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Dean of the School of Allied Health Professions

AGE AND EXPERIENCE DIFFERENCES IN POSTURE
AND MOVEMENT OF CHILDREN
WHILE ENGLISH HORSEBACK RIDING AT A WALK

by

Mary Katherine Belissary

B. S., Medical University of South Carolina, 1983

Director: Ann F. VanSant, Ph.D.

Associate Professor of Physical Therapy

Thesis

submitted in partial fulfillment of the requirements for the

Degree of Master of Science in the

Department of Physical Therapy

School of Allied Health Professions

Medical College of Virginia Campus

Virginia Commonwealth University

Richmond, Virginia

November, 1986

Acknowledgements

The stroke of a pen...a simple task to write letters to form words... but not so simple a task to form words into feelings and emotions. I hardly know where to start...

I would like to thank:

God for holding me tight in the palm of His hand and for the wonderful family and friends He has given me.

My parents who sustained me in prayer and love and who have always put their children before themselves; for loving me enough to let me go. I would also thank them for helping me videotape the children riding and calling parents and making arrangements for me to videotape.

Dr. Ann VanSant for showing me that professors really do care--for her time, her knowledge and guidance, and for her friendship.

Dr. Roberta Newton and Mrs. Pat Brown for their interest in my work and their willingness to sit on my committee.

Sandi and Randy Bassett for the use of their word processor for four months and for teaching me how to use it, for allowing me to be part of Magnolia Centre for Special Equestrians, and for making me a part of their family.

Mrs. Tammala Watkins for her time and talent in the art work she did on the horse's walk and back muscle action and for helping me film.

Barbara Price, Helen George, and Vanessa Gable, riding instructors at Stillmeadows Farm, and Mr. and Mrs. Ward, owners of Stillmeadows Farm, and Pat Betts, riding instructor and owner of Level Green Riding School, for their knowledge and their willingness to allow me to use their facilities, horses, and students for my study; Judy Hill, trainer for Magnolia Centre for Special Equestrians for her technical advice.

Mr. Dutton Beatson, riding instructor and owner of Long Lane Stables, Darlington, S. C., for teaching me to ride and giving me a firm foundation of horsemanship, for his concern, and for the use of his stable and students for this study.

All the children who rode for my study--"Heads up, heels down" and the parents who were willing to allow them to ride for this study.

Sandi and Randy Bassett, Carla Cripes, Judy Dannenhoffer, Janet Klosterman, Shari Luehring, Beth Myers, Katy Reese, Jean Shake, Adrian Truluck, and Tammala Watkins for helping me videotape the riders even though it was freezing cold at times.

Shari Luehring for always going the extra mile(s) in more ways than one and for being a friend I could talk to about anything.

Linda Love for her friendship, her thoughtfulness, and her willingness to listen.

Lydia Morris for being a wonderful boss; for always being willing to work with my school schedule and for being my friend.

The staff at Retreat Hospital for their friendship and support through it all.

My horses, Sundance and Cocoa, who have given me many happy moments, who patiently rode the five year old children in this study to allow them the thrill of horseback riding.

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ABSTRACT

AGE AND EXPERIENCE DIFFERENCES IN POSTURE AND MOVEMENT OF CHILDREN WHILE ENGLISH HORSEBACK RIDING AT A WALK

Mary Katherine Belissary, P. T.

Department of Physical Therapy, School of Allied Health Professions, Medical College of Virginia, Virginia Commonwealth University, Richmond, Virginia

Director: Ann F. VanSant, Ph. D., P. T.

The purposes of this study were to: (1) describe posture and movement of non-disabled children while English horseback riding at a walk, (2) propose a developmental sequence for each of three components of body posture and movement: the upper extremity, the lower extremity, and the head and trunk, and (3) describe age differences in posture and movement while riding.

The study was designed as a cross-sectional descriptive study. Thirty children without disabilities: ten five-year-olds who had never received formal riding lessons; ten seven- and eight-year-olds who had received six months or less of formal riding lessons; and ten nine- and ten-year-olds who had received seven months or more of formal riding lessons; were videotaped while horseback riding at a walk. Posture and movement of the upper extremity, the lower extremity, and the head and trunk, were each described in writing and categories were

established to summarize the different postures and movements observed within each component. Horseback riding literature, which describes an "advanced" form for English riding was consulted to propose a developmental sequence for each component. The frequency of occurrence of each category in each age group was determined and graphed with respect to age. This graph was compared with the sequence proposed after consulting the riding literature.

As a result of the study, five categories of posture and movement were formed for each of the components. As a group, the children demonstrated 54 different combinations of component posture or movement while riding. Each age group demonstrated a different modal combination of component posture or movement. None of the developmental sequences proposed from riding literature were supported by the data. However, age differences observed in this study enabled new developmental sequences to be proposed for development of component posture in the task of English horseback riding.

CHAPTER 1

Introduction

Therapeutic horseback riding is a form of English horseback riding which is adapted to the needs of the disabled. In the past fifteen years, therapeutic horseback riding has become a popular sport for people with disabilities. Over 8000 disabled citizens are estimated to participate in therapeutic horseback riding programs in 331 centers across the country (Annual Report, North American Riding for the Handicapped Association, 1985).

Hippotherapy is different from therapeutic horseback riding. In hippotherapy the horse is considered a physical therapy treatment modality much like a bolster or equilibrium board. Due to the horse's body warmth, rhythmic movements, and shape, some therapists use the horse as a part of a neurodevelopmental treatment (NDT) regime (Desautels, 1984). In contrast, in therapeutic horseback riding the person is taught to ride as well as to do general exercise on horseback. The disabled person gets the physical benefits of horseback riding without direct treatment by a therapist.

All physically handicapped individuals that participate in riding through the North American Riding

for the Handicapped Association's (NARHA) affiliated centers are required to have a doctor's referral and a physical therapy evaluation before they begin a therapeutic riding program (McCown, 1972). The role of physical therapists working with these programs is to recommend appropriate adaptive equipment, horse, mounting and dismounting procedures, and therapeutic exercises to be carried out by the rider while on the horse.

As therapeutic horseback riding becomes increasingly popular among disabled individuals, it is important to examine the claims made by horseback riding enthusiasts. The theoretical basis of therapeutic horseback riding has been linked to Berta Bobath's concepts of "reflex-inhibiting patterns", and elicitation of equilibrium reactions (Kyne, 1982). "Reflex-inhibiting patterns" are used to inhibit abnormal movement patterns and postural reactions (Bobath, 1978). The position of the rider's upper body and upper extremities while on horseback to some extent simulates a "reflex-inhibiting pattern" (Kyne, 1982). The posture of the rider's lower extremities exemplifies the idea of a "reflex-inhibiting pattern": when riding the hips are abducted, externally rotated, and slightly flexed with the knees flexed and the ankles dorsiflexed and everted.

Due to the inherent rhythmic anterior-posterior, medial-lateral, and up-down movement of the horse, balance reactions are necessary to remain on the horse. Bobath (1978) emphasized the use of equilibrium reactions in patient treatment.

