pattern

The final pattern for subject 4 began with the subject facing the target and with the ball held over the right shoulder and just above the top of the head (Figure 17-1F). The left elbow was flexed so that the left hand was held forward at about waist height.

A second ready position was assumed when the subject rotated the shoulders slightly to the right and extended the right elbow so that the ball was held as high and as far
Figure 17

Overarm Throw
Subject 4

Initial Performance

Final Performance
behind the head as possible (Figure 17-2F). The left arm demonstrated medial rotation to bring the hand in near the waist. The right elbow was again flexed as the ball was placed into a position behind the neck (Figure 17-3F).

Hip flexion, followed by shoulder and elbow extension, brought the ball forward to the point of release high above the head (Figure 17-4F). This motion was accompanied by a small degree of shoulder rotation to the left.

The follow through consisted of a forward and downward swing of the right arm, while the hips continued to flex slightly (Figure 17-5F).

Subject 4 - Pattern

Changes

The initial pattern contained an ipsilateral step forward on the right foot while for the final pattern the subject's feet remained in contact with the floor. A second change in the pattern involved the actions preceding the throw. During the initial performance, the only arm motion preceding the effort phase was that of elbow flexion, while for the final performance, elbow extension followed by elbow flexion preceded the throw.

Subject 5 - Initial Pattern

The subject began from a standing position turned to the right so that the hips and shoulders were halfway between perpendicular and parallel to the intended line of flight (Figure 18-1I). The ball was held in the right hand
Figure 18

Overarm Throw
Subject 5

Initial Performance

Final Performance
about waist high and forward of the body.

Motion began with a forward stride of the left foot as the right hand began to draw the ball up and back to a position behind the neck (Figure 18-2I). At the same time, the right side of the body flexed slightly at the knee and hip, while the shoulders and hips rotated to the right until they were parallel to the line of flight. The left hand was drawn across the body to a position just forward of the right hip.

When the left foot made contact with the floor, the subject began to shift his weight to the left leg causing the body to rock forward (Figure 18-3I). This was accompanied by rotation of the hips and shoulders to a position perpendicular to the line of flight at the point of release. Lateral rotation, followed immediately by medial rotation of the upper arm and elbow flexion caused the ball to be released at a point high above the right shoulder. The left elbow flexed as it was drawn back to a position near the left hip.

The throwing arm continued to extend forward and then swing downward and backward while remaining to the right side of the body during the follow through (Figure 18-4I). The right foot took a step forward to a position even with the left foot while the hips and knees flexed slightly and the left arm extended behind the body for balance. The hips remained perpendicular to the line of flight while the shoulders continued to rotate slightly to the left.
Subject 5 - Final Pattern

Subject 5 began his final performance from a position facing the target (Figure 18-1F). The hips and shoulders were perpendicular to the intended line of flight while the right hand held the ball below and forward of the waist. The knees and hips were slightly flexed.

The knees and hips extended as the ball was drawn upward in a circular path, over the shoulder to a position behind the head, with the elbow flexed. Abduction and lateral rotation of the upper arm was seen as the shoulders rotated to the right.

The forward motion began with shoulder rotation to the left (Figure 18-3F). Some shoulder extension accompanied by elbow extension provided the greatest portion of the force as the shoulders had stopped rotating at the point of release. Some hip and knee flexion could be seen at this point.

The follow through consisted mainly of knee and hip flexion as both arms swung downward and backward to aid in balance (Figure 18-4F). Note that the right arm remained on the right side of the body.

Subject 5 - Pattern Changes

The main change in the pattern for subject 5 was related to the usage of body rotation in order to produce a forceful overarm throw. For the initial pattern, the subject rotated the shoulders and hips to the right in
preparation for the throw and then rotated them to the left to aid in the production of force. For the final pattern, the subject remained facing the target, except for a small amount of shoulder rotation to the right in preparation for the throw and then to the left during the execution of the throw.

Subject 6 - Initial Pattern

The starting position for subject 6 was with the whole body rotated slightly to the right of the intended line of flight (Figure 19-1I). The right arm was drawn back so that the ball was above and well behind the right shoulder. The knees and hips flexed slightly as the weight shifted to the left leg while the hips and shoulders rotated slightly to the right (Figure 19-2I).

The right elbow flexed to bring the ball to a ready position behind the right shoulder. Forward motion began as the hips and shoulders rotated to the left while medial rotation of the right upper arm accompanied by elbow extension were seen (Figure 19-3I).

The follow through consisted of the right arm extending and moving in a downward direction while crossing over to the left side of the body (Figure 19-4I). As the weight was all shifted to the left foot, the entire body pivoted on the left foot to bring the right foot slightly forward of the left foot. Note that the left arm was not utilized to aid in the throw.
Figure 19

Overarm Throw
Subject 6

Initial Performance

Final Performance
Subject 6 - Final Pattern

The feet were pointed directly toward the target as subject 6 prepared for her final throw (Figure 19-1F). The shoulders were rotated to the right with the ball held above and behind the right shoulder. The left arm was raised and extended forward. The hips were only slightly rotated to the right.

Motion began as the right elbow flexed and the left elbow was drawn up to shoulder level (Figure 19-2F).

Forward motion began as the shoulders and hips rotated to the left. Lateral rotation, followed immediately by medial rotation of the upper arm, accompanied by elbow flexion and then elbow extension brought the ball to the point of release slightly above but well forward of the head (Figure 19-3F).

As the right arm extended forward in the follow through, the weight shifted to the left foot. Hip and shoulder rotation to the left, accompanied by hip flexion and flexion of the left knee aided the performer in swinging the right arm to the left side of the body (Figure 19-4F). The left elbow extended as the left arm swung backward to aid the individual in balance. The right foot swung forward to a position slightly forward of the left foot.

Subject 6 - Pattern Changes

Very little change could be seen between the initial and final overarm throw patterns for subject 6. The subject
began the throw with the body rotated to the right in the initial pattern while facing the target in the final pattern. It was also noted that the subject did utilize the left arm for force production and for balance in the final pattern while in the initial pattern the arm remained at or near the left side during the entire performance.

Subject 7 - Initial Pattern

The subject began by facing the target with his arms at his sides (Figure 20-1I).

The ball was brought to the cocked position through lateral rotation of the upper arm and through elbow flexion (Figure 20-2I). The shoulders rotated slightly to the right while the left arm moved only enough to maintain balance.

The throw began with a minimal amount of shoulder rotation to the left, followed by a small amount of hip flexion (Figure 20-3I). The upper right arm rotated medially while the elbow extended to release the ball at a point high above the forehead. The left elbow flexed to place the left hand in a position immediately in front of the chest.

During the follow through, the throwing arm extended forward and downward crossing over to the left side of the body (Figure 20-4I). The hips and shoulders rotated to the left only enough to allow the right arm to cross over to the left side of the body. Note that the feet remained in the same position on the floor throughout the pattern.
Figure 20

Overarm Throw
Subject 7

Initial Performance

Final Performance
Subject 7 - Final Pattern

The subject began the final pattern by drawing the ball up toward the right ear while shifting the weight to the right foot (Figure 20-1F). The subject was facing the target but rotated slightly to the right.

Moving into the cocked position, the left foot stepped forward, while the ball was drawn back behind the ear at ear level (Figure 20-2F). The stride forward caused the hips to slightly increase their rotation to the right, but did not change the position of the shoulders.

When the left foot made contact with the floor, the shoulders and hips rotated to the left until they were perpendicular with the line of flight at the point of release (Figure 20-3F). The ball was released at eye level well forward of the head. The arm action in this throwing pattern consisted mainly of elbow extension.

After releasing the ball the arm continued until extended forward at shoulder level. It then moved left as the right foot stepped forward to a position slightly behind the left foot (Figure 20-4F). The left arm was utilized only for balance during the follow through phase of the throw.

Subject 7 - Pattern Changes

There were two basic changes in the overarm throw pattern for subject 7. The most noticeable change was the addition of a forward step, first with the left foot and then
with the right foot in the final pattern. No steps were taken during the initial pattern.

A second pattern change dealt with the utilization of the arm to produce the force. In the initial pattern force was produced by a combination of medial rotation of the upper arm and by elbow extension with the ball being released high in the air. In the final pattern the subject relied on elbow extension to produce the force with the ball being released at eye level well in front of the head.

**Subject 8 - Initial Pattern**

The ball was supported by both hands, just forward of the right shoulder, while the weight was supported mainly by the left leg as subject 8 prepared herself for the initial throw (Figure 21-11). The entire body was turned to the right so that the subject's shoulders were parallel to the intended line of flight. The subject was looking at the camera.

Motion began as the subject's head turned toward the target while the ball was raised and drawn back to a position behind the head. The right foot began to stride forward causing the hips to rotate to the left. As the right foot continued to stride forward, the shoulders also began to rotate left while the upper right arm began lateral rotation to put the ball in a position behind the back (Figure 21-21).

Throwing action began as the right foot contacted
Figure 21

Overarm Throw
Subject 8

Initial Performance

1I  2I  3I  4I

Final Performance

1F  2F  3F  4F
the floor. The shoulders continued to rotate left, while medial rotation of the upper right arm, followed by elbow extension, caused the ball to be released at a point above and slightly forward of the head (Figure 21-3I). At the same time the weight was being shifted to the right foot.

The follow through consisted of the right arm extending forward and downward to the left side while the entire body continued to rotate to the left (Figure 21-4I). Some of the weight was again shifted back to the left leg in order to allow this body rotation to continue. A small amount of hip flexion was also seen during the follow through phase of the throw.

Subject 8 - Final Pattern

The subject began by facing the target with the ball held above the right shoulder and the left foot striding forward (Figure 21-1F).

The ball was brought to the cocked position above and behind the right shoulder with lateral rotation of the upper arm (Figure 21-2F).

As the left foot contacted the floor, transverse adduction and medial rotation of the upper arm in combination with elbow extension provided much of the force for the throw. The ball was released slightly above and well forward of the head (Figure 21-3F).

During the follow through phase of the throw, the right arm continued forward and downward crossing over to
the left side of the body (Figure 21-4F). As the weight shifted to the left foot, only a slight amount of body rotation to the left could be seen while the right leg swung slightly forward. A small amount of hip flexion was also seen near the end of the follow through.

**Subject 8 - Pattern Changes**

Changes between the initial and final patterns for subject 8 were seen in the utilization of body rotation to produce force. For the initial pattern, the subject began with the shoulders and hips rotated right to a position parallel to the line of flight. During the preparation for the throw the subject began rotating left and continued to do so on into the follow through. During the final pattern, the subject remained in a position facing the target. It was only during the follow through phase that she rotated slightly to the left.

A second change in the pattern dealt with the utilization of the legs. The initial performance was that of an ipsilateral pattern with a step forward on the right foot while the final performance was that of a crosslateral pattern with a step forward on the left foot.

**Subject 9 - Initial Pattern**

The starting position was with the left foot forward so that the subject's body was rotated and facing to the right of the target (Figure 22-11). The ball was held in
Figure 22

Overarm Throw
Subject 9

Initial Performance

1I  2I  3I  4I

Final Performance

1F  2F  3F  4F
the right hand, forward, to the right and level with the subject's right shoulder.

As the ball was drawn upward and backward, the right leg rotated so that the right foot was perpendicular to the line of flight. The weight then shifted to the right foot causing the hips and shoulders to rotate to the right to a position parallel to the line of flight (Figure 22-2I). The left arm abducted toward the target while the left leg increased its stride toward the target. The ball was moved to a position above and behind the right shoulder.

Hip and shoulder rotation to the left began as the left foot made contact with the floor. Lateral rotation of the upper arm, followed by medial rotation of the upper arm and elbow extension brought the ball to the point of release above and forward of the head (Figure 22-3I). The weight shifted over the left foot, the left knee and left hip flexed to bring the subject's right knee near the floor at the point of release. Note that the subject's hips and shoulders were perpendicular to the line of flight at the point of release.

After releasing the ball, the right arm continued forward and downward crossing over to the left side of the body (Figure 22-4I). Hip and knee flexion continued on both sides of the body until the right knee made contact with the floor. With some weight supported on the right knee, hip flexion continued so that balance could be maintained.
Subject 9 - Final Pattern

The final pattern began from a sideward stride position with the left foot toward the target and with the hips and shoulders parallel to the intended line of flight (Figure 22-1F). The ball was held at waist level in front of the body.

As the left foot took a long stride toward the target, the right hand circled the ball backward and upward, flexing the elbow to position the ball behind the right shoulder (Figure 22-2F). The body moved toward the target until supported equally by both legs while the head looked upward.

The throwing force began as the shoulders and hips rotated to the left placing the weight on the left leg (Figure 22-3F). Medial rotation of the upper right arm plus elbow extension brought the ball to a point of release above the forehead. The left arm, which was extended toward the target, was drawn into the left side, although not with force.

During the follow through stage, the right arm continued forward and downward ending up near the left knee (Figure 22-4F). With all the weight on the left foot, and the body leaning to the left, the right foot remained well back and to the right for balance.

Subject 9 - Pattern Changes

Although the initial and final patterns for subject 9 appeared to be very different and hence had a number of changes they were very much alike. The only real change was
that during the initial pattern, the subject flexed his left knee thus lowering his center of gravity to end up with some weight supported by the right knee. During the final pattern, the left knee flexed only slightly thus allowing the subject to keep his center of gravity balanced higher over his left leg. This allowed the subject to end his throw in a standing position.

**Subject 10 - Initial Pattern**

A sideways crossover step was utilized by subject 10 as he moved toward the target in preparation for his throw. The hips and shoulders were rotated to the right half way between perpendicular and parallel to the intended line of flight while the right leg crossed in front of the left leg (Figure 23-11). The right foot was placed on the floor perpendicular to the line of flight. The ball was held in the right hand in front of the body at about waist height.