Kyne (1982) proposed that "the movements of the horse offset the rider's balance in a rhythmical pattern--almost like dynamic rhythmic stabilizations. Rhythmic stabilizations are a technique used by therapists to retrain balance" (p. 8). Though Kyne does not mention it, rhythmic stabilization is a therapeutic technique of proprioceptive neuromuscular facilitation (PNF) proposed by Knott and Voss (1968). However, she does write that the exercises the riders perform may consist of "bilateral symmetrical neuro-muscular patterns of movement" and references this to Knott and Voss's work (p. 13).

Research must be performed in order to develop a rationale for therapeutic horseback riding. No research has examined the above hypotheses linking Bobath's or Knott and Voss's concepts with therapeutic horseback riding. As a physical therapist who has experience riding, the connections drawn appear empirically valid. However, the efficacy of Bobath's or Knott's and Voss's hypotheses have not been confirmed by research, and therefore, the rationale for therapeutic horseback riding remains weak.

As therapists take an active role in riding for the disabled, the lack of research describing the English riding posture at various gaits of the horse and for various age and experience levels of the riders also becomes apparent. The purposes of this study were to: (1) describe the posture and movement of normal children seated in an English saddle while riding a horse at a walk, (2) propose a developmental sequence for each of three components of body posture and movement: the upper extremity; the lower extremity; and the head and trunk; during the task of English horseback riding, and (3) describe the differences in postures and movements of the various age groups.

The present study employed developmental theory as a foundation for research. Motor development was viewed as an orderly sequence of changes in motor behavior as an organism interacts with its environment (Wickstrom, 1977).

This study used a component model of movement analysis (Robertson, 1977) to describe the posture and movement of children riding horseback. Robertson used the component model to propose motor development sequences in particular segments, components, of the body for a specific task. Categorical descriptions of the patterns of movement were formulated within each component. These categories were then ordered into developmental steps for

a specific component.

The component model has been used to describe component movements and form developmental sequences for a variety of motor tasks such as overhand throwing (Robertson, 1978), moving from supine to standing (VanSant, 1983), and rolling from supine to prone (Richter, 1985). Although the component model has previously only been used to describe body movements, the model can reasonably be adapted to describe the posture or movement of a child riding horseback. The practicality of using the component model described by Robertson (1977) to do research in the realm of horseback riding arises from the fact that riding instructors usually divide the body into the arms, the legs, and the trunk or body when instructing a student in the riding position to assume and methods to influence the horse.

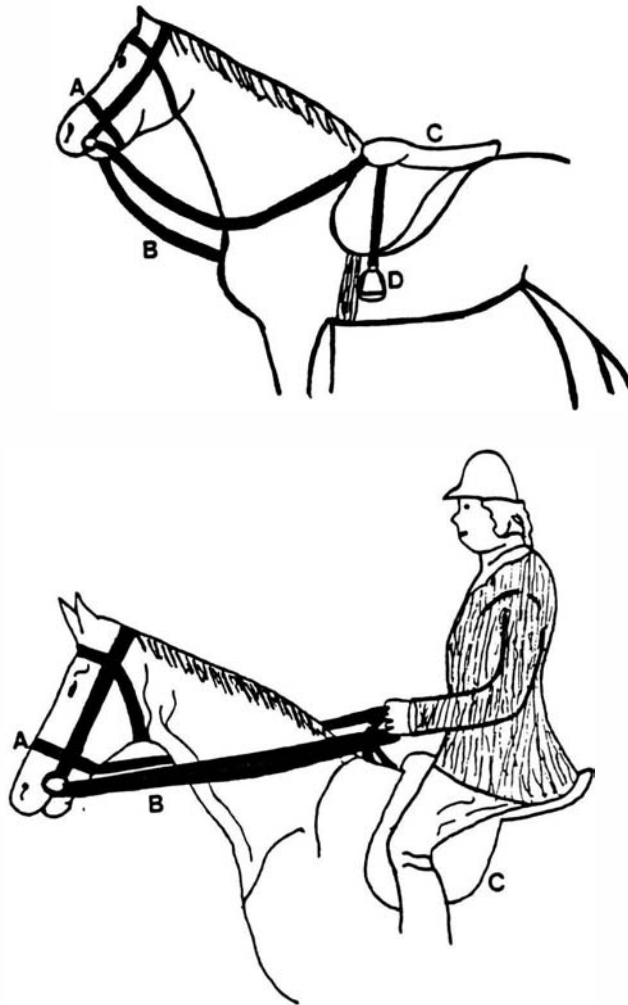
Statement of the Question

1. What are the postures and movements of normal children in an English saddle while riding a horse at a walk?
2. Are developmental sequences hypothesized from horseback riding literature valid for each of the three components of body posture and movement: the upper extremity, the lower extremity, and the head and trunk, within the task of English horseback riding at a walk?

3. What are the differences between postures and movements while English horseback riding at a walk of five year old children, seven- and eight-year-old children, and nine- and ten-year-old children with increasing experience levels?

Operational Definitions

1. Posture: A posture is the position of body segments with respect to each other that is exhibited by an individual.
2. English Horseback Riding: English horseback riding is a style of riding in which an English saddle and bridle are used and an English riding style (equitation) is employed (see Figure 1).
3. English Saddle: An English saddle consist of a wooden "tree" covered with leather which is placed on the horse's back and secured with a girth. There is no horn and the back of the saddle, or cantle, is low (see Figure 1).
4. Gait: Gait refers to the various natural patterns of locomotion exhibited by a horse. A gait is characterized by uniformity of movement (Heipertz, 1977/1981).
5. Walk: A horse's walk is a slow, flat-footed, four-beat gait in which each step action overlaps the stride length of the opposite leg by approximately half the length as the horse places his hind legs in



Equipment

- A. Bridle
- B. Reins
- C. Saddle
- D. Stirrup

Figure 1. English horseback riding equipment.

Note. Top figure from Horses and Ponies (p.40) by J. Campbell, 1972, New York: Bantam. Copyright 1971 by Grosset and Dunlap.
 Bottom figure from The Riding Instructor's Manual (p. 31) by G. Wright and M. Kelley, 1975, Garden City, NJ: Doubleday and Co. Copyright 1975 by G. Wright and M. Kelley.

the track of the front leg. The horse simultaneously lowers one and raises the other front leg (Heipertz, 1977/1981) (see Figure 2).

6. Component: A component is a region of the rider's body. The components selected for this study are the right upper extremity, the right lower extremity, and the head and trunk.

Assumptions

The assumptions for this study were:

1. Motor development proceeds in an orderly manner.
2. A developmental sequence within a motor task is related to both age and experience in the task.
3. The posture of the right and left sides of the body are symmetrical when English horseback riding at a walk.
4. Riding instructors of seven-, eight-, nine-, and ten-year-old children teach the same basic form of English riding.
5. The sex of a rider does not affect riding posture or movement.
6. The speed of the horse's walk does not affect the rider's posture or movement.

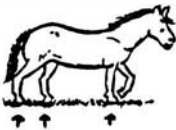
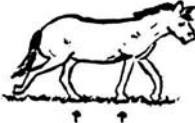

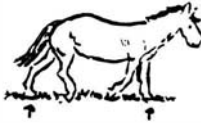
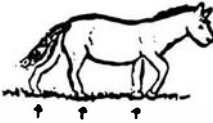
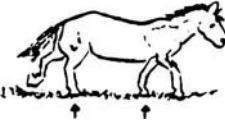
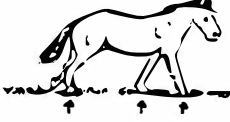

	1.	x	o	3-leg support
	2.	x	o	2-leg support, diagonal
	3.	x	x	3-leg support
	4.	x	x	2-leg support, lateral
	5.	x	o	3-leg support
	6.	o	x	2-leg support, diagonal
	7.	o	x	3-leg support
	8.	o	o	2-leg support, lateral

Figure 2. The horse's walk in eight phases.

Note. From Therapeutic Riding-Medicine, Education, Sports (p. 104) by W. Heipertz, 1977/1981, Ottawa, Canada: National Printers. Copyright 1981 by W. Heipertz.

Limitations

The limitations of this study were:

1. The study does not address posture or movement of the rider during other gaits of the horse.
2. The study does not consider other riding styles such as Saddle-seat or Western riding.
3. The study does not allow for generalization to other age groups.
4. The study does not consider the coronal plane posture or movement of the rider.
5. The study does not address the effect the sidewalker and leader might have on the riding posture or movement of the five year old children.
6. The size of the horse may affect the rider's posture and movement, but the size of the horse was not controlled in this study.
7. The length of the stirrup leathers affects the position of the lower extremities, but the length of the stirrup leathers was not controlled in this study.

Organization of Remaining Chapters

There are four remaining chapters in this thesis. Chapter II is a review of the literature concerned with English horseback riding, therapeutic horseback riding, motor development, and Robertson's (1977) component model. Chapter III describes the methods used in this study.

Subject information, materials used, and the data collection procedures are included as well as data analysis and reduction methods. In Chapter IV, the results found in this study are presented. Chapter V presents a discussion of the results and the conclusions of the study. Implications and recommendations for further study are given. In the final appendix (Appendix H), a publishable article summarizing the study can be found.

CHAPTER II

Review of Literature

This review of literature is designed to help the reader understand the theoretical basis and methods of this thesis. The review covers the realms of horseback riding, therapeutic horseback riding, motor development, and the theoretical basis for the method used. In a study in which children of various age and experience levels are observed horseback riding, a familiarity with horseback riding and motor development are important.

A section on equitation, the art of horseback riding, is presented first. In this section, detailed information about the rider's posture on horseback is provided. Next, a historical perspective of therapeutic horseback riding is provided. This is followed by a discussion of contemporary therapeutic horseback riding. This latter section presents a typical therapeutic horseback riding program. Then, research available on therapeutic horseback riding is reviewed.

The next section of the review of literature focuses on motor development including a brief historical overview. The interactionist theory of motor development forms the theoretical basis of this thesis. This theory is reviewed next. Lastly, the component model of movement analysis, along with a pre-longitudinal screening technique, is

presented. This study used this component model and the screening technique (Robertson, Williams, and Langendorfer, 1980).

Equitation

Equitation refers to the rider's position or posture on the horse. Equitation varies according to the style used, the movement the rider uses to maintain balance, and the cues the rider uses to control the horse.

There is no research investigating various riding styles, but there are numerous books written describing the equitation of a rider. In the following section, a general overview of equitation will be presented. A narrative description of the posture the rider uses in a basic balance seat will be provided. This description will include the position of the upper extremities, the lower extremities, and the head and trunk.

The different styles of horseback riding are related to the type of riding the rider will do and the type of training the horse has received. The two major divisions of riding styles are English and Western riding. Within the English style, there are various forms: (1) Saddle-seat, (2) Hunt-seat, and (3) Dressage.

Rider's "Seat"

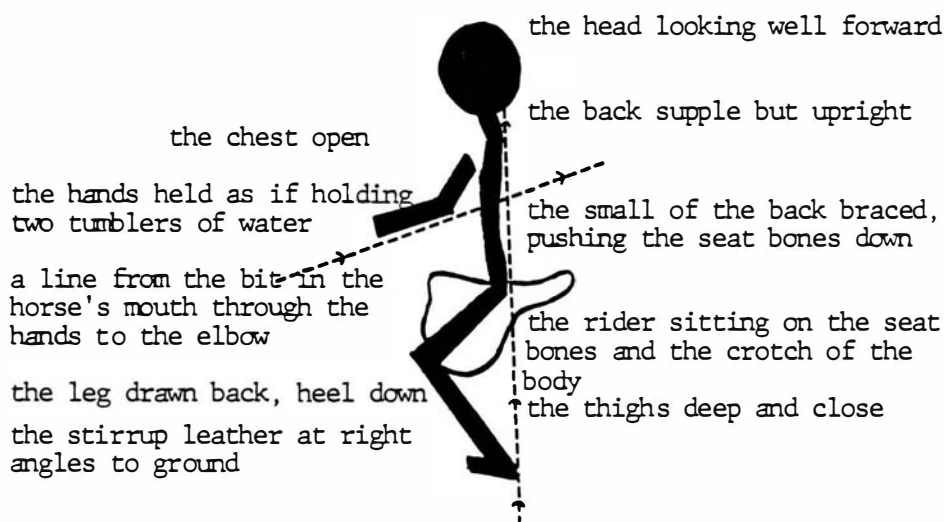
Within dressage, a basic balance seat is taught. A "seat" is defined as the rider's position as he sits on a horse. The rider adjusts his position to maintain equilibrium with the horse. Prince and Collier (1974) proposed that the "basic seat" is fundamental for all riding styles, and is just modified for the other forms of riding.

There are various opinions on what a rider's "seat" actually is or does. According to de Romaszkan (1937/1967), the "seat" a rider assumes or uses allows him to maintain a position when the horse moves. However, Froissard (1971/1979) proposed that it was the rider's "seat" which "encourages, promotes, accompanies, or opposes the movements of the horse" (p. 11). Another horseman, Kulesza (1966), suggested that the rider does not "sit" on horseback, but instead adopts a position which changes according to the horse's movement and allows the horse free natural movement while maintaining control. Even though there are various opinions about the rider's "seat", within all riding forms, the rider's objective is to remain on the horse in the most comfortable and energy efficient position attainable. However, a basic balance seat allows the rider to use a "minimum of muscular effort to remain in the saddle and ... interferes least with the horse's movements and equilibrium" (Ensminger, 1969, p. 768).