As the weight shifted to the right leg, the ball began to move downward, backward and upward while the left leg began to stride forward. The left arm was raised toward the target and then swung to a position behind the subject above waist height. The cocked position was reached as the left foot contacted the floor (Figure 23-21). The ball reached a position above, behind and to the right of the subject's right shoulders. At this point, the shoulders and hips were parallel to the line of flight.

As the weight shifted to the left foot, the hips and
Figure 23

Overarm Throw
Subject 10

Initial Performance

Final Performance
shoulders rotated to the left to a position perpendicular to the line of flight (Figure 23-3I). The right arm remained in its cocked position during this rotation. Once the shoulders were perpendicular to the line of flight, medial rotation of the upper arm accompanied by elbow extension placed the ball well forward and slightly above the right shoulder at the point of release. During the throw, the left arm had dropped down to a position near the left hip.

After releasing the ball, the right arm extended and then swung to the left side of the body lowering only slightly. The shoulders continued to rotate to the left while the hips remained perpendicular to the line of flight (Figure 23-4I). All the weight was supported by the left leg as the right leg began to step forward. The left arm swung away from the body to the rear as an aid to balance.

Subject 10 - Final Pattern

The subject assumed a sideways stride position with the hips parallel and the shoulders nearly parallel to the intended line of flight (Figure 23-1F). The ball was held in the right hand toward the target at about waist height.

Movement began with knee and hip flexion as the subject began to squat, while circling the ball downward, backward and upward to a position shoulder high, with the right arm extended to the right of the subject. The right elbow was slightly flexed. The subject began shifting his weight to the left foot while the ball continued circling to
a position above and behind the right shoulder (Figure 23-2F).

The weight shifted to the left leg, the shoulders were perpendicular and the hips were nearly perpendicular to the line of flight at the point of release (Figure 23-3F). Medial rotation of the upper arm and elbow flexion were delayed until the shoulders reached this position. The ball was released at a point well forward of the head but at a point about level with the top of the head.

Very little motion was seen during the follow through. The right arm extended toward the target and then continued movement crossing over the chest to the left side of the body (Figure 23-4F). The feet remained in the same position while the shoulders and hips remained in a position perpendicular to the line of flight. The left arm remained near the left side during the entire performance.

Subject 10 - Pattern

Changes

The initial pattern for subject 10 included a cross-over step in preparation for the throw, giving the body some momentum toward the target. This was seen through the follow through as the subject took a small step forward with the right foot. However, during the final pattern, the subject's feet remained relatively stationary as little body movement toward the target could be seen. The left arm was utilized some for balance during the intitial pattern, while it remained rather useless at the side during the final
pattern. Other than these two changes, the initial and final patterns were very similar.

Subject 11 - Initial Pattern

The initial pattern began with the subject's body rotated somewhat to the right (Figure 24-11). The weight was supported by the left leg while the right foot was forward, pointing slightly to the right of the target. The ball was held in front of the body just below the chest. The left hand was moving toward the ball from above in preparation to taking hold of the ball with both hands.

The right foot was lifted up and began a forward stride while the right hand began to circle downward, backward and upward. The ball reached its cocked position slightly above and behind the head with the right elbow flexed. The left arm reached toward the target and began to drop downward toward the left hip. The long forward stride caused the hips and shoulders to rotate to the right to a position nearly parallel to the line of flight (Figure 24-21).

The weight was taken on the left leg and the hips and shoulders rotated to the left to a position perpendicular to the line of flight at the point of release (Figure 24-31). The left elbow was drawn in to the left side. Medial rotation of the upper right arm accompanied by elbow extension brought the ball to its point of release very high above and forward of the head. The trunk also began to flex to
Figure 24

Overarm Throw
Subject 11

Initial Performance

Final Performance
the left just prior to the point of release.

With all of the weight supported on the left leg, the subject continued to flex left with the trunk and flex at the hips to allow the throwing arm to reach toward the target and then crossover to the left side of the body (Figure 24-4I). The right foot remained well back and to the right in order to maintain balance.

Subject 11 - Final Pattern

The subject assumed a position with the entire body rotated to the right (Figure 24-1F). The hips and shoulders were nearly parallel to the intended line of flight. The weight was supported mainly on the left foot. The ball was held in the right hand, supported by the left hand, at waist height in front of the body.

Motion began with the left foot striding toward the target while the left arm also reached up toward the target. The right hand began to circle the ball downward, backward and upward with the right elbow flexing, to bring the ball to the cocked position above and behind the right shoulder (Figure 24-2F).

The throw began as the left foot contacted the floor, causing the hips and shoulders to rotate to the left to a position perpendicular to the line of flight (Figure 24-3F). The left elbow flexed and was drawn back near shoulder level as the shoulders rotated. Once the shoulders reached a position perpendicular to the line of flight, the upper right
arm began medial rotation while the elbow began to extend. The ball was released at a point above and forward of the forehead.

During the follow through phase, the right arm continued forward and crossed over the body to the left side (Figure 24-4F). The left upper arm was adducted in opposition to the right arm crossing over. The subject's trunk flexed slightly to the left while the right leg remained behind and to the right for balance.

Subject 11 - Pattern Changes

The changes in the pattern for subject 11 were minimal. In the initial pattern the ball was released at a position higher above the head than in the final pattern. Also, in the initial pattern, the subject flexed more at the hips and trunk causing the body to end up in a much lower position at the end of the follow through.

The Final and Mature Overarm Throwing Patterns Compared

None of the final overarm throwing patterns of the mentally retarded subjects could be classified as mature. The mature performer utilized his whole body in the performance of the overarm throw. The experimental group did not involve all the body parts, nor did they utilize the involved body parts to the best advantage in the performance of the skill. All of the subjects failed to use the arms
and shoulders to the same extent as the mature performer. Many of the subjects failed to use the body from the waist down, except to maintain balance.

The body actions that were seen as the mentally retarded subjects performed the overarm throw were sequenced correctly when compared to the mature pattern. Again, the patterns of the experimental group simply did not contain all the parts of the mature sequence as several very basic body actions were omitted.

The timing of the body actions for the experimental group did vary slightly from the mature pattern. While the mature performer combined the movements for the total pattern the results appeared to be a continuous flow of movement from beginning to end for the total body as well as the individual body parts. Many of the mentally retarded subjects paused in their movement between the preparation and effort phases of the throw. This break in the movement appeared to separate the throw into two parts.

The range of movement demonstrated by the mature performer was very different from the range of movement demonstrated by the mentally retarded subjects. Much of the difference was due to the lack of use of certain body parts by the experimental group. In that some of the experimental group did not utilize an initial step, and that some subjects did not utilize a stride step, the possible range of motion was very limited. Simply because the lower part of the body was not totally involved, the range of motion in the upper
half of the body was limited. The body was not allowed to rotate or to move forward as the throw was performed.

The Initial and Final Overarm Throwing Patterns Compared

The sign test was utilized to compare the differences between the initial and final overarm throwing patterns for the educable mentally retarded subjects. The data in Table 3 indicate that six subjects had the same number of positive changes and negative changes, two subjects had more negative changes than positive changes, while three subjects had more positive changes than negative changes. An N of five and x of two yields a p value of 1.00. A p value of .05 or less was needed in order for the changes in the patterns to be significant.

Analysis of the Place Kick

The mature place kick pattern model was established through filming the varsity place kicking specialist from the Western Illinois University football team. The mentally retarded subjects were the students utilized for the standing long jump and overarm throw patterns previously analyzed.

Mature Place Kick Pattern

The subject utilized a running three step approach for the place kick. At the beginning of the last step the

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3Siegel, loc. cit.
Table 3
Changes in the Overarm Throwing Pattern

<table>
<thead>
<tr>
<th>Subject</th>
<th>Positive Changes</th>
<th>Negative Changes</th>
<th>Direction of Change</th>
<th>Sign</th>
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<td>0</td>
<td>4</td>
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<td>-</td>
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$N = 5, x = 2, p = 1.00 = N.S. at .05 confidence level$
subject's body was leaning slightly forward. The shoulders were slightly flexed and abducted with the elbows also being slightly flexed. The left arm was higher than the right arm.

As the subject approached midstride, with both feet off the floor, the trunk assumed a vertical position. The shoulders continued to flex and abduct. As the left foot, the support foot, made contact with the floor heel first, the trunk assumed a very slight backward lean (Figure 25-1). The hands were extended sideways with the left hand slightly higher than the left shoulder while the right hand was slightly lower and forward of the right shoulder. The right hip was slightly hyperextended while the right knee flexed to about ninety degrees. The left hip and knee were flexed with the foot making contact with the floor so that the toes were even with the back edge of the ball (that portion of the ball farthest from the target). As the left foot rocked forward, to a position flat on the floor, the right hip began to flex driving the right knee forward. The right knee continued to flex slightly and then began to extend with force, bringing the foot forward so that the toes made contact with the ball (Figure 25-2). As the knee drove forward, the hands drove downward and backward to a wide position above and to the rear of the waist. After contact with the ball was made, the knee continued to extend to full extension, while the right hip continued to flex bringing the foot high in the air so that the toes were at eye level
Figure 25

Place Kick
Mature Pattern
(Figure 25-3). As the forward and upward drive of the right leg came to a stop, enough momentum was transferred to the rest of the body to cause the subject to hop forward on the left foot. During the hop, the hands began to move forward at waist level, while the right hip began to extend, bringing the right foot into contact with the floor a short stride ahead of the left foot.

**Subject 1 - Initial Pattern**

Subject 1 utilized a one step walking approach with the support foot placed flat on the floor, well behind the ball. At this point both feet were in contact with the floor. The shoulders flexed as the hands began to reach forward and upward. As the weight shifted forward over the left leg, the body began to lean forward while the right knee began to flex. The left hip extended, to bring the hips forward over the support leg, while the right knee reached its greatest degree of flexion (Figure 26-11).

The forward shift of the hips brought the body to a vertical position. During this shift of the hips, the left arm swung wide to the left side, toward the rear, while the right arm remained extended forward for a while and then began to drop. The right hip then began to flex while the right knee began to extend (Figure 26-21). The left foot plantar flexed to bring the heel off the floor, at the point of contact, while the left arm began to swing forward with the right arm extended sideways. As the right hip flexed,
Figure 26

Place Kick
Subject 1

Initial Performance

Final Performance
the right knee continued to extend. The toes reached a height of about chest high (Figure 26-3I).

When the right leg began to drop, the arms fell to the sides. The subject took a step backward on the right foot in order to maintain balance.

**Subject 1 - Final Pattern**

The final pattern was performed from a standing approach. The subject stood with his feet together immediately behind the ball. He began his motion by shifting his weight to his left leg and by drawing his right leg back. This motion began with hyperextension of the right hip followed by flexion of the right knee (Figure 26-1F). The hands, which were hanging at his sides began to shift to the left during this motion.

The right hip began to flex before the flexion of the right knee was completed. As the right hip flexed and as the right knee began to extend, the right arm began to swing down to the rear while the left arm began to abduct and then swing forward (Figure 26-2F). At the point of contact, the subject's weight was shifted to the rear in opposition to the action of the right leg.

During the follow through, the right hip continued to flex while the right knee continued to extend. However, due to incomplete hip flexion and knee extension, the toes of the right foot only reach to a point above knee high but below waist high (Figure 26-3F). The left hand ended in a
forward position to the left, while the right hand was extended to the rear. Note also, that as the subject over balanced backward, only the heel of the left foot was in contact with the floor. The subject was also required to take a step backward on the right foot in order to keep from falling backward.

Subject 1 - Pattern Changes

The most significant change in the pattern for subject 1 was that of utilizing a step approach for the initial performance and a standing approach for the final performance. The other two changes were related to the type of approach utilized. The arm actions during the initial performance more closely resembled the arm actions of the mature pattern than did the arm action of the final performance. Also, the kicking leg reached a higher final position during the follow through for the initial pattern than for the final pattern.

Subject 2 - Initial Pattern

The subject began his initial place kick pattern with a two step running approach. The trunk was leaning forward at the beginning of the last stride and was leaning backward at mid-stride. The shoulders were abducted and hyperextended as the left foot made contact with the floor well behind the ball (Figure 27-11).

The right knee flexed to approximately ninety
Figure 27

Place Kick
Subject 2

Initial Performance

Final Performance
degrees as the right hip began to flex. At the point of contact, the right knee had remained flexed at about ninety degrees while the right hip had flexed considerably (Figure 27-2I). The right arm pointed directly toward the floor while the left shoulder abducted so that the arm pointed directly away from the body. The body weight had shifted to a position well behind the support foot. As the right foot contacted the ball toes first, plantar flexion at the ankle could be seen. It was also noted that the left foot began to plantar flex slightly at the point of contact.

After the kick, the right hip continued to flex, the right knee continued to extend and the right arm continued to abduct (Figure 27-3I). The toes of the kicking foot reached a position at about chin height. Once the motion of the right leg stopped, the right hip began to extend and then hyperextend so that the right foot made a step backward in order to keep the subject from falling backward. The right arm remained in place at the right side while the left shoulder abducted, swinging the arm slightly to the rear. The arm then swung forward to the left side.

Subject 2 - Final Pattern

A one step approach was utilized by subject 2 for the final place kick pattern. The step was short with the left foot being positioned well behind the ball (Figure 27-1F). As the support foot made contact with the floor, the hips were slightly flexed so that the trunk leaned
forward. The right shoulder was slightly abducted while the left shoulder abducted considerably. At this point, the right knee was only slightly flexed. However, it continued to flex as the right hip began to flex driving the right knee forward.