A rider is using a basic balance seat when an imaginary straight line can be drawn from the rider's ear, to the shoulder, to the elbow, to the hip, and on to the heel; i.e., the shoulder is parallel to the hip (Froissard, 1971/1979) (see Figure 3). In contrast, the Hunt-seat form of riding specifies that the rider's shoulder is in front of the hips; and in the Saddle-seat form of riding, the rider's shoulder should be behind the hip when a vertical line is drawn through the rider's hip.

Upper Extremity's Position

According to Coggins (1966), accepted standards in English riding style require that one rein is held in each hand unless double reins are used in which case two reins are held in each hand (see Figure 4). This differs from Western style riding where both reins are held in one hand and double reins are never used. In English riding, the rider's shoulders are drawn back with the arms dropping naturally into adduction with slight flexion. The elbows are bent forming an obtuse angle between the upper arms and the forearms (de Romaszkan, 1937/1967) (see Figure 3). A straight line from the bit of the horse's bridle, through the reins, hands, wrists, and forearms, to the elbows allows for efficient and effective control of the horse (Froissard, 1967). The wrists are held in "neutral" with the hands lightly placed around the reins with the thumbs



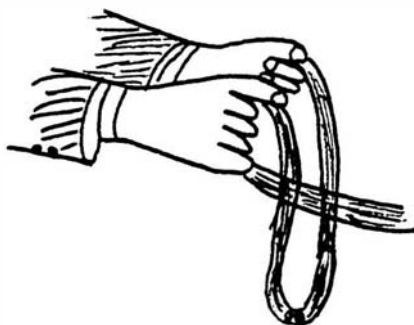
a line from heel, hip, and shoulder

(the lines are given to help in the maintenance of the correct position.)

Figure 3. Basic balance seat.

Note. From Progressive Steps in Riding (p. 32) by F. Chruchill, 1965, New York: Arco. Copyright 1964 by Blandford Press Ltd.

A. Single reins



B. Double reins



Figure 4. Correct way to hold single (A)
or double (B) reins.

Note. From Illustrated Horseback Riding for Beginners
(p. 72) by J. Mellin, 1972, North Hollywood, CA:
Wilshire. Copyright 1970 by Sterling Publishing Co.

pointing up. The hands are "held as if holding two tumblers of water" (Churchill, 1965, p. 30). de Romaszkan (1937/1967) stated that the distance between the hands and their height above the withers, the top part of the horse's shoulder right in front of the saddle, depended on: (1) the horse's head carriage, (2) the thickness of the horse's neck, (3) the width of the rider's chest, and (4) the type of rein action used. However, it is always stylistically inappropriate for the rider to rest the hands on the horse's neck or withers.

There are various opinions regarding the role of the hands while riding. Froissard (1971/1979) suggested that the hands shorten the horse's pace, halt the horse, and control the horse's direction. Museler (1937/1983) stated that steady hands are the mark of a truly advanced rider whereas de Romaszkan (1937/1967) proposed that the hands accompany the forward movement of the horse's head and neck with each stride. McTaggart (1951) suggested that the role of the hands was to reinforce what the rider's legs indicated to the horse.

Lower Extremity's Position

The lower extremities are a vital tool for the horseback rider as they are used to control the horse's hindquarters (Farshler, 1959). The thighs maintain contact with the saddle with the hips and knees flexed. The hips are adducted, but there should be no gripping of the knees.

The angle between the thigh and the leg varies according to the rider's leg and thigh length and the curvature of the horse's body (Museler, 1937/1983).

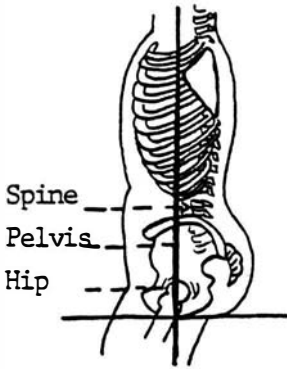
For basic balance seat type riding, the base of the stirrups should fall one-inch below the medial malleolus with the legs hanging freely (de Romaszkan, 1937/1967). The stirrups are placed under the balls of the feet. Even though all riders have heard the command "heels down", according to Froissard (1971/1979), the rider should actually raise his toes. Dorsiflexion is achieved in either case, but according to Froissard, if the heels are pushed down muscles around the knee and ankle joints contract, limiting free movement, whereas if the toes are raised, only one muscle contracts on one side of the joint, and therefore, allows for movement at the knee and ankle joints. With dorsiflexed and everted ankles, the proper contact of the rider's knee on the saddle would be established (Kulesza, 1966). As the rider looks down his leg, he should not see his toes out in front of the knee.

Head and Trunk's Position

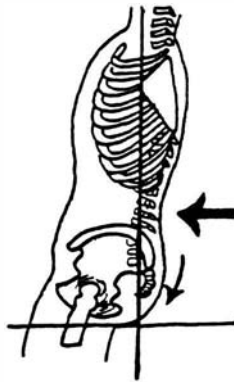
The head and trunk position are also vital in horseback riding as the rider uses his body weight and his trunk to influence the horse to change gaits (Farshler, 1959) and to maintain equilibrium with the horse (Museler, 1937/1983). The head and upper trunk position are also

important to the rider as their position can affect the entire body's position while riding. In the "correct" position, the head is held "erect" with the head straight, or in midline, and "clear of the shoulders" (Froissard, 1967). If the head is lowered, "everything goes wrong: the shoulders slump, the back hunches, the hands recede to your stomach, your seat moves towards the cantle, your legs advance and the changes of direction lose precision" (Froissard, 1971/1979, p. 10). The upper trunk is also to be held "erect" with the shoulders "squared", but the upper trunk should be "at ease".

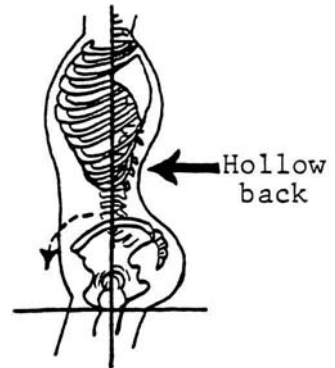
The abdominal and back muscles are active along with the gluteal and thigh musculature to allow the rider to remain in the saddle as the horse moves. The rider, sitting astride the horse, sits on his or her os ischii and os pubis allowing for the rider to adapt to the horse's movement (Heipertz, 1977/1981). It is proposed that the "hollow" back position, a back with an increased lordosis, is undesirable as the buttocks are forced out of the saddle (Museler, 1937/1983). In contrast, a "braced" back riding position is characterized by a decreased lordosis and the pelvis tilted posterior; therefore, the buttocks are pushed deep into the seat of the saddle (see Figure 5). Riding with a "braced" back prevents the rider's body from tilting forward and is considered the "correct" position according to Museler (1937/1983).



Normal back



Braced back



Hollow back

Figure 5. Back muscle action.

Note. From Riding Logic (4th ed.) (p. 17) by W. Museler, 1983, New York: Arco. Copyright 1973 by Eyre Methuen Ltd.