As the right knee drove forward, the right shoulder hyperextended while the left shoulder and elbow flexed. The right knee reached its greatest amount of flexion just prior to the toes making contact with the ball. As contact with the ball was made, the right knee extended while flexion in the right hip stopped (Figure 27-2F).

During the follow through, the left foot plantar flexed slightly while the left shoulder and elbow continued to flex. At the end of the follow through, the right knee was straight with the foot reaching a point above knee high. The kicking foot was drawn back to the floor while crossing over to the left side, causing the hips to turn to the left. This was followed by the left foot striding to the left to maintain balance.

Subject 2 - Pattern Changes

A much greater range of movement was seen in the initial pattern than in the final pattern. This could be seen in the two step approach for the initial pattern as opposed to the one short step in the final pattern, the degree of hip and knee flexion and extension and the height of the kicking foot during the follow through. The arms
however, were utilized better in the final pattern as they worked in opposition to the action of the kicking leg.

Subject 3 - Initial Pattern

A one step approach was utilized by subject 3 for his initial place kick pattern. The step was a long stride with the arms swinging in a normal cross-lateral pattern with the legs. This arm swing also caused the shoulders to rotate slightly to the right. The body leaned forward at the beginning of the stride, but was in a vertical position as the right foot made contact with the floor, the toes in line with the back edge of the ball (Figure 28-11). As the weight shifted to the right foot, the right hip began to extend while the left hip began to flex. The left knee only partially flexed and the left ankle plantar flexed causing the toes to drag along the floor as the foot approached the ball. The left elbow was drawn backward while the left knee drove forward.

The left ankle remained in a plantar flexion position as contact with the ball was made (Figure 28-21). The left knee did not begin to extend until after contact with the ball was made. Also, as the left knee extended, the left hip ceased to continue to flex.

During the follow through, once the knee reached full extension, hip flexion continued bringing the left foot to a position above waist height (Figure 28-31). Also, after contact with the ball was made, the right ankle
Figure 28

Place Kick
Subject 3

Initial Performance

Final Performance
plantar flexed as the toes remained in contact with the floor. At the end of the follow through, the left foot was placed on the floor slightly ahead of the support foot. The shoulders remained slightly abducted with the elbows flexed as the arms were utilized for balance.

Subject 3 - Final Pattern

The final place kick pattern for subject 3 began with a long one step approach. The support foot made contact with the floor at a point well behind the ball (Figure 28-1F). The body was in a nearly vertical position while the left shoulder flexed and the right shoulder abducted.

As the weight shifted to the right leg, the right hip extended causing the subject to lean backward while the left hip flexed bringing the knee and leg toward the ball. The left knee failed to flex enough, while the left ankle plantar flexed, causing the toes to drag across the floor. The left elbow was drawn back in opposition to the forward swing of the left leg. At the point of contact, the body was leaning backward (Figure 28-2F). The left ankle remained in a plantar flexion position as the foot contacted the ball.

After the ball was contacted, the left knee began to extend while the left hip ceased to flex. As the knee reached full extension, the hip again continued to flex bringing the foot to a position of about waist height (Figure 28-3F). Only a slight amount of plantar flexion
was seen in the right ankle near the end of the follow through. Also, at the end of the follow through, the left shoulder was hyperextended while the left shoulder was flexed and abducted. The arms worked in opposition to the legs for balance. At the conclusion of the follow through, the left leg moved downward into a short step backward while both arms dropped to a position near the sides.

Subject 3 - Pattern Changes

The changes in the place kick pattern for subject 3 were very subtle. For the initial pattern, the subject placed the support foot so that the toes were even with the back edge of the ball while in the final pattern the foot was placed so that the toes were a considerable distance behind the ball. This caused the subject to lean back farther in final pattern in order to extend the kicking leg forward to contact the ball. For the final pattern, the subject utilized the arms more as they worked in a cross lateral pattern in opposition to the leg action.

Subject 4 - Initial Pattern

The subject began the initial pattern with a forward stride of the left foot. The foot was placed on the floor so that the back edge of the ball was in line with the ankle (Figure 29-11). During the stride, the arms moved in a cross lateral pattern in opposition to the legs. As the support foot contacted the floor, the body was in a
Figure 29

Place Kick
Subject 4

Initial Performance

Final Performance
vertical position.

Right hip flexion began to drive the right knee forward while the knee began to flex. The arms continued to swing in a cross lateral pattern in opposition to the leg action. As the toes contacted the ball, the right ankle plantar flexed while the right knee began to extend (Figure 29-2I).

Hip flexion stopped after the ball was contacted while the right knee extended until the foot reached a position slightly below waist height (Figure 29-3I). Also, during the follow through, the left hip flexed causing the body to lean forward. As the right leg began to drop to the floor, the left ankle plantar flexed while the arms continued their cross lateral patterning. The kicking foot made contact with the floor behind the support leg as the small step backward was needed in order for balance to be maintained.

**Subject 4 - Final Pattern**

The subject began the final pattern from a stride position with the left foot forward (Figure 29-1F). The toes of the support foot were aligned with the back edge of the ball while the body leaned forward.

The kicking action began with a slight rotation of the shoulders to the left as the weight was shifted to the left leg. This was followed immediately by right hip and right knee flexion. As the hips moved forward over the
support foot, the body assumed a vertical position. At the same time, the elbows began to flex bringing the hands to a position in front of the body with the left hand above the waist and the right hand in front of the chest (Figure 29-2F). As the foot contacted the ball, the right knee began to extend while the right hip ceased its flexing action.

This action continued until the foot reached a position at about knee height (Figure 29-3F). During this follow through, the left shoulder flexed and then abducted while the right shoulder abducted. The kicking foot was drawn back very quickly and placed on the floor behind the subject in order to prevent a backward fall. Note that the heel of the support foot remained in contact with the floor throughout the pattern.

Subject 4 - Pattern Changes

The approach for subject 4 changed from a one step approach for the initial pattern to a no step approach for the final pattern. The subject also changed the use of the arms for the pattern. For the initial pattern, the arms worked in a cross lateral pattern in opposition to the leg action, while in the final pattern the arms remained very close to the body and were used mainly for balance. Another change dealt with the range of motion that was demonstrated. Movement in the final pattern appeared to be rather limited in comparison to the initial pattern. This may have been due in part to the change in the approach. It was also
noted that the support foot remained flat on the floor in the final pattern while plantar flexion of the ankle of the support foot for the initial pattern was seen. This caused the heel to be lifted from the floor.

**Subject 5 - Initial Pattern**

The initial pattern for subject 5 was performed with a no step approach. With the weight supported on the left foot and with the left foot placed well behind the ball, the right hip and right knee began to flex. At the same time, the left shoulder began to abduct. Once the right foot was off the floor, the right hip began to extend and then hyper-extend, while the right shoulder began to abduct. The right knee continued to flex (Figure 30-1I). As the right foot was drawn up behind the subject, the body leaned forward.

The right hip began to flex in order to drive the right knee forward and the left hip extended bringing the subject to a vertical position. At the same time, the left ankle plantar flexed slightly. The right knee began to extend before the foot made contact with the ball. At the point of contact, the body was leaning backward (Figure 30-2I). Note that the foot contacted the ball to the right side of the ball. The left arm moved in opposition to the kicking leg while the right arm was held high for balance.

During the follow through, the right hip continued to flex while the right knee continued to extend bringing the foot to a position above waist height (Figure 30-3I).
Figure 30

Place Kick
Subject 5

Initial Performance

Final Performance
The right arm began to drop to the side while the left arm did the same. The right foot dropped to the floor slightly forward but well to the right side of the left foot for a balanced finish.

**Subject 5 - Final Pattern**

A no step approach was utilized by subject 5 in the final pattern. Again, the support foot was placed well behind the ball (Figure 30-1F). The kicking foot was drawn up behind the subject through hyperextension of the right hip and flexion of the right knee. The right shoulder abducted to bring the hand to a position high above the head.

As the right hip began to flex, the right shoulder began to extend. The left ankle began to plantar flex and the right knee began to extend as the foot approached the ball. At the point of contact, the right knee was fully extended (Figure 30-2F). The right arm was back at the right side. Note that the foot skimmed across the top of the ball.

The right hip continued to flex during the follow through as the left hip also flexed bringing the body slightly forward. The left foot continued to plantar flex. At the end of the follow through, the right foot had reached a position slightly above waist height. Note that the arms, while working in a cross lateral pattern in opposition to the legs, ended in a position down and near the sides. After the follow through, the right foot dropped to the
floor well forward of the left foot as momentum carried the subject forward.

Subject 5 - Pattern Changes

Only one change of any significance could be seen between the initial and final place kick patterns for subject 5. For the initial pattern, the left arm appeared to be doing most of the work to offset the swing of the kicking leg. For the final pattern, the right arm appeared to be doing most of the work in opposition to the kicking leg.

Subject 6 - Initial Pattern

The subject began from a standing position behind the ball. The left foot was positioned so that the toes were behind the ball. Movement began with a shifting of the weight to the left foot, while the right knee began to flex and the right hip began to hyperextend. At the same time, the right shoulder began to flex while the left shoulder began to abduct. As the right hip began to flex to drive the knee forward, the right knee continued to flex to a position of less than a ninety degree angle (Figure 31-11).

Just prior to the foot contacting the ball, the right knee began to extend while hip flexion began to slow down. At the point of contact, hip flexion temporarily stopped (Figure 31-21).

After the ball was contacted, the right knee con-
Figure 31

Place Kick
Subject 6

Initial Performance

Final Performance
continued to full extension while the right hip began to flex again. The kicking foot reached a position only slightly above knee height (Figure 31-3I). During the follow through, the left foot began to plantar flex while the left arm was drawn forward. The right arm remained in the same relative position throughout the kick. Note also, that the trunk remained in a vertical position throughout the whole performance. After the follow through, the right foot returned to the floor in a stride position well ahead of the left foot.

Subject 6 - Final Pattern

A forward stride position with the left foot forward and with the arms at the sides was the starting position for subject 6 in the final pattern. Movement began with a short forward stride of the left foot while the left shoulder flexed slightly (Figure 31-1F). As the weight shifted to the left leg, the right hip began to flex while the right knee also began to flex. The support foot was placed a short distance behind the ball.

As the kicking leg approached the ball, the body changed from a vertical position to a backward lean. The right hip continued to flex until the point of contact (Figure 31-2F).

The right knee began to extend prior to contact and continued to full extension after the ball had been kicked (Figure 31-3F). The left arm was drawn forward during the
follow through so that it pointed toward the target. Since the subject was leaning backward, the heel of the left foot maintained contact with the floor. After the follow through, the right foot was brought back to the floor to a position even with the left foot.

Subject 6 - Pattern Changes

The changes in the pattern for subject 6 are all related to the approach that the subject utilized and the position in which the support foot was placed. For the initial pattern the support foot was closer to the ball, allowing the subject to shift her weight forward during the kick. In the final pattern the foot was positioned farther behind the ball, but was forward of the body. This kept the weight positioned over the heel causing the subject to lean backward. Also, in the initial pattern, the subject shifted her weight forward and was able to take a step forward after the follow through. However, for the final pattern, the weight remained of the heel of the support foot until the kicking leg was drawn back after the follow through. This allowed the subject to shift her weight directly over the support foot thus allowing the kicking foot to be placed beside the support foot.

Another change in the pattern was the action of the kicking leg in preparation to the actual kick. For the initial pattern, the subject hyperextended the right hip and flexed the right knee in order to cock the leg. However,
for the final pattern, as a long stride position was utilized, the right foot was already positioned a good distance behind the subject. Hence, no deliberate hip hyperextension could be seen.

**Subject 7 - Initial Pattern**

Subject 7 began the initial pattern from a stride position with the left foot forward. The left foot was placed well behind the ball. The hips were slightly flexed causing the subject to lean forward. The arms hung near the sides. Motion began with a shift of the weight to the left leg while the right hip began to extend and then hyperextend. The left hip flexed slightly and then began to extend. The right shoulder flexed and then abducted while the left shoulder abducted. The right knee began to flex as right hip hyperextension ceased. The right knee continued to flex as the right hip began to flex (Figure 32-11). At this point both arms had abducted to a horizontal position. The body remained in a forward lean position.

When the right hip flexed to drive the leg toward the ball, the left hip extended causing the hips to move forward and the body to lean backward. The right knee began to extend as the foot approached the ball (Figure 32-21). The right shoulder continued to abduct with some lateral rotation and elbow flexion to place the right hand in a position high above the shoulder. At the point of contact, the right hip ceased to flex until the knee completed its extension.
Figure 32

Place Kick
Subject 7

Initial Performance

Final Performance
Note that the knee did not reach full extension (Figure 32-3I).

The right foot reached a position just slightly above knee height during the follow through. While the left ankle plantar flexed slightly just prior to the right foot contacting the ball, the left heel returned to the floor during the follow through. Also, during the follow through, the right elbow continued to flex to bring the right hand to a position behind the head while the left shoulder adducted, and the left elbow flexed to bring the left hand to a position immediately in front of the waist. After the follow through, the kicking foot returned to the floor in a position beside the support foot.

**Subject 7 - Final Pattern**

The subject began from a forward stride position with the left foot forward and placed a short distance behind the ball. The subject was flexed at the hips causing the body to lean forward while the arms hung at the sides. Movement began as the left foot took a small stride forward and was positioned on the floor so that the toes were aligned with the back edge of the ball. During the stride, the right shoulder began to abduct. As the weight shifted to the left foot, the right hip began to extend slightly. This was followed immediately by flexion of the right knee. As the right knee continued to flex, the right hip began to flex and the left hip extended to cause the body to
straighten to a vertical position (Figure 32-1F). At this same time, the left shoulder began to hyperextend, but only for a short distance.

As the right leg drove toward the ball, the right shoulder began to adduct and hyperextend. The right knee began to extend as the foot approached the ball. Also, as the right foot approached the ball, the left ankle plantar flexed and remained in a plantar flexion position throughout the follow through. At the point of contact right hip flexion temporarily stopped (Figure 32-2F).

During the follow through, once the right knee ceased to extend, the right hip continued to flex. Note that the foot reached a position at about thigh height and that the right knee did not fully extend (Figure 32-3F). After the follow through, the right foot returned to the floor just slightly behind the left foot.

Subject 7 - Pattern Changes

There was very little difference between the two patterns for subject 7. The subject did add a small step to the approach for the final pattern which placed the support foot in a better position in relationship to the ball. However, the subject did flex the right knee more for the initial pattern, which in turn put the kicking foot into a better position for the kick.
Subject 8 - Initial Pattern

A one step approach was utilized by subject 8 as she made a long stride forward with the left foot. The foot was placed well behind the ball while the arms swung slightly in a cross lateral pattern (Figure 33-1I).

As the weight was taken on the left leg and was moving forward, the right hip and knee both began to flex. Note that the weight remained behind the support foot as the body leaned backward (Figure 33-21). When the right knee extended to allow the foot to make contact with the ball, the right hip ceased to flex.

During the follow through, the right knee fully extended before the hip began to flex again (Figure 33-3I). The right foot reached a position below knee height before being drawn back quickly to a backward stride to prevent a backward fall. Note that the arms remained at the sides throughout the kick and did very little to aid the performance.

Subject 8 - Final Pattern

A one step running approach was utilized by subject 8 for her final place kick pattern. The left foot was placed so that the toes were forward of the back edge of the ball while the arms swung in a cross lateral pattern (Figure 33-1F).

The weight shifted to the left leg, the right hip
Figure 33

Place Kick
Subject 8

Initial Performance

Final Performance
and knee both began to flex while the right foot plantar flexed. This continued to the point of contact while the body continued to move forward over the left foot in a vertical position (Figure 33-2F).

After the ball was contacted, the right knee began to extend while the right hip continued to flex. The arms continued to swing slightly in a cross lateral pattern. During the follow through, the right hip began to extend while the right knee continued to extend to full extension (Figure 33-3F). At this point the foot was about knee high. It was also noted that the left foot plantar flexed slightly. As the subject continued to move in a forward direction, the right foot returned to the floor in a forward stride position.

Subject 8 - Pattern Changes

Most of the changes for subject 8 were related to the placement of the support foot for each pattern. In the initial pattern, the foot was placed well behind the ball. The subject kept her weight behind the support foot and therefore had to reach forward with the kicking foot in order to contact the ball. In order to reach, the right knee extended considerably before the foot contacted the ball. Also, since the weight remained behind the support foot, a backward step was needed after the follow through to prevent a fall.

For the final pattern the support foot was placed
beside the ball. This eliminated the need for the subject to reach out for the ball and the extension of the right knee was delayed until after the ball had been contacted. Since the weight was shifted forward of the support foot, the subject was able to stride forward after the follow through.

Another change noted was the position of the kicking foot before and at the point of contact. For the initial pattern, the ankle was in a normal kicking position while for the final pattern the ankle plantar flexed. This allowed a toe kick for the initial pattern and an instep kick for the final pattern.

Subject 9 - Initial Pattern

The subject began in a forward stride position with the left foot forward and positioned well behind the ball. A very slight step forward of the left foot kept its position well behind the ball. During this step, the body leaned forward and the left shoulder abducted. As the weight shifted to the left foot, the left hip flexed causing the body to lean forward even more. At the same time, the right hip began to hyperextend and the right knee began to flex, while the right shoulder abducted. It was also noted that the shoulders began to rotate to the left. Flexion of the right hip began before the right knee had completed its flexion (Figure 34-11).

Left hip extension, along with flexion of the right
Figure 34

Place Kick
Subject 9

Initial Performance

Final Performance
hip and knee, brought the foot to the point of contact (Figure 34-21). Note that the right ankle plantar flexed causing the toes to hit the floor, which in turn, caused the ankle to plantar flex even more before contacting the ball. The arms moved in a cross lateral pattern as they worked in opposition to the legs.

During the follow through, the right hip ceased to flex temporarily until the right knee completed its extension (Figure 34-31). The shoulders were rotated back to the right during the follow through phase of the kick. At the end of the follow through, the right foot had reached a position at about knee height. Note also, that the support ankle began to plantar flex as the right leg drove forward toward the ball, and continued to plantar flex throughout the follow through. After the follow through, the right foot was returned to the floor, forward and slightly to the left of the left foot, as the subject had over balanced to the left.

**Subject 9 - Final Pattern**

A two step approach was utilized by subject 9 in his final place kick pattern. At the beginning of the final step, the subject was leaning forward with the arms swinging in a normal cross lateral pattern. At mid-stride the subject was in a vertical position with both feet off the floor. The support foot was placed a short distance behind the ball while the right hip and knee began to flex (Figure 34-1F).

The right knee began to extend just prior to the
point of contact while the body leaned backward (Figure 34-2F). The right ankle plantar flexed prior to contacting the ball and remained in that position throughout the kick.

At the point of contact, the right hip ceased to flex until the right knee completed its extension. At that time, the right hip increased flexion to bring the kicking foot to a position at knee height. The left ankle began to plantar flex during the follow through. As the subject's momentum carried him forward and upward after the follow through, the subject hopped forward on the left foot before the right foot returned to the floor, slightly ahead of the left foot. This forward hop caused the support foot to be placed ahead of the body which in turn caused the body to lean backward. A step backward with the left foot was needed in order for the subject to maintain his balance. Note that the arms continued to swing in a cross lateral pattern throughout the performance.

**Subject 9 - Pattern Changes**

The major change in the pattern for subject 9 was that of a very short and rather insignificant step approach for the initial performance, to a running two step approach for the final performance. With the short step approach, the subject had to draw the foot backward to a cocked position, while in the running approach, the cocked position was reached through the natural stride. The running approach also allowed the subject to develop momentum which
in turn aided in increasing the range of movement during the follow through. It also allowed the subject to include the forward hop that was seen at the end of the follow through.

It was noted that the right ankle was plantar flexed for both patterns. However, for the final performance, the toe did not catch on the floor prior to contacting the ball. This may have allowed more momentum to carry on through the kick and into the follow through.

**Subject 10 - Initial Pattern**

Although the subject utilized a walking two step approach, any effect that the approach might have had on the kicking performance was negated by the fact that the subject came to a complete stop before the kicking action began. The steps involved a short step forward with the right foot, followed by an even shorter step forward with the left foot. The heel of the left foot remained behind the heel of the right foot. The support foot was placed at quite a long distance behind the ball. As the weight shifted to the left foot, the left shoulder began to flex, the right shoulder began to hyperextend, while the left hip flexed causing the subject to lean forward. Then, as the left shoulder began to extend and the right shoulder began to flex, the right hip began to extend and then hyperextend. The right knee, although slightly flexed, did not increase in flexion during this cocking movement (Figure 35-11).
Figure 35

Place Kick
Subject 10

Initial Performance

Final Performance
It was only after the right hip began to flex, to drive the leg forward, that the right knee increased its flexion and then extended in order to contact the ball with the foot (Figure 35-21). As the right knee extended with force, the right shoulder abducted and the right elbow extended to place the arm in a horizontal position pointing at the camera.

At the point of contact, the right hip ceased to flex but only until the right knee reached full extension during the follow through. The kicking foot only reached a position to just above knee height (Figure 35-31). At this point, the right knee had already begun to flex as the foot was drawn back toward the body. During the follow through, the right arm was drawn back so that it, along with the left arm, remained synchronized in a cross lateral pattern. After the follow through, the subject's right foot returned to the floor in a short forward stride position. It was noted that the subject maintained his weight immediately over the left foot throughout the kick, and that only a slight amount of plantar flexion could be seen in the left ankle, just prior to the point of contact and throughout the follow through.

**Subject 10 - Final Pattern**

The subject was standing a short distance behind the ball with the right foot slightly forward at the beginning of the pattern. The left foot made a very small step
forward as the subject began to lean forward and then began to shift the weight to the left foot. The left hip began to flex while the right hip began to extend, causing the subject to lean forward. The arms began to swing in a cross lateral pattern in opposition to the legs (Figure 35-1F).

From this position, the left hip began to extend while the right hip and knee began to flex. This caused the subject's body to return to a vertical position as the kicking leg began to approach the ball. Just prior to contacting the ball, the right knee began to extend (Figure 35-2F).

At the point of contact, the right hip ceased to flex, but only until the right knee had extended to full extension. At that time, the right hip continued to flex lifting the foot high in the air to a point just below chest height. Toward the end of the follow through, the right knee flexed as the foot was drawn in toward the body. The right foot returned to the floor forward of and to the left of the left foot as the subject rotated his whole body slightly to the left. The only plantar flexion seen in the left ankle came at the end of the follow through. It was very slight and lasted for just a very short time as the heel returned to the floor immediately.

Subject 10 - Pattern Changes

The changes in the place kick pattern for subject 10 were very subtle. The kicking actions were very similar
with the only real differences noted at the beginning and at the end of the pattern. For the initial pattern, the subject placed himself quite a distance from the ball. This allowed the subject to step forward, although he could have stepped forward even more. In the final pattern, the subject stood much closer to the ball and as a result did not take a step forward of any significant distance.

At the end of the kick, during the follow through phase, the subject demonstrated a greater range of movement as the kicking foot went quite high in the air in the final pattern. This was not seen in the initial performance.

Although there was a change in the amount of time that the support ankle was plantar flexed during the kick, it was insignificant in that the plantar flexion was so slight it was hardly noticeable in the film.

Subject 11 - Initial Pattern

Subject 11 began the initial place kick pattern from a position flexed at the hips, left arm hanging toward the floor and with the right shoulder flexed so that the hand was held above the ball. The left foot was slightly forward of the right foot with both feet well behind the ball.

Motion began as the right hip began to extend with all weight supported on the left leg. The left hip also extended slightly, causing the body to assume a more upright position. As the right hip ceased to extend, the right knee began to flex (Figure 36-11). At this point, the right
Figure 36

Place Kick
Subject 11

Initial Performance

Final Performance
shoulder was flexed while the left shoulder was slightly hyperextended and abducted.

When the right hip began to flex forcefully, the right knee continued to flex to bring the foot to a position immediately behind the right hip. At the same time, the right shoulder extended to bring the arm down to the side, with force, while the left ankle plantar flexed. Then, the right knee began to extend rapidly to bring the foot into contact with the ball while right hip flexion momentarily stopped (Figure 36-2I).

After the right foot had contacted the ball and the right knee had reached full extension, the right hip continued to flex. Both shoulders flexed and abducted with some elbow flexion to place the hands in a position forward of the neck (Figure 36-3I). It was noted that the kicking foot reached a position of about thigh height during the follow through.

After the follow through, the right hip extended and the right knee flexed to bring the right foot to the floor well ahead of the left foot. At the same time, the right shoulder extended to bring the arm down to the side.

**Subject 11 - Final Pattern**

The subject began from a standing position well behind the ball. The first motion was a small step backward with the right foot, followed immediately with a long step forward of the left foot. The left foot was placed
beside the ball so that only the back half of the foot was visible (Figure 36-1F). During this stride forward, both shoulders flexed to bring the hands to a position high above the head.

As the weight shifted to the left foot, the right hip and right knee began to flex, followed very quickly by right knee extension. The shoulders began to adduct as the right foot contacted the ball (Figure 36-2F). It was also noted that prior to the right foot contacting the ball, the left ankle began to plantar flex.

At the point of contact, the right hip ceased to flex until the right knee reached full extension, at which time the right hip continued to flex. This allowed the kicking foot to follow through to a position at about waist height (Figure 36-3F). During the follow through, the right arm continued to adduct in order to bring the right arm down to the side. As the follow through ended, the right hip extended to bring the right foot into contact with the floor slightly ahead of the left foot.

Subject 11 - Pattern Changes

The three major changes from the initial to the final performances for subject 11 all represent changes toward a more mature pattern. The first change was the utilization of a step approach in the final pattern, which was completely absent in the initial pattern. This also allowed the support foot to be placed closer to the ball.
The second change involved the utilization of the arms. During the initial pattern, only the right arm worked in opposition to the kicking leg, up to the point of contact, after which both arms moved with the leg. In the final pattern, both arms were drawn down in opposition to the kicking leg, and this continued throughout the follow through.

The third change in the pattern was that for the final performance, the kicking foot followed through to reach a higher position. This may be due in part to the utilization of the step approach, allowing the kicking leg to create more momentum, which in turn carried the kicking foot higher during the follow through.

The Final and Mature Place Kick Patterns Compared

Many of the final place kick patterns of the mentally retarded subjects contained characteristics similar to the mature pattern. However, each pattern demonstrated characteristics so as to make it different from the mature pattern.

There were many similarities in the place kicking patterns of the mentally retarded subjects and the mature performer during the effort phase of the skill. However, during the preparation phase the retarded subjects did little to develop momentum for the kick. While the mature performer utilized a three step running approach, the majority of the mentally retarded subjects used a one step walking approach or did not use any steps at all. This meant that the mentally retarded subjects had little or no momentum at the
beginning of the effort phase of the kick. In general, the majority of the momentum produced by the mentally retarded subjects, by the time the kicking foot contacted the ball, was produced during the effort phase of the kick and was absorbed by the ball. The mature performer however, combined momentum from the running approach and effort phase of the kick so that after the ball was contacted a very significant follow through was necessary in order to absorb the remaining momentum.