Equitation Summary

The rider makes the horse perform by using the reins and his body. With a good riding position, the rider is able to give precise, effective, and discrete commands to the horse by use of his upper and lower extremities, head and trunk, and body weight (Froissard, 1971/1979). The reins and upper extremities act to slow or stop the horse, the lower extremities act to urge the horse onward, and the body weight acts to turn the horse, with the back muscles acting as the link connecting the various influences (Museler, 1937/1983). Sensitive hands, legs, and "seat" working simultaneously allow the horse to perform to his rider's commands and are considered "good" equitation.

Therapeutic Horseback Riding

In this section, a historical perspective is presented first. This is followed by information concerning contemporary therapeutic horseback riding programs and the research in this area.

Historical Perspective

Horseback riding has been used to help disabled people for centuries. In the mid-1600's, Lord Thomas Sydenham, a physician in England, recommended horseback riding for patients with chronic conditions and loaned his horses for poor patients to ride (Licht, 1958). In 1875, Chassaigne of Paris conducted an experiment in which he used riding as treatment for various diseases and complaints (Bain, 1965).

Chassaigne concluded that riding was most beneficial in the treatment of hemiplegia, paraplegia, and other neurological paralyses. He noted improvements in individuals' posture, balance, joint movement, and muscle control.

Some medical gymnastics equipment and positions assumed by patients suggest an imitation of horseback riding. For example, the mechanotherapy devices of Zander, used in the late 1800's and early 1900's, included high plinths that resembled the horse's back in width and had boards on which to place the feet with the hips and knees flexed (Wide, 1902) (see Figure 6). The positions assumed resembled horseback riding and were called such things as "ride-sitting" and "hips firm-ride sitting".

Modern day therapeutic horseback riding began with Liz Hartel of Denmark. She brought therapeutic horseback riding to world-wide attention when she won a medal in the 1952 Olympics. Hartel was stricken with polio in 1943, but nine years later won a silver medal for her skill in dressage. She had ridden her horse as part of her rehabilitation. She stated,

A horse is not a machine or a piece of gymnastic apparatus. Although its movements are regular, they are, nevertheless, subject to variation and different situations can arise which force the rider to unconsciously use or attempt to use a group of muscles. (Heipertz, 1977/1981, pp. 180-181)

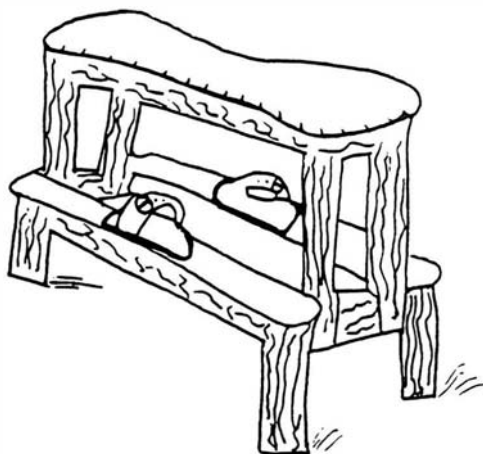


Figure 6. Gymnasium plinth.

Note. From Individual Gymnastics (2nd ed.) (p.23)
by L. C. Drew, 1923, Philadelphia, PA: Lea and
Febiger. Copyright 1923 by Lea and Febiger.

Contemporary Therapeutic Horseback Riding Programs

Contemporary therapeutic horseback riding programs began in this country in 1969. According to McCown (1972), a "therapeutic program has a two-fold purpose: (1) to use riding as therapy in addition to other forms of therapy, and (2) to make it as enjoyable as possible for the student" (p. 92).

There are 331 therapeutic horseback riding centers in the United States and Canada that are affiliated with NARHA (NARHA Handbook, 1985-86). Instructors involved with these programs work closely with medical professionals. First, a physician refers an individual to a physical therapist to be evaluated. Following the evaluation, the therapist consults with the riding instructor to outline a specific program for that student. Children and adults most often participating in therapeutic horseback riding programs include those with cerebral palsy, multiple sclerosis, muscular dystrophy, mental retardation, learning disabilities, cerebral vascular accident, closed head injury, amputation, paraplegia, blindness, and deafness.

The following information gives an overview of a typical therapeutic horseback riding class and the equipment used. Even though there are numerous articles on this subject, McCown (1972) is one of the foremost authorities in this country on therapeutic horseback riding. Her text is used as a reference for designing a

program in accordance with NARHA guidelines.

According to McCown (1972) a typical therapeutic horseback riding class lasts one hour and includes stable management and skills, horseback riding, exercises, and games on horseback. The stable management and skills section address such items as grooming, tacking the horse, i.e., putting on equipment, learning the parts of the horse's body and tack, and general care of the horse such as feeding, worming, and caring for the hooves. For older riders, business management of a stable is included.

The horseback riding part of the program consists of a standard English horseback riding lesson where the individual learns how to ride and control the horse (McCown, 1972). Riding is adapted to the disabled individual. Mounting and dismounting procedures using assisted transfers from the mounting ramp or ground are used as indicated. Also, mounting from the right side of the horse is allowed for those riders with hemiplegia or an amputation. The horse, too, is chosen with the special needs of an individual in mind. For example, mounting a tall horse is a difficult procedure for most riders. In order to make an individual as independent as possible, a horse is selected of appropriate height for mounting from the ground or ramp. The width of the horse also should be a consideration for those individuals with tight leg

muscles in order to prevent unnecessary stress.

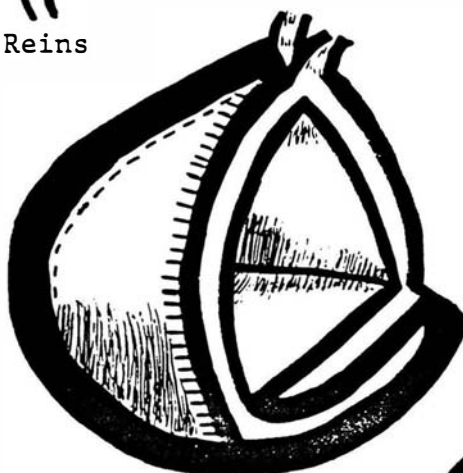
Equipment is also adapted as necessary. Examples of special adaptive equipment used in therapeutic horseback riding include: ladder reins, devonshire boots, hand holds, and safety belts. Ladder reins are used by students who have difficulty with their grasp (see Figure 7). Devonshire boots are stirrups which have a solid base for the ball of the foot and a leather covering into which the forefoot fits. These are used for students with tight heelcords or weak ankle muscles (see Figure 7). A hand hold is attached across the front of an English saddle so the rider has something to grip to help maintain his or her balance. Safety belts are placed on the rider to allow the sidewalkers to assist with balance as necessary.

In addition to the above adaptive equipment, safety stirrups and helmets are used. Safety stirrups are stirrups in which the outside of the stirrup is rubber instead of iron (see Figure 7). If a fall occurs, the rubber will allow for a quick release of the foot from the stirrup. A helmet is worn to protect the head in case of a fall.