The Initial and Final Place Kick Patterns Compared

The data in Table 4 represent the changes in the place kick pattern for the educable mentally retarded subjects from their initial to final performances. Four subjects had the same number of positive and negative changes or had no changes at all. Four subjects had more negative than positive changes while three subjects had more positive than negative changes. An N of seven and an x of three yields a p value of 1.00. A p value of .05 or less was needed in order for the changes in the place kick patterns to be significant.

Analysis of Striking

The mature striking pattern model was established through filming the performance of a university level

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4Siegel, loc. cit.
Table 4
Changes in the Place Kick Pattern

<table>
<thead>
<tr>
<th>Subject</th>
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<th>Negative Changes</th>
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<th>Sign</th>
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</table>

$N = 7, x = 3, p = 1.00 = N.S. at .05 confidence level$
varsity baseball player. The mentally retarded subjects utilized in the previous patterns were used again in the striking pattern.

**Mature Striking Pattern**

The subject assumed a starting position with the feet in a sideward stride position slightly greater than shoulder width apart (Figure 37-1). The left foot was placed in a line slightly behind the ball. The weight was supported primarily by the right leg. The knees and hips were slightly flexed. The bat was held out to the right side with the left elbow flexed slightly and the right elbow flexed considerably. The bat was held in a nearly vertical position leaning slightly toward the subject's back and left.

Motion began as the subject's left foot took a stride in the direction of the intended line of flight (Figure 37-2). The left foot was placed slightly forward of the ball. At the same time the bat increased its amount of lean toward the subject's back and left. These movements put the subject into a position ready to begin the forward swing of the bat.

When the subject's left foot made contact with the floor, the right knee increased its flexion. This caused the hips and trunk to rotate to the left as a single unit while the heel of the right foot was pulled off the floor. As the bat began to approach the ball, the shoulders also
Figure 37

Striking Mature Pattern
began to rotate left, while transverse abduction of the left shoulder and transverse adduction of the right shoulder were initiated (Figure 37-3). At the point of contact, the rotation of the hips to the left ceased.

After contacting the ball with the bat, the shoulders continued to rotate left, while the left shoulder continued to transverse abduct and the right shoulder continued to transverse adduct. It was also noted that the left arm demonstrated lateral rotation and the right arm demonstrated medial rotation causing the right hand to roll over the top of the left hand. At the same time, both elbows extended. As the bat continued to move around to the left side of the subject at about head height, the hips again began to rotate to the left (Figure 37-4).

It was noted that during the swing, the feet remained in contact with the floor. The heel of the right foot was off the floor allowing the foot to pivot on the ball of the foot. After the stride toward the intended line of flight, the left foot remained in contact with the floor with the ankle demonstrating inversion toward the end of the follow through.

Subject 1 - Initial Pattern

Subject 1 began the striking pattern from a upright position, with no knee or hip flexion (Figure 38-11). The feet were less than shoulder width apart with the left foot in line with the back edge of the ball. The bat was held in
Figure 38

Striking
Subject 1

Initial Performance

Final Performance
a nearly horizontal position in front of the body so that the bat pointed toward the subject's right.

The shoulders began to rotate to the right, followed almost immediately by hip rotation to the right (Figure 38-21). At the same time, the bat was drawn back behind the subject in a transverse plane while remaining in a horizontal position. The weight was also shifted to the right foot during this motion as the left knee flexed pulling the left heel off the floor. As the left foot began to stride toward the intended line of flight, the tip of the bat dropped to a position at about waist height while the handle was held at about shoulder height.

Movement toward the ball began with hip and shoulder rotation as a single unit to the left while the left leg continued to stride to the left. The left foot made contact with the floor slightly forward of the ball (Figure 38-31). As some weight shifted to the left foot, the hips and shoulders continued to rotate to the left as a single unit. The elbows began to extend, followed by transverse abduction of the left arm and transverse adduction of the right arm as the bat approached the ball. At the point of contact, hip and shoulder rotation ceased just momentarily and then continued into the follow through.

After the ball was contacted, the right foot was lifted from the floor as the subject began to pivot on the left foot (Figure 38-41). The hips and shoulders continued to rotate as a single unit. The left shoulder continued
transverse abduction while the right shoulder continued transverse adduction. The left arm demonstrated lateral rotation while the right arm demonstrated medial rotation causing the right hand to roll over the left hand. At the same time, the right elbow extended fully while the left elbow remained slightly flexed. The bat continued to swing horizontally ending up behind the subject.

Subject 1 - Final Pattern

For his final performance subject 1 began the striking pattern from a position with the hips and knees slightly flexed (Figure 38-1F). The feet were slightly greater than shoulder width apart with most of the weight supported by the right leg. The left foot was placed a short distance behind the ball. The bat was held in front of the body in a horizontal position at about waist height.

Motion began as all the weight was shifted to the right leg while the shoulders, followed by the hips, began to rotate to the right (Figure 38-2F). The bat was drawn back to a horizontal position behind the right shoulder with both elbows flexed. At the same time the left leg began to stride to the left with the foot contacting the floor in line with the ball.

When the left foot made contact with the floor, the hips and shoulders began to rotate left as a single unit. Also, the weight began to shift to the left rather rapidly. As the hips and shoulders came into a line parallel to the
intended line of flight, the arms began to move in a transverse plane toward the ball while the elbows began to extend (Figure 38-3F). At the point of contact, the hips and shoulders were rotated to the left and temporarily ceased any rotary motion.

After contact with the ball had been made, the left arm continued transverse abduction while the right arm continued transverse adduction and the elbows continued to extend. The left arm demonstrated lateral rotation while the right arm demonstrated medial rotation causing the right hand to roll over the left hand. As the right arm crossed the front of the chest, the shoulders, followed by the hips, continued to rotate to the left (Figure 38-4F). After contact with the ball had been made, the right foot was pulled off the floor but was replaced in the same position as the follow through came to an end. The final position of the bat was horizontal behind the subject's upper back and was pointed toward the camera.

Subject 1 - Pattern Changes

The first change noted in the striking pattern for subject 1 was that in the initial pattern, the subject placed himself so that the ball was at his midline when it was contacted by the bat, while in the final performance the subject remained well behind the ball throughout the swing. It was also noted that the subject assumed a much wider stance and utilized a much longer stride for the
A second change was seen in the utilization of body rotation. For the initial pattern, much of the hip and shoulder rotation was done as a single unit and was somewhat limited in its range of motion. In the final pattern, even though the hips and shoulders did rotate some as a single unit, some separation could be seen. Also, for the final pattern, the range of motion had increased considerably.

**Subject 2 - Initial Pattern**

The stance at the beginning of the initial pattern for subject 2 was with the body in an upright position, feet close together, with most of the weight supported by the right leg (Figure 39-1I). The subject positioned himself so that the ball was in line with his left side. The bat rested on the right shoulder while the hips and shoulders were rotated to the right of being parallel to the intended line of flight.

The left foot began to stride to the left while the shoulders increased their rotation to the right (Figure 39-2I). At the same time, the arms pushed the bat away from the shoulder.

When the left foot made contact with the floor, and as the weight began to shift to the left, the hips and shoulders began to rotate left as a single unit. As the hips and shoulders reached a position parallel to the intended line of flight, the arms began to swing the bat in a...
Figure 39

Striking Subject 2

1I  2I  3I  4I

Initial Performance

1F  2F  3F  4F

Final Performance
transverse plane. At the point of contact, the subject was positioned so that the ball was at his midline (Figure 39-3I). It was noted that at the point of contact and throughout the follow through that the hips and shoulders continued to rotate.

During the follow through phase of the swing, the left shoulder transversely abducted while the right shoulder transversely adducted (Figure 39-4I). The left arm demonstrated lateral rotation while the right arm demonstrated medial rotation causing the right hand to roll over the left hand. The feet remained in contact with the floor after the left foot stride, until the end of the follow through at which time the left foot took a stride backward to a position beside the right foot. The subject did pivot on the ball of the right foot as he rotated his body to the left. The bat ended in position behind the left shoulder, pointing to the rear and slightly upward.

Subject 2 - Final Pattern

Subject 2 placed himself so that the ball was at his midline for the final performance (Figure 39-1F). His feet were close together with the weight supported on the right leg. The left knee was flexed to lift the left heel off the floor. The bat was drawn back so that the hands gripped the bat behind the subject's right ear. The bat was pointed downward about half way between horizontal and vertical.
Motion began with a slight hip and shoulder rotation to the right while the left leg took a short stride to the left (Figure 39-2F). As the left leg began to accommodate the weight shift, the hips and shoulders began to rotate to the left. At the same time both arms began to move in a transverse plane to the left while the elbows began to extend (Figure 39-3F). At the point of contact the body and the hands were well forward of the ball.

After contact with the ball had been made, the shoulders continued to rotate left while the hips temporarily ceased to rotate. As the arms moved in a transverse plane across the front of the body, the hips again began to rotate while the right hand rolled over the left (Figure 39-4F). It was also noted that, at the point of contact and during the early part of the follow through, the right foot was lifted from the floor and moved slightly in the direction of the line of flight. Toward the end of the follow through the left foot was pulled from the floor and moved backward to a position slightly forward of the right foot. At the end of the follow through the bat was positioned behind the left shoulder pointing to the rear and slightly upward.

Subject 2 - Pattern Changes

There were only two observable differences between the patterns for subject 2 and both of these were very small differences. The first was that, for the initial
pattern during the preparation for the swing, the bat was held with the end pointing slightly upward while for the final pattern the end of the bat was pointing toward the floor. The second change involved the subject's position at the point of contact. For the initial performance, the ball was contacted at midline while for the final performance the body was well ahead of the ball at the point of contact.

**Subject 3 - Initial Pattern**

Subject 3, a left handed batter, positioned himself so that the right foot was slightly ahead of the ball (Figure 40-1I). His feet were in a sideward stride position about shoulder width apart. The knees and hips were very slightly flexed. The bat was held in a horizontal position at the left side and was pointed in the direction opposite the intended line of flight. The left elbow was tucked in close to the side.

A backswing began as the hips and shoulders rotated left as a single unit. The hips and knees increased in flexion and the weight shifted to the right leg (Figure 40-2I). At the end of the backswing, the left foot took a small step to the left and forward.

The forward swing began with hip and shoulder rotation to the right. As the bat approached the ball, the weight was evenly distributed on both feet. The right foot pivoted to the right and the heel (Figure 40-3I). At the
Figure 40

Striking
Subject 3

Initial Performance

Final Performance
point of contact, the arms had begun to move in order to swing the bat in a transverse plane.

During the follow through phase of the swing, the arms accelerated their movement to the right in the transverse plane, while the hips and shoulders continued to rotate to the right. It was noted that the shoulders rotated slightly more than the hips. The weight shifted to the right foot as the entire body pivoted to the right. As this was done, the left foot took a step in the direction of the intended line of flight to bring it in line with the right foot (Figure 40-1F). The final position of the bat was vertical and forward of the right shoulder as the subject ended his follow through with his back to the camera. It was noted that the subject did not roll the left hand over the right hand during the follow through.

Subject 3 - Final Pattern

The starting position for subject 3 was with the feet about shoulder width apart and with the ball positioned just to the right of the right foot (Figure 40-1F). The bat was held in front of the body with the hands spread apart on the bat handle. The bat was held at an oblique angle.

The backswing began with shoulder rotation to the left, followed immediately by hip rotation to the left (Figure 40-2F). At the same time, the knees and hips began to flex while the shoulders flexed and the elbows extended
to push the bat away from the body. The subject's weight remained over both feet as the heel of the right foot and the toes of the left foot were lifted from the floor.

Shoulder rotation to the right, followed by hip rotation to the right, initiated the forward swing (Figure 40-3F). The arms also began to move to the right in a transverse plane as the bat approached the ball. At the point of contact, the hips and shoulders temporarily ceased to rotate.

During the first part of the follow through, the arms remained extended as they moved in a transverse plant to the right. As they crossed in front of the body, the shoulders and hips began to follow the arms as they began to rotate to the right again (Figure 40-4F). As the subject neared the end of the follow through, his weight shifted to the right leg. The left foot was drawn from the floor and moved to a position slightly forward of the right foot. At the same time, the elbows flexed while the shoulders extended to draw the bat to a vertical position in front of the head. Again, it was noted that the subject did not roll the left hand over the right hand during the follow through.

**Subject 3 - Pattern Changes**

The initial and final patterns for subject 3 look very much alike. The changes in the pattern were rather subtle. For example, during the backswing phase of the pattern, the subject held the bat close to the body in the initial pattern but pushed the bat away from the body in
the final pattern. Another change during the backswing was that for the initial performance the subject took a small stride to the left with the left foot while for the final performance no stride was taken. The only other change was that the subject demonstrated a greater range of motion, both in the backswing and the follow through for the initial performance than for the final performance.

**Subject 4 - Initial Pattern**

The subject positioned herself so that the ball was at her midline (Figure 41-1I). Her feet were about shoulder width apart while the knees and hips were slightly flexed. The bat was held at an oblique angle at her right side with the handle just above waist height.

The arms began the motion as they pushed the bat away from the body (Figure 41-2I). There was no backswing as the shoulders immediately began to rotate to the left while the subject increased the amount of flexion at the hips. The subject continued to extend the elbows as the bat approached the ball (Figure 41-3I).

The bat missed the ball, passing too high to make contact. After the bat had passed the ball, the elbows continued to extend, the shoulders continued to rotate and the hips began to rotate to the left (Figure 41-4I). The follow through continued until the bat reached a position pointing directly away from the camera and slightly upward. It was noted that the feet remained flat on the floor.
Figure 41

Striking Subject 4

Initial Performance

Final Performance
throughout the swing. It was also noted toward the end of the follow through that the right hand rolled over the left hand.

Subject 4 - Final Pattern

The shoulders were rotated to the right, the hips were parallel to the intended line of flight and the feet were rotated to the left as the subject assumed her position for the final performance (Figure 41-1F). The ball was directly forward of the left hip. The bat was held at the right side with the right elbow tucked in against the hip.

A backswing was utilized as the shoulders and hips began to move, rotating to the right until the bat was hidden from the camera view (Figure 41-2F).

The forward swing began as the hips flexed while the left shoulder began transverse abduction and the right shoulder began transverse adduction. The shoulders then began to rotate to the left. As the bat approached the ball, the hips also began to rotate to the left while the elbows extended to almost a complete extension (Figure 41-3F). At the point of contact, the hips and shoulders ceased to rotate.

As the follow through phase of the swing began, the hips and shoulders again began to rotate to the left (Figure 41-4F). The bat continued to move in a transverse plane until it was slightly past pointing in the direction of the intended line of flight. It was noted that the right hand
did not roll over the left hand during the follow through and that the feet remained in their position on the floor throughout the entire swing.

**Subject 4 - Pattern Changes**

The changes from the initial to the final pattern for subject 4 included a different starting position. For the initial pattern, the ball was at the subject's midline and the body was facing at a right angle to the intended line of flight. For the final pattern, the feet were turned toward the intended line of flight while the shoulders were turned away from the intended line of flight. The ball was positioned in front of the left hip.

A second change in the pattern includes the addition of a backswing in the final pattern while there was no backswing in the initial pattern. This allowed for an increase in the range of motion at the beginning of the swing for the final pattern. However, in the follow through, the initial pattern demonstrated a greater range of motion. It was noted that for both patterns, the arms tended to swing ahead of the body rotation.

**Subject 5 - Initial Pattern**

The body was in an upright position as subject 5 prepared to strike the ball from the batting tee (Figure 42-11). The ball was in front of the left hip. The feet were close together with the right foot slightly forward of
Figure 42

Striking
Subject 5

Initial Performance

Final Performance
the left foot. The bat was in a horizontal position resting on the right shoulder while the right elbow was tucked in against the body.

The only movement that might be considered as backswing was that of lifting the bat off the shoulder while shifting the weight to the right leg (Figure 42-21).

The swinging motion began as the arms pulled the bat down and forward toward the ball (Figure 42-31). At the same time, the elbows extended while the left foot took a small stride to the left. As the left foot made contact with the floor, the shoulders, and then the hips began to rotate to the left. At the point of contact, the hips and shoulders continued to rotate while the arms continued to move in a transverse plane to the left. The elbows were completely extended.

During the follow through phase of the swing, the hips and shoulders continued to rotate to the left while the arms continued to move to the left in a transverse plane (Figure 42-41). Toward the end of the backswing, the left foot began to pivot on the heel while the right foot began to pivot on the ball of the foot. The subject ended in a position facing in the direction of the intended line of flight, while the bat was pointed away from the camera and slightly upward. It was noted that the right hand did not roll over the left hand during the follow through.
Subject 5 - Final Pattern

The weight was supported on the right leg as subject 5 positioned himself directly behind the ball for his final performance (Figure 42-1F). The left knee was flexed and the right thigh was medially rotated allowing the toes of the right foot to rest on the floor. The hips and shoulders were rotated to the right while the bat was held in a horizontal position near the right shoulder.

The only backswing motion that could be seen was that of the hands pushing the bat further behind the subject while the tip of the bat dropped toward the floor (Figure 42-2F).

Forward motion began as the left foot took a small stride to the left and was placed flat on the floor (Figure 42-3F). The hips and shoulders began to rotate to the left while the arms began to extend and continued to extend until almost straight at the point of contact.

Shortly after contacting the ball, the hips and shoulders stopped rotating. The right shoulder continued to transverse adduct while the left shoulder continued to transverse abduct. However, the right hand released its grip on the bat while the left hand continued to hold the bat (Figure 42-4F). The right elbow flexed and then extended, as the arm dropped to the right side, while the left elbow completely extended as the bat continued to move in a transverse plane until pointing directly away from the intended line of flight. It was noted toward the end of the
backswing that the shoulders and hips increased their rotation to the left and that the left foot pivoted to the left on its heel.

**Subject 5 - Pattern Changes**

The major changes in the patterns for subject 5 were in the starting position and the follow through. At the starting position for the initial performance, the ball was forward of the left hip while the subject faced the ball with his weight distributed on both feet. For the final pattern, the ball was in line with the subject's midline, his hips and shoulders were rotated to the right and his weight was supported on the right foot.

Even though the starting positions were different, the actual swings were very much alike through the point of contact. However, during the follow through the subject continued to grip the bat with both hands for the initial pattern but let go of the bat with the right hand for the final pattern. This meant that in the initial pattern, the hips and shoulders had to continue to rotate during the early part of the follow through. In the final pattern, the one handed grip on the bat allowed the hips and shoulders to cease rotating while the left arm and bat continued to move in a transverse plane. However, toward the end of the follow through, when the left shoulder had transverse abducted about as much as it could, and the bat still had momentum, the shoulders and hips had to again start
rotating as the momentum of the bat was absorbed by the body.

Subject 6 - Initial Pattern

The ball was directly forward of the left hip as subject 6 positioned herself for the initial striking pattern (Figure 43-1I). The feet were about shoulder width apart and the body was in an upright position. The bat was held at the right hip and was pointing away from the intended line of flight.

The backswing began as the bat was drawn upward and backward while the left foot took a stride to the left (Figure 43-2I). This positioned the ball at the subject's midline.

When the left foot contacted the floor, the hips began to rotate to the left and then became stationary (Figure 43-3I). The shoulders also began to rotate to the left while the arms began to move in a transverse plane to the left. At the point of contact, the shoulders continued to rotate while the arms continued to swing the bat in a transverse plane.

The shoulders continued to rotate left until near the end of the follow through (Figure 43-4I). The arms continued to cross in front of the body, while the right hand rolled over the left hand, until the bat came to rest at the left side pointing away from the camera. It was noted throughout the follow through that the hips remained stationary.
Figure 43

Striking Subject 6

Initial Performance

Final Performance
Subject 6 - Final
Pattern

The ball was just slightly to the left of the left hip as subject 6 positioned herself for her final striking pattern (Figure 43-1F). Her feet were about shoulder distance apart and her body was in an upright posture. The bat was held at the right side in a nearly horizontal position and was pointing slightly toward the rear.

There was no observable movement that could be considered as a backswing (Figure 43-2F). Forward motion began as the hips and shoulders rotated to the left (Figure 43-3F). This was followed by arm movement to the left in a transverse plane as the bat began to approach the ball. Just prior to the point of contact, the hips ceased to rotate as they flexed slightly.

Immediately after contacting the ball, the weight shifted to the left leg. As this happened, the hips again began to rotate. The entire body pivoted on the left hip while the right foot pivoted on its ball. The arms ceased to move in a transverse plane as the hands lowered the bat to about waist height in front of the body. The right arm demonstrated medial rotation and the left arm demonstrated lateral rotation. The bat ended in a position nearly horizontal and pointing away from the camera while the subject ended in a position facing the intended line of flight.

Subject 6 - Pattern
Changes

The two patterns for subject 6 were very much
alike. However, there were some small changes. The initial pattern did have a backswing and a stride to the left with the left foot while the final pattern had neither of these.

The use of the arms, shoulders and hips during the swing and follow through were very much alike for both patterns. The entire body did rotate more to the left in the final pattern than in the initial pattern. Otherwise the range of motion was about the same for both patterns.

Subject 7 - Initial Pattern

Subject 7 assumed an upright position with the ball to his left (Figure 44-11). His feet were shoulder width apart with the left foot forward of the right foot. This caused the entire body to be rotated slightly to the right. The bat rested on the right shoulder.

The backswing began as the right foot took a stride to the right while the knees and hips flexed to put the subject into a slightly crouched position (Figure 44-21). The trunk demonstrated lateral flexion to the right. The bat was also lifted from the shoulder. Only a very slight amount of shoulder rotation to the right was seen.

The forward swing of the bat began with shoulder rotation to the left, followed by a transverse movement of the arms to the left and hip rotation to the left (Figure 44-31). As the bat approached the ball, the elbows began to extend. Just prior to the point of contact, the hips and shoulders ceased to rotate.
Figure 44

Striking Subject 7

Initial Performance

Final Performance
As the bat contacted the ball and moved on past the batting tee, the shoulders again began to rotate to the left. The arms continued to move in a transverse plane to the left (Figure 44-4I). Toward the end of the backswing, the left knee extended causing the hips to rise and rotate further to the left. The subject ended in a position with his upper body facing the intended line of flight with the bat held in front of the body at an oblique angle. It was noted that the right arm did not rotate medially and hence the right hand did not roll over the left hand during the follow through.

Subject 7 - Final Pattern

The position that subject 7 utilized for the final pattern was such that the ball was well to the subject's left (Figure 44-1F). This caused the subject to be turned somewhat toward the intended line of flight as he supported his weight on the right foot. The knees were slightly flexed and the bat was held in a vertical position in front of the body.

The backswing began as the left foot took a stride in the direction of the intended line of flight, while the hands lifted the bat and tipped the bat to a horizontal position (Figure 44-2F). As the left foot contacted the floor, the hips flexed slightly.

The forward swing began as the left arm moved with transverse abduction and the right elbow extended. The
hips rotated slightly to the left while the subject shifted his weight forward (Figure 44-3F). The shoulders did not begin to rotate until just prior to the point of contact. At the point of contact, the bat was held at a considerable distance forward of the body.

After striking the ball, the bat and arms continued to move to the left in a transverse plane (Figure 44-4F). The hips and shoulders continued to rotate to the left well into the follow through. The right hand rolled over the left as the right elbow extended pointing the bat away from the camera. The weight shifted to the left foot as the heel of the right foot was pulled from the floor. The subject ended in a position facing the intended line of flight.

Subject 7 - Pattern

Changes

There were many changes in the striking pattern for subject 7. The first change was in the initial positioning of the body in relationship to the ball. In the initial pattern, the ball was located slightly to the left of the left hip while in the final pattern the ball was a considerable distance to the left. Also, in the initial pattern the subject's left foot was forward causing the entire body to be rotated to the right while in the final pattern the subject's right foot was forward causing the body to be rotated to the left.

During the initial pattern the bat rested on the right shoulder while for the final pattern the bat was held
in front of the body.

The right foot took a step away from the intended line of flight in the initial pattern while the left foot took a stride in the direction of the intended line of flight in the final pattern.

The range of motion for both patterns were the same. However, due to the changes in the starting position, the initial pattern had a relatively longer swing and shorter follow through than the final pattern. The change in the starting position also allowed the subject to face toward the batting tee at the end of the swing in the initial pattern and to face toward the intended line of flight at the end of the swing in the final pattern.

Subject 8 - Initial Pattern

The subject assumed a position so that the ball was immediately to the right of the right hip (Figure 45-11). The right foot was pointed toward the camera while the left foot was turned some toward the intended line of flight. The right foot was also forward of the left foot, causing the hips to be rotated to the left. The bat was held near a horizontal position in front of the body with the hands spread apart. The body was in an upright position.

The backswing began as the bat was lifted up and the shoulders began to rotate to the right (Figure 45-21). At the same time, the left foot took a step to the left causing the hips to rotate slightly to the right. As the
Figure 45

Striking
Subject 8

![Initial Performance](Image)

![Final Performance](Image)
bat continued to be lifted and turned over the right shoulder, the right foot was taken from the floor and replaced immediately in the same spot.

When the right foot was placed on the floor again, the hips began to flex, the shoulders began to rotate to the left and the shoulders began to extend, drawing the bat downward toward the ball (Figure 45-3I). The trunk also flexed slightly to the right as the bat approached the ball. Just prior to the point of contact, the right hand released its grip on the bat.

Very little movement was seen during the follow through as the bat and the left arm continued to move downward and finally in a transverse plane toward the end of the follow through (Figure 45-4I). The left arm did demonstrate lateral rotation toward the end of the follow through. It was also noted, toward the end of the follow through, that the shoulders and hips did rotate to the left in order to absorb the momentum of the bat as the left arm had transverse abducted to its maximum. This caused the subject to end in a position with the shoulders facing the intended line of flight while the feet remained in a position facing the camera.

Subject 8 - Final Pattern

The starting position for subject 8 was with the feet shoulder width apart, the body in an upright position and the bat held in a horizontal position over the right
shoulder and pointing away from the camera (Figure 45-1F). The subject had positioned herself so that the ball was immediately to the right of her midline. Much of the weight was supported on the right leg.

The backswing began as the shoulders rotated to the right while more weight was being shifted to the right leg (Figure 45-2F). The shoulder rotation caused the bat to point toward the intended line of flight.

The forward motion of the swing began with a weight shift to the left (Figure 45-3F). At the same time, the hips flexed while the shoulders rotated to the left. This was followed by transverse abduction of the left arm and extension of the right elbow, causing the bat to move in a rather downward path toward the ball. As the bat approached the ball, the left elbow also began to extend.

After hitting the ball, the bat also hit the top of the batting tee. The bat bounced upward off the tee, but then continued to move at an oblique angle (Figure 45-4F). The follow through consisted only of arm movement, until the very end, at which time the hips and shoulders rotated to the left slightly.