A leader for the horse and two sidewalkers assist the rider as necessary during the riding lesson. The leader helps control the horse, and the sidewalkers help the rider maintain his or her balance. As the rider improves, the leader and the sidewalkers are eliminated.



Ladder Reins



Devonshire Boot



Safety Stirrup

Rubber
Release
Strap

Figure 7. Special equipment used in therapeutic horseback riding programs.

Note. From It's Ability that Counts (p. 57) by Lida McCown, 1972, Olivet, MI: Olivet College Press. Copyright 1972 by Cheff Center for the Handicapped.

According to McCown (1972) the riding instructor must be knowledgeable in horsemanship and able to convey this knowledge to the students. The instructor also needs to be familiar with disorders or disabilities of the students as well as medications students take and their side effects. The instructor confers with other professionals: the physical therapist, the occupational therapist, and possibly the physician, and then establishes individual goals for each rider and addresses each rider's individual needs.

When riding, a basic balanced seat is taught by the instructor. It is postulated that the balanced position compliments good standing and sitting posture because the trunk musculature is active during horseback riding to allow the rider to remain in equilibrium with the horse (Museler, 1937/1983). The rider aligns his vertical gravity line with the horse's center of gravity which "runs along a vertical line going through the withers" (Froissard, 1971/1979, p. 9). The rider learns to maintain his balance by adjusting his body to compensate for the horse's movement.

The standard riding class is directed towards English riding techniques and controlling the horse at the walk, trot, and canter. After this part of the class, exercises are performed (McCown, 1972). Exercises are used that emphasize balance, coordination, muscle function, posture,

and rhythm (Haskin, Erdman, Bream, & MacAvoy, 1974). After exercising, games are played which have therapeutic value. Many games address perceptual motor difficulties such as eye-hand coordination, crossing the body's midline, and left/right discrimination (McCown, 1972) (see Appendix A).

Research Related to Therapeutic Horseback Riding

In the following section, examples of descriptive and predictive research concerning therapeutic horseback riding are presented. In the first section, a summary of foreign research is presented. In the next section, three case studies of riders participating in therapeutic horseback riding programs are provided. The first case study goes into detail about the rider, but not about the riding program. In the other two case studies, the riding program is emphasized. Then, following the case studies of the riders, there are two other examples of descriptive research on therapeutic horseback riding. The first example concerns a pilot handicapped riding program. The second one provides insight into the riders' feelings about their "motivation", "courage", "confidence to physically move", and "positive mental-physical reaction". In the last section, one predictive research study is presented. This study, conducted by the Department of Aerodynamic Engineering at the University of Colorado, is the sole example of predictive research on therapeutic riding that

is known to have been performed in the United States.

Foreign Literature

Most of the foreign literature seems to deal with hippotherapy instead of therapeutic horseback riding. In one abstract, "Motor Goals of Therapeutic Horseback Riding for Cerebral Palsied Children " (Feldkamp, 1979), motor problems of children with cerebral palsy are presented. The author's purpose was to survey current opinions of the benefits of therapeutic horseback riding for children with cerebral palsy. Feldkamp suggested that many motor difficulties of cerebral palsied riders cannot be solved by horseback riding, and that the professionals involved can only speculate if horseback riding can positively effect movement problems. If horseback riding is shown to be beneficial, Feldkamp proposes it must be due to the psychological aspects of riding.

An abstract entitled "Scientific Fundamentals of Hippo- and Riding Therapy: A Compilation of Study Results" by Rieger (1978), reports that the benefits of hippotherapy and riding therapy using gymnastic exercise were studied via electromyography, videotapes, and motor tests for balance and coordination. The purpose of the survey of studies was an attempt to document the benefits of hippotherapy for insurance companies so that therapists might be reimbursed for these types of treatments. The various methods used to document the benefits of riding and

hippotherapy included videotape, coordination tests, and electromyography. For example, in one study, cerebral palsied riders were reportedly filmed to show the influence of riding on posture, pelvic position, and balance reactions. A long-term study was said to have shown lasting improvements in motor as well as intellectual ability with motivation considered to be the "driving force".

Descriptive Studies of Therapeutic Horseback Riding

Saywell (1975) presented the case history of Sharon. Sharon appeared normal at birth, but at eighteen months, her walking was slow and deliberate. She was diagnosed as having a severe case of ataxia-telangiectasia and was treated with L-dopa. However, it was reported that her condition continued to deteriorate.

Sharon did not start horseback riding until she was twelve years old. According to Saywell, at that time, she was unable to stand, had spastic adduction of the legs, and continuous involuntary movement. She was overweight and had "psychological problems". Sharon could not feed herself. She was also unable to sit in a wheelchair without a fixed belt.

Sharon was mounted onto the horse using a total body lift. Initially, she needed assistance from side helpers to stay in the saddle. Reportedly after the first twenty

minutes, Sharon sat comfortably and wanted to continue horseback riding.

Her weekly riding session varied from ten to forty minutes. The author reported that after three "terms" of riding, Sharon could stand long enough to mount from the ramp. Later, she reportedly walked up the ramp while being supported on either side and mounted the horse. Saywell wrote that Sharon progressed to being able to handle the reins. Her "psychological problems" of withdrawal and being uncommunicative with strangers reportedly were overcome as she and the volunteers interacted. She passed the first of a series of nationally recognized tests that have been established by the Riding for the Disabled Association in England. This test includes riding the horse at a walk and simple points of the horse and tack. The article stated:

Undoubtedly L-dopa medication has enabled her to develop her abilities...and it cannot be claimed that her improvement is entirely due to riding or that riding will maintain it. (p.335)

However, according to Saywell, Sharon enjoyed riding, giving her incentive to improve her physical skills and allow for social interaction even if riding did not affect her motor abilities directly.

Haskin et al, (1974), provided details about their riding program before presenting several case studies. This riding program followed the guidelines established by

the British Riding for the Disabled Association. Children with various disabilities enrolled in these programs ride and do exercises for balance, strength, coordination, posture, and rhythm. The riders perform the exercises at a standstill, a walk, and a trot. The riders are said to learn balance and suppleness and the ability to influence a horse with their feet, the rhythm and motions of their body, as well as with the reins. The authors pointed out that the riders improve psychologically because: (1) the treatment is not presented in a traditional treatment setting, and (2) they are able to participate in a sport as "normal" children do.

In one case, a seven year old girl was described as being unable to hold up her head or walk alone. After six months of riding, she reportedly rode with a straight back with her head "bobbing only slightly" and was "independent on crutches". A second case concerned a seven year old boy who could only walk four steps with his crutches at the beginning of horseback riding lessons. According to the authors, after six months, he was able to walk four blocks using only one crutch or no crutches at all. The authors did not supply information about the number of weekly riding sessions, the length of the riding sessions, or if the children were concurrently receiving any other therapy.

Wingate (1982) described a pilot riding program for children with cerebral palsy. This program probably

represented a pilot program for a specific geographical region, as therapeutic horseback riding programs in general have been described in greater detail by authorities such as McCown (1972) and Davies (1967).