Subject 8 - Pattern Changes

Even though there were many changes in the pattern for subject 8, the actual swings of the initial and final patterns were very much alike. The first change noted was in the subject's position prior to beginning the backswing.
In the initial pattern, the ball was to the right of the subject, while in the final pattern, the ball was near the subject's midline.

The handling of the bat also changed. For the initial pattern, the bat was held in front of the body with the hands spread apart. For the final pattern, the bat was held over the right shoulder with the hands close together. During the swing and follow through, the right hand released its grip from the bat in the initial pattern. However, for the final pattern, both hands gripped the bat throughout the entire swing.

The transfer of weight during the backswing also changed. In the initial pattern, the subject began with her weight on the left leg, transferred it to the right leg and then back to the left leg. Once the swing began, her weight remained shifted to her left side. For the final pattern, the weight shifted from the right leg to the left leg during the backswing, and then remained toward the left side throughout the swing and follow through.

Subject 9 - Initial Pattern

The ball was directly forward of the right hip as subject 9 prepared himself to strike the ball (Figure 46-II). The left foot was slightly forward of the right foot, while the body was in an upright position with the knees and hips slightly flexed. The hips and shoulders were rotated to the right as the bat was held at an oblique
Figure 46

Striking Subject 9

Initial Performance

Final Performance
angle to the right side.

The left shoulder began to flex, while the left arm rotated medially and the right arm rotated laterally. The tip of the bat moved to a position pointing directly behind the subject and somewhat toward the intended line of flight (Figure 46-21). The hips and knees both began to flex during the backswing phase of the pattern.

The hips led the forward swing as they began to rotate to the left (Figure 46-31). Shoulder rotation to the left and movement of the arms in a transverse plane followed the hip rotation. As the bat approached the ball, the elbows began to extend until they were fully extended at the point of contact. At the point of contact, the hips and shoulders both stopped rotating.

After the bat had contacted the ball and had passed the batting tee, the shoulders first, and then the hips, began to rotate to the left again. As the left shoulder had transverse abducted and the right shoulder had transverse adducted, and as the hips and shoulders had rotated left, the momentum then began to cause the entire body to pivot on the ball of the right foot and the heel of the left foot (Figure 46-41). The subject completed the follow through so that he was facing the intended line of flight, and the bat was pointing away from the intended line of flight over the left shoulder. During the follow through, the right arm demonstrated medial rotation while the left arm demonstrated lateral rotation allowing the right hand to roll
Subject 9 - Final Pattern

The ball was well to the left of the subject as he positioned himself for his final striking performance (Figure 46-1F). The weight was supported on the right leg while the left foot was forward and pointing toward the batting tee. The body was in an upright position with the bat held over the right shoulder, at an oblique angle, pointing away from the camera.

The left arm was the first body part to move in the backswing as the left shoulder flexed to raise the hands up to head height (Figure 46-2F). At the same time, the tip of the bat dropped bringing the bat to a horizontal position. Other movements in the backswing include a stride to the left of the left foot and a considerable amount of knee flexion of both knees. By the end of the backswing, the stride to the left had positioned the subject so that the ball was in line with a point to the immediate left of the left hip.

The forward motion began as the knees and hips increased in flexion while the hips and shoulders began to rotate (Figure 46-3F). The arms moved in an oblique plane as the bat swung downward toward the ball. As the bat approached the ball, the elbows extended. At the point of contact, the hips and shoulders continued to rotate left. Throughout the swing, the weight was being shifted to the
left side so that at the point of contact, almost all the weight was being supported by the left leg.

As the subject began the follow through phase of the pattern, all the weight shifted to the left leg. When the arms crossed in front of the body and as the shoulders and hips continued to rotate to the left, the subject pivoted on the left foot until the subject had completed a 270 degree turn with his back to the intended line of flight (Figure 46-4F). The bat ended its swing by being held in a vertical position in front of the left shoulder. It was noted, during the follow through, that the right hand rolled over the left hand.

Subject 9 - Pattern Changes

The subject's position in relationship to the ball changed from the initial pattern to the final pattern. In the initial performance, the ball was positioned forward of the right hip, while in the final performance, the ball was positioned well to the left of the left hip.

During the backswing, the subject utilized a stride in the direction of the intended line of flight in the final pattern, while the feet remained in contact with the floor in the initial pattern. This stride allowed the subject to shift his weight during the swing, and to develop more momentum. This added momentum caused the subject to turn three fourths of a turn on the left foot. In the initial pattern, the subject pivoted a quarter turn on both
Another change included the path that the bat took during the swing. In the initial pattern, the bat was swung in a transverse plane, while in the final pattern, the bat followed an oblique path as it swung downward toward the ball and then upward during the follow through.

**Subject 10 - Initial Pattern**

Subject number 10 was a left handed batter. He positioned himself so that the ball was in line with a point to the immediate right of his right hip (Figure 47-11). His feet were in a stride position about shoulder width apart with the right foot forward of the left foot. The knees and hips were only slightly flexed as the body was in an upright position. The bat was held at an oblique angle in front of the left shoulder.

The backswing began as the weight shifted to the left leg in order to allow the right foot to take a stride in the direction of the intended line of flight (Figure 47-21). At the same time, the elbows extended slightly to lower the bat, while the shoulders rotated to the left. Only a slight rotation of the hips to the left was seen. Toward the end of the back swing, the shoulders flexed to raise the bat back to shoulder height.

Toward the end of the stride to the right, just prior to the right foot making contact with the floor, the weight began to shift back to the right. As soon as the
Figure 47

Striking Subject 10

Initial Performance

Final Performance
foot made contact with the floor, the hips began to rotate to the right (Figure 47-3I). This was followed by a rotation of the shoulders to the right while the arms began to move in a transverse plane to the right. At the same time, the elbows began to extend. At the point of contact, the elbows remained slightly flexed while the weight was distributed evenly over both legs. Also, at the point of contact, even though the hips and shoulders did continue rotating, they did so at a much slower rate.

After the ball had been contacted, the hips and shoulders again increased their rate of rotation while the arms continued to move in a transverse plane to the left (Figure 47-4I). The weight continued to shift to the right so that prior to the end of the follow through, the left foot took a small stride in the direction of the intended line of flight. The subject ended in a position facing in the direction of the intended line of flight, with the bat in a horizontal position pointing away from the intended line of flight and held next to the right shoulder. During the follow through, the left hand rolled over the right hand, beginning at the point of contact and ending near the end of the follow through.

Subject 10 - Final Pattern

The position assumed by subject 10 for his final pattern was such that the ball was located forward of a point at a considerable distance to the right of his right
hip (Figure 47-1F). His feet were close together, while the body was in an upright position with very little knee and hip flexion. The bat was held in a horizontal position on the left shoulder.

Shoulder rotation to the left began the backswing (Figure 47-2F). This was followed by hip rotation to the left. As the hips began to rotate, they also began to flex, shifting the weight to the left leg. This allowed the right foot to begin a rather short stride in the direction of the intended line of flight.

When the right foot contacted the floor, the hips and shoulders began to rotate to the right (Figure 47-3F). At the same time, the hips continued to flex, accompanied by knee flexion. The arms also began to move in an oblique plane while the elbows began to extend. This caused the bat to move downward as it was swung to the right. However, at the point of contact, the arms and bat were moving in a transverse plane. It was noted that just prior to the point of contact, the hips and shoulders stopped rotating.

As the subject moved into the follow through phase of the swing, the bat and arms began to move in an oblique plane in an upward direction. The knees and hips began to extend, bringing the subject to an upright position at the end of the follow through. After contacting the ball, the shoulders again began to rotate, while the hips remained stationary. At the end of the follow through, the subject's feet were pointing toward the camera while the shoulders
were facing in the direction of the intended line of flight. From the point of contact, through the follow through, the left arm demonstrated medial rotation while the right arm demonstrated lateral rotation as the left hand rolled over the right hand.

**Subject 10 - Pattern Changes**

The many changes in the striking pattern for subject 10 represent a regression in striking pattern development. The initial pattern very much resembled a mature pattern while the final pattern was relatively immature.

One such change was seen in the posture assumed by the subject as he prepared himself to hit the ball. The initial pattern posture was with the feet in a stride position, the knees and hips slightly flexed and the bat held near the left shoulder. The posture for the final pattern, was with the feet close together, the body in an upright position and the bat resting on the left shoulder.

During the backswing phase of the initial pattern, the subject drew the bat back while taking a good stride toward the intended line of flight. For the final pattern, the bat remained on the shoulder while a rather short stride was utilized.

The actual swinging of the bat changed from the initial to the final pattern. The initial swing of the bat was in a transverse plane with the elbows almost fully extended at the point of contact and were fully extended
during the follow through. The final swing was an oblique downward and then upward swing with the elbows remaining rather flexed throughout the swing, especially in follow through phase.

Another change noted dealt with the shifting of weight throughout the swing. The initial pattern weight transfer was to the left leg during the backswing and then to both legs and finally to the right leg during the follow through. The final pattern weight transfer was to the left leg during the backswing. However, during the forward swing the weight shifted to both legs and remained over both legs throughout the follow through.

Subject 11 - Initial Pattern

Subject 11 assumed a starting position for his initial striking pattern so that the ball was directly in line with his midline (Figure 48-11). His feet were shoulder width apart with the left foot forward, causing the body to rotate to the right. The body was in the upright position with the bat resting on the right shoulder. The hands gripped the bat in front of the chest.

The backswing began with shoulder flexion, raising the handle of the bat to place the bat in a horizontal position (Figure 48-21). At the same time, the weight shifted to the right leg while the left foot began to take a stride in the same direction as the intended line of flight. The trunk also flexed slightly to the right,
Figure 48

Striking Subject 11

Initial Performance

Final Performance
causing the shoulders to tilt to the right.

As soon as the left foot contacted the floor, and as the weight began to shift to the left, the hips and shoulders began to rotate to the left (Figure 48-3I). The arms began to move in a transverse plane while the elbows began to extend. At the point of contact, the left elbow was completely extended while the right elbow remained slightly flexed. Also, at the point of contact, hip and shoulder rotation stopped.

After the ball had been hit and as the arms continued to move to the left in a transverse plane, first the shoulders and then the hips, began to rotate to the left again (Figure 48-4I). Also, after the ball had been hit, and while the weight continued to shift to the left, the trunk straightened and then began to flex left. As the arms crossed in front of the body, the entire body began to pivot to the left. With most of the weight on the left leg, both feet pivoted on the balls so that the subject ended the backswing facing in the direction of the intended line of flight. It was noted that the right hand rolled over the left hand after the bat had contacted the ball and continued to do so to the end of the follow through. At the end of the follow through, the bat was in a horizontal position, pointing away from the intended line of flight and was near the left shoulder.
Subject 11 - Final Pattern

The subject positioned himself for the final performance so that the ball was in line with a point to the immediate left of the left hip (Figure 48-1F). The feet were shoulder width apart with the body in an upright posture. The left foot was positioned slightly forward of the right foot, causing the body to be rotated slightly to the right. The hands gripped the bat in front of the chest with the bat resting on the right shoulder.

The subject began the backswing with left shoulder flexion, a slight amount of trunk flexion to the right, a shifting of the weight to the right and a stride to the left of the left foot (Figure 48-2F). These actions caused the handle of the bat to be lifted while the right shoulder lowered to put the bat in a horizontal position.

Forward motion of the bat began with hip and shoulder rotation to the left as soon as the left foot made contact with the floor (Figure 48-3F). This was followed by transverse abduction of the left shoulder, transverse adduction of the right shoulder and elbow extension of both elbows. As the bat approached the ball the weight continued to shift to the left leg. At the point of contact, the hips and shoulders ceased to rotate.

After the ball had been contacted, the arms continued to move in a transverse plane to the left while the hips and shoulders again began to rotate to the left (Figure 48-4F). During the follow through, the left foot
pivoted on the heel allowing the entire body to face in the direction of the intended line of flight. At the same time, the right foot pivoted on its ball and was then lifted from the floor as all the weight shifted to the left foot. After the bat had contacted the ball, the right hand began to roll over the left hand. However, before the follow through was completed, the right hand released its grip on the bat. At the end of the follow through the left arm dropped to the left side of the body so that the bat was pointing at the floor.

**Subject 11 - Pattern Changes**

The changes in the striking pattern for subject 11 were very minor as the patterns were almost identical. The first and most notable change was the relationship between the batter and the ball at the start of the performance. In the initial pattern the ball was directly in line with the subject's midline. In the final pattern the ball was positioned to the left of the subject.

The only other two changes were that the subject released the grip of the right hand on the bat during the follow through of the final pattern while both hands remained on the bat in the initial pattern. The subject shifted all his weight to the left leg in the final performance, causing the right foot to be picked up from the floor, while in the initial pattern, even though there was a weight shift, the right foot did not actually leave
the floor.

The Final and Mature Striking Patterns Compared

A comparison of the final striking patterns of the mentally retarded subjects to the mature pattern revealed that the patterns were very different in the preparation and effort phases, but very much alike in the follow through phase. While the mature performer assumed a cocked position many of the mentally retarded subjects had to make a special effort to move from their initial position to the cocked position. Many of the mentally retarded subjects failed to utilize the same sequence and timing of the body movements during the effort phase. They used incorrect stride procedure, led with incorrect body parts and failed to use all of the body for force. The utilization of body parts, the sequence and timing of movements and the range of motion during the follow through were however, very much like the mature pattern.

The Initial and Final Striking Patterns Compared

The data representing the changes from the initial to final performances in the striking pattern of the educable mentally retarded subjects can be found in Table 5. Two subjects demonstrated the same number of positive and negative changes, four subjects had more positive than negative changes and five subjects had more negative than
Table 5
Changes in the Striking Pattern

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<th>Negative Changes</th>
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</table>

N = 9, x = 4, p = 1.00 = N.S. at .05 confidence level
positive changes. An N of nine and an X of four yields a p value of 1.00.\textsuperscript{5} A p value of .05 or less was needed in order for the changes in the striking patterns to be significant.

Summary

The initial and final patterns of the eleven educable mentally retarded subjects and the mature patterns in the standing long jump, overarm throw, place kick and striking skills were analyzed. The final patterns were compared to the mature patterns and the initial patterns were compared to the final patterns. In all cases the patterns of the educable mentally retarded subjects were different from the mature pattern model. Although there were some changes in the patterns of the educable mentally retarded subjects from their initial to final performances, the changes were both positive and negative so that the end result was such that the subjects did not make gains or losses in motor pattern development.

\textsuperscript{5}Siegel, loc. cit.
Chapter 5

SUMMARY, FINDINGS AND CONCLUSIONS

The final chapter includes a summary, the findings, a discussion of the findings, the conclusions and the recommendations.

Summary

It was the purpose of this study to compare the standing long jump, place kick, overarm throw and striking patterns of educable mentally retarded children to the mature patterns of highly skilled individuals. It was also the purpose of this study to determine if these same motor patterns are inherent in educable mentally retarded subjects and to determine if these patterns would emerge naturally in a goal-centered teaching-learning environment.

Eleven educable mentally retarded children between the ages of five and eight years were selected to participate in the study. The children participated in a one week (fifteen minutes per day) orientation program so that they could become familiar with working with the investigator and an assistant and accustomed to performing before the camera. During this time the children participated in motor activities not related to the motor patterns being investigated.

The first filming session, during which the initial
motor patterns were recorded, was held the first day of the treatment period. The second filming session was held on the twentieth and final day of the treatment period. During each day of the treatment period, each subject performed the standing long jump, overarm throw, place kick and striking patterns ten times.

Two university students were utilized to establish, on film, the mature patterns used in this study. One subject, a place kicker on the varsity football team, served as the model for the mature place kick pattern. The second subject, a member of the varsity baseball team, served as the model for the mature standing long jump, overarm throw and striking patterns.

Once the motor patterns of the mentally retarded subjects and the mature patterns were recorded on film, they were viewed and analyzed, and tracings were made. For each of the four motor patterns, the standing long jump, place kick, overarm throw and striking, the final motor patterns of the mentally retarded subjects were compared to the mature motor patterns. The initial motor patterns of the mentally retarded subjects were also compared to their final motor patterns in order to determine pattern changes.

Findings

The findings of this study, an analysis of motor pattern development of educable mentally retarded children, are presented here.
The Final Patterns of the Educable Mentally Retarded Subjects Compared to the Mature Patterns

The findings, based on the analysis and comparisons of the standing long jump, overarm throw, place kick and striking patterns of the educable mentally retarded subjects and the mature patterns were:

1. The mentally retarded subjects, in their final patterns, generally utilized the same body parts as the mature performers in the execution of the skills. However, some body parts of the educable mentally retarded subjects were not used, were used only for balance, moved in an incorrect direction or did not aid in the production of force.

2. The sequences of movements in the final patterns of the mentally retarded subjects were similar to those demonstrated by the mature subjects inasmuch as the movements were the same. When the mentally retarded subjects substituted a different kind of movement then that movement appeared at the same place in the sequence that the correct movement would have appeared. While the mature performer executed several movements simultaneously, the mentally retarded subjects often separated those movements into ordered sequences.

3. The timing of movements in the final patterns of the mentally retarded subjects was similar to the timing of movements in the mature patterns inasmuch as the movements were the same. When the mentally retarded subjects
substituted different kinds of movements, the substitute movements were executed in the same time space as the movements they replaced. An exception to this finding was noted when the mature subjects timed several movements to happen simultaneously and the mentally retarded subjects often timed those movements so that they appeared separately, but in an ordered sequence.

4. The mentally retarded subjects, in both the initial and final patterns, utilized a range of movements which was considerably less than that utilized by the mature performer through all phases of the skills.

The Initial Patterns Compared to the Final Patterns of the Educable Mentally Retarded Subjects

The findings, based on the comparisons of the initial and final standing long jump, overarm throw, place kick and striking patterns of the educable mentally retarded subjects were:

1. The mentally retarded subjects made numerous changes in the involvement of body parts, the sequence of movements and the range of movements utilized from their initial to final patterns.

2. The mentally retarded subjects did not change the timing of movements from their initial to final patterns, whenever the movements were the same. When similar movements were utilized then the timing of those movements was also similar.
3. The changes in the patterns from the initial to final performances of the educable mentally retarded subjects were a mixture of positive and negative developmental changes so that the total outcome indicated that the skills did not improve or regress.

Discussion of Findings

The findings of this study indicate that the standing long jump, overarm throw, place kick and striking patterns of the mentally retarded children had characteristics both similar and different from that of the mature pattern. In many cases, the fact that the patterns were different in one phase of the skill, caused the patterns to be different in another phase of the skill. This relationship was especially true for the preparation, or approach, and the follow through phases.

In the standing long jump, overarm throw and place kick patterns, the mentally retarded subjects utilized limited preparation and approach movements. This put them at a disadvantage at the beginning of the effort phase, which, in turn, limited the force production during the effort phase, resulting in only a limited follow through in order to absorb the momentum of the skill.

In the striking patterns, the mentally retarded subjects placed themselves at a disadvantage as they prepared to hit the ball. However, before beginning the effort they added an additional preparation movement which improved
their ready position. Even though the effort phase was different for some of the subjects, they all utilized a follow through in order to absorb the momentum developed during the effort phase of the skills.

The majority of the differences between the patterns of the mentally retarded subjects and the mature patterns, in reference to the involvement of body parts, were that the mentally retarded subjects used fewer body parts in that they deleted some movements from the pattern. When the mentally retarded subjects used similar body actions to the mature patterns, those actions were often limited.

The sequence of movements utilized by the mentally retarded subjects appeared to be related to the kind of movements the subjects utilized. In the standing long jump, overarm throw and place kick patterns, the mentally retarded subjects utilized a sequence of movements similar to the mature sequence when the movements were similar. When the movements of the mentally retarded subjects were different from the mature pattern, but similar to each other, then, sequences of those movements were also similar to each other. This was also true in the striking pattern, with the following exception. The mature subject made several movements simultaneously during the stride step while the mentally retarded subjects utilized those same movements in an ordered sequence.

The timing of movements was closely related to the sequence of movements in this study. For the most part,
movements were timed in a similar fashion when the sequence of movements were the same. This included movements which were similar to the movements of the mature pattern as well as movements which were different from the mature pattern but were similar to movements in other patterns of the mentally retarded subjects.

In the overarm throw and place kick patterns, some of the mentally retarded subjects changed the timing between the preparation, or approach phase, and effort phase by including a pause. The subjects simply stopped movement temporarily and then began movement into the next phase. Another movement, in which the mentally retarded subjects segmented the skill by utilizing different timing, was the stride step in the striking pattern. While the mature subject utilized several movements simultaneously, the mentally retarded subjects, who utilized a stride step, timed those movements so that they appeared as an ordered sequence.

During the effort phase of the striking pattern, some of the mentally retarded subjects utilized a timing of movements in such a way that the sequence of movements was reversed. It is unclear whether the difference in sequence caused the difference in timing, or the difference in timing caused the difference in sequence.

The ranges of movement of the mentally retarded subjects were, for the most part, limited when compared to the mature patterns. This was due in part to the fact that the mentally retarded subjects utilized fewer body parts in
order to complete the skills. It was also due to the fact that even when the same body parts were utilized, they were often utilized in a different manner, which tended to limit the range of movement in the involved joints.

The range of movements during one phase of a skill was related to the range of movements during another phase of the skill. Then the range of movement during the preparation or approach phase was limited, the subjects were not able to become fully cocked, this in turn limited the range of movement during the effort phase, which in turn, limited the range of movement during the follow through.

It was noted in the striking patterns, that the mentally retarded subjects utilized a range of movements during the preparation phase that was not utilized in the mature pattern. However, this movement allowed the mentally retarded subjects to assume a position so that they could use a full range of movement during the effort and follow through phases of the skill.

The findings, which were based on the comparisons of the initial and final standing long jump, overarm throw, place kick and striking patterns of the mentally retarded subjects, indicated that while the subjects were capable of making changes in their patterns, they were unable to determine which changes improved their performances. Many of the subjects made positive and negative changes in their patterns so that in the final analysis the patterns were different, but without any overall improvement. For some
subjects, the positive changes out numbered the negative changes so that in the final analysis, their patterns did improve. However, for some subjects the negative changes out numbered the positive changes so that in the final analysis their patterns regressed. A composite of all the changes in the patterns for the mentally retarded subjects revealed that the initial and final patterns were very much alike.

The literature reviewed supported the concept that educable mentally retarded children can and do develop efficient motor skills. It has been established that educable mentally retarded children develop motor skills at a slower rate than normal children. It is generally agreed that educable mentally retarded children need to be given more time for motor skill development than that needed for normal children. Rarick, Dobbins and Broadhead\(^1\) indicated that educable mentally retarded children, when given proper instructions, can, in time, perform motor skills at a level comparable to that of children with normal intelligence.

Flinchum\(^2\) found that normal preschool age children improved their motor patterns through a goal-centered teaching-learning environment with only thirteen practice sessions. It was therefore expected that the educable mentally retarded primary grade children in this study would also

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\(^1\) Rarick, Dobbins and Broadhead, op. cit., p. 123.

\(^2\) Flinchum, loc. cit.
improve their motor patterns after participating in twenty goal-centered teaching-learning practice sessions. However, this did not happen.

The author felt that twenty practice sessions over a four week period of time for the educable mentally retarded subjects was sufficient in order to bring about a developmental change in the motor patterns studied. This was based on the fact that individual children did demonstrate some positive changes in some phases of their motor patterns. However, these gains in motor pattern development were negated by a similar number of negative changes in the same or different phases of the motor patterns.

It appears that the emergence of motor patterns in educable mentally retarded children is somehow inhibited by the mental functioning capacities of the children. If motor patterns are inherent in both normal and educable mentally retarded children, then a normal level of mental functioning is necessary in order for those patterns to emerge naturally in a goal-centered teaching-learning environment.

**Conclusions**

Within the limits of this study, the following conclusions were drawn:

1. The standing long jump, overarm throw, place kick and striking patterns of educable mentally retarded children between five and eight years old, do to some extent resemble the patterns of mature performers. However, in
reference to the involvement of body parts, the sequence of movement, the timing of movements and the range of movements, the patterns of the educable mentally retarded subjects are immature and are executed in an inefficient manner.

2. The standing long jump, overarm throw, place kick and striking patterns of educable mentally retarded children will not emerge nor develop naturally through a goal-centered teaching-learning environment.

Recommendations

The findings of this study provided some basic information concerning motor patterns and the development of motor patterns of educable mentally retarded children in a goal-centered teaching-learning environment. Based on this information, the following recommendations are offered:

1. Motor development programs for educable mentally retarded children should provide other types of instruction, in place of, or in addition to, the goal-centered teaching-learning instructional environment.

2. A study should be conducted to determine the effect that visual model and/or auditory feedback instructional programs have upon the motor development of educable mentally retarded children.

3. A study should be conducted to determine the cause-effect relationship between the involvement of body parts and the range of movements.
4. A study should be conducted to determine the cause-effect relationship between the sequence of movements and the timing of movements.

5. A study should be conducted to identify the changes in motor patterns which represent skill progression and which changes represent skill regression.

6. A longitudinal study should be conducted to determine the developmental sequences of selected motor skills for educable mentally retarded children, and to compare those sequences with the developmental sequences for normal children.
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APPENDIX A

Letter To Parents

September 22, 1976

Dear Parents:

Leonard Hill, an elementary physical education specialist on the faculty at Western Illinois University has planned a program of physical education activities for the children of Bushnell East Elementary School. The program, under the direction of Mr. Hill will provide the children with the opportunity to develop basic skills on an individual basis. Your son or daughter has been selected to participate in this program. However, your permission is needed in order to have your child participate as the program involves making movies of the children as they practice the skills.

Sincerely,

Dr. Tom Crowell
Superintendent of Schools

Leonard M. Hill
Assistant Professor, WIU

Please sign and return by Monday, September 27, 1976 if you wish to have your child participate in this skill development program.

Signature of Parent
VITA

The author was born in Elkhorn, Wisconsin on June 3, 1944. He attended Palmyra Public School and graduated in May of 1962. He received a Bachelor of Science degree from the University of Wisconsin, Whitewater in 1967 with a major in mathematics and a minor in physical education. He received a Master of Science degree from Emporia Kansas State University in 1968 with a major in physical education and a minor in education.

In the fall of 1968, the author accepted his first elementary physical education teaching position in Two Rivers, Wisconsin. In the fall of 1970, he accepted a similar position in the Watertown, Wisconsin Public School System.

In the summer of 1972, the author began studying full time toward the Doctorate Degree in Education at Louisiana State University. After the completion of all course work for the doctorate in 1974, the author assumed a position in higher education at Western Illinois University Macomb, Illinois as elementary physical education specialist.

The author is married to the former Judith Ann Henkel of Sturgeon Bay, Wisconsin and has two children, Jason and Nicole.
EXAMINATION AND THESIS REPORT

Candidate: Leonard Max Hill

Major Field: Health, Physical, and Recreation Education

Title of Thesis: A Film Analysis of Motor Pattern Development of Educable Mentally Retarded Children

Approved:

[Signatures]
Major Professor and Chairman

Dean of the Graduate School

EXAMINING COMMITTEE:

[Signatures]

Date of Examination:

July 15, 1980