The purpose of Wingate's (1982) work was to design a program to "demonstrate the effectiveness of horseback riding in promoting both socially integrative and physically therapeutic benefits" (p. 184). Wingate felt a riding program should allow:

(1) objective evaluation of the participant's physical function both before and after the program's implementation, and (2) a measure of the participant's eventual activity in a riding program with non-handicapped children. (p. 184)

Seven patients with cerebral palsy rode twice weekly for five weeks. The riders ranged from age six to sixteen. Hard hats, safety belts, English saddles, sidewalkers, and a leader for the horse were used. Exercises were performed to promote "strengthening of midline muscles" and "good balance and posture".

Parents of four children reported that they observed physical improvements during the pilot program. In the parents' written evaluations, they wrote "that all of the children had enjoyed the program immensely, were unaware that they were receiving therapy, and had an improved self-image" (Wingate, 1982, p. 185). All the parents believed that the program was beneficial and should be continued.

The author mentioned that the pilot program could form the basis of a broader study in which the effectiveness of therapeutic horseback riding might be measured more objectively. Surprisingly, this pilot program lacked a physical therapy evaluation. The author's stated criterion for riding programs, to objectively evaluate the rider's physical function before and after the riding program, was not met. Wingate wrote "this project did not have the breadth to provide the physical examination component" (p. 184). This criterion is also a part of the NARHA guidelines: a physical therapy evaluation is required for all physically handicapped riders.

It appears that Wingate did not utilize the available resources concerning therapeutic horseback riding, such as NARHA, United Cerebral Palsy, or the National Easter Seal Society. These organizations could have provided information or referral to other authorities on therapeutic horseback riding.

Parents' written evaluations, done after the riding program, were the only measurement tool used in Wingate's pilot project. As the reader is not provided with a sample evaluation form, it is not possible to determine if the research question was addressed in the parents' survey. A subsequent study planned by Wingate reportedly will include a videotaped gait analysis with surface electromyography electrodes placed on lower extremity muscle groups of the

children before, during, and after the program. A two-month follow-up was also planned.

A study by Rosenthal (1975) was designed to document psychological benefits reported by riders, such as increased self-confidence, courage, or motivation, in addition to the pleasure of riding. This study of riding was based on "risk exercise" theory. Rosenthal (1975) suggested that risk exercise is necessary for our well being. Early man had to fight daily for survival, and Rosenthal proposes that modern man still has this basic need or instinct to encounter risk daily. He suggested that mankind today is operating below his capacity due to the lack of risk exercise, and that those individuals with disabilities even more so. In other words, there is a decrease in "courage" and "motivation" because of the lack of opportunities for risk exercise. Horseback riding provides the disabled with a risk exercise which Rosenthal felt was necessary for well being.

Questionnaires were completed by professionals for the participants from ten programs that included horseback riding with handicapped individuals (Rosenthal, 1975). One hundred and two individuals, participating in the horseback riding programs, were surveyed. They ranged in age from four to sixty-seven with 75% being between the ages of five and fifteen. Information concerning the standards of the

riding program, i.e., if the riding programs all followed the same protocol or were part of a national organization with set guidelines, was not provided.

Individual's feelings towards their handicap showed that 90% had a "reasonable outlook" about their disability. The subjects' "confidence to physically move" response showed that 68 of the subjects were self assured and that 32 of the subjects were unsure about moving.

Approximately 50% of the subjects reported they were afraid when they started horseback riding (see Table 1). Within two years only 6% remained frightened. However, many riders enjoyed riding from the beginning, and the enjoyment increased with learning and experience in the saddle.

After participating in horseback riding, 67% of the subjects reported a "good" mental reaction and 25% reported an "elated to euphoric" mental reaction after zero to six months of riding, whereas in those subjects riding two years or more, 29% had a "good" reaction and 64% had an "elated to euphoric" mental reaction after riding (see Table 2). The reader is not supplied with information concerning when this reaction occurred: i.e., immediately after that day's riding class, or after the months of riding. "The sum total was that in 90% or better, the effect of risk exercise sport was a positive one on the general attitude of the subjects throughout the study

Table 1
The Element of Fear Associated with Risk Exercise Sports
 (N=97)

Length of Participation		Number and Percent Frightened by Participation	
		YES	NO
zero to six months	Number	6	8
	Percent	43	57
six months to one year	Number	8	39
	Percent	17	83
one year to two years	Number	6	12
	Percent	33	67
over two years	Number	1	17
	Percent	6	94

Note. From "Risk exercise and the physically handicapped" by S. R. Rosenthal, 1975, Rehabilitation Literature, 36(5), p. 144-149.

Table 2
Subjects' Mental Reaction after
Participation in Risk Exercise Sports
 (N=93)

Length of Participation		Depressed-Indifferent	Good	Elated-Euphoric
0-6 months	# %	1 8	8 67	3 25
6 months to 1 year	# %	4 9	27 59	15 33
1 year to two years	# %	2 11	10 56	6 33
over 2 years	# %	1 6	5 29	11 64*

*0-6 months vs. 2 years+, $p=.02$

Note. From "Risk exercise and the physically handicapped" by S. R. Rosenthal, 1975, Rehabilitation Literature, 36(5), p. 144-149.

period" (Rosenthal, 1975, p. 146).

Sixty percent of the subjects reported a "moderate to marked" increase in their "mobility" during the first six month period of riding (see Table 3). This percentage then dropped to 45% for riders during the second six month period. Seventy-one percent of the riders who had ridden for over two years reported increased mobility which was found to be significant ($p=.04$) in comparison to the six to twelve month group of riders.

Subjects also reported an increase in "motivation" during the first six months of riding (91%) which then waned (44%), but then increased again over time to 71-80%. Rosenthal proposed the fluctuation in "motivation" was due to the enthusiasm of the rider at first learning a new sport and then having to work on improving his or her skills.

Ninty-seven percent of the subjects wrote they had a moderate increase in "courage" at the beginning of riding lessons. This decreased to 67% as riders' became frustrated with their handicap hampering their riding ability. Once again, with time and practice, the percent of subjects reporting a moderate increase in "courage" rose (94%).

Seventy-five percent of the subjects reported a "positive mental-physical reaction" during the early phases of riding. For those riding for longer periods of time,

Table 3.

Effect of Risk Exercise Sports on the Subjects' Mobility

(N=87)

Length of Participation		Slight	Moderate
zero to six months	# %	4 40	6 60
six months to one year	# %	24 55	20 45
one year to two year	# %	5 31	11 69*
over two years	# %	5 29	12 71*

* six months to one year versus one year to two years, $p=.06$;
 six months to one year versus over two years, $p=.04$

Note. From "Risk exercise and the physically handicapped" by S. R. Rosenthal, 1975, Rehabilitation Literature, 36(5), p. 144-149.

88% experienced a "positive mental-physical reaction" (see Table 4). The length of time that the "positive mental-physical reaction" lasted changed from 58% in the zero to six month period to 6% in the over two year period for those subjects reporting a short-term positive effect; whereas for those reporting a long-term positive reaction, there was an increase from 42% in the zero to six month period to 94% in the over two year period ($p=.001$). However, the reader is left to draw his own conclusion about the definition of a "positive mental-physical reaction".

Predictive Research on Therapeutic Horseback Riding

A study on therapeutic horseback riding, carried out at the University of Colorado, represents the first known attempt in the United States to investigate physical effects of therapeutic horseback riding. The purpose of the research was to develop an instrument that would allow for "reliable measures of the physical and psychological benefits associated with programs of rehabilitation" (Fox, Lawlor, Luttges, 1984, p. 30). Horseback riding was chosen as the rehabilitation program because riding has been suggested to improve sitting balance, coordination, and strength. Riding was also selected because riding instructors teach specific exercises and games which address areas of individual needs and also because riding allows for evaluation of a rider's social and psychological

Table 4
Time When Positive Change in Subjects'
Mental-Physical Reaction Occurs
 (N-85)

Length of Participation		During Participation	Shortly Afterwards	Long Afterwards
zero to six months	# %	9 75	2 17	1 8
six months to one year	# %	29 74	7 18	3 8
one year to two years	# %	10 59	7 41	0 0
over two years	# %	15 88	2 12	0 0

Note. From "Risk exercise and the physically handicapped" by S. R. Rosenthal, 1975, Rehabilitation Literature, 36(5), p. 144-149.

status.

Nineteen riders, seven to fourteen years old, were subjects for this study. Their medical diagnoses ranged from cerebral palsy to mental retardation. All were participating in a therapeutic riding program at the time of the study.

An apparatus was designed by the investigators and used to test "balance and coordination" and "strength" (see Figure 8). It consisted of a balance beam attached to the "slider" of a potentiometer which translated movement of the balance beam into electrical resistance. A grooming brush, stirrup, or rein could be attached to the balance beam. A small horse figure was attached to the top of a scale to give a visual cue in guiding the horse straight. Visual feedback was provided to the subject through the use of this scale with a pointer and a floral display which lit up during balanced periods. Auditory feedback was given by a voltage-frequency converter from the potentiometer which produced sound of progressively higher frequency as the subjects deviated from the balanced position. Either type of feedback, visual or auditory, could be discontinued if it was distracting to a subject.

Each subject participated in two ten-minute testing sessions; one before and one after a two hour riding lesson. The "balance and coordination" test consisted of three tasks "designed to evaluate the subjects' ability to

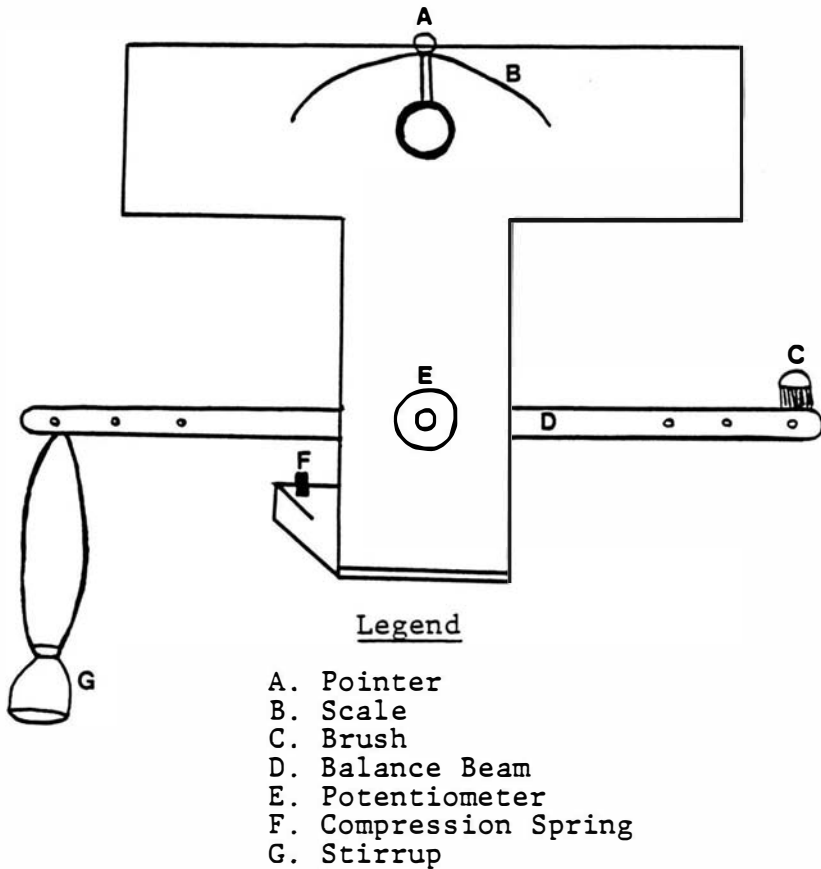


Figure 8. Apparatus designed by the University of Colorado Aerodynamic Engineering Department.

Note. From "Pilot Study of Novel Test Instrumentation to Evaluate Therapeutic Horseback Riding" by V. M. Fox, V. A. Lawlor, and M. W. Luttges, 1984, Adapted Physical Activity Quarterly, 1, p. 32. Copyright 1984 by Adapted Physical Activity Quarterly.

attain an accurate positioning and control of the balance beam" (Fox et al, 1984, p.33). The first task, "use of hands/arms in pulling", required the subject to hold the reins and steer the horse figure straight. Each ten-second trial started with the horse deviated to the left or right. In the second task, "use of hands/arms in pressing", the subject's hands were placed in the brushes, and instructions given to bring the pointer into the target zone by balancing the beam. The third task, "use of legs in balance and coordination", required the subject to use his legs to balance the beam therefore bringing the pointer from the left or right side of the board into the target area.

According to the researchers, the "strength" tests were designed to evaluate the extent to which subjects could retain a stable riding position (Fox et al, 1984). In the first task, "use of hands/arms", the subject pushed the brushes that were on the beam down as hard as possible for a five-second period. Two trials were done with the right and left hand simultaneously. For the second task, "use of legs", the student was required to push into the stirrup as hard as possible for the five-second trial. Two trials were performed with measurements recorded via the potentiometer.

The researchers recorded personal data from the subjects such as:

measurements of the spine from C7 to S4, shoulder length from C7 to the left and right acromion process, tilt of the left shoulder in relation to the right one, and spinal curvature, determined by pressing a flexible curve along the spine. (p. 34)

Posture was examined in terms of "straightness" using the spinal curve measurements. Data analyses for "balance and coordination" and "strength" were done using group means to compare before and after riding. The posture analysis and the spinal curve measures were compared to "normal posture" described by Kendall, Kendall, and Boynton (1952).

The results showed that there had been an increase of 18.6% in pre-test to post-test scores of the group in accurately positioning the balance beam after the 90-120 minute riding lesson. For the "strength" testing, there was an increase in the group of subjects' arm "strength" measurements of 8.1% and an increase in leg "strength" measurements of 13.1%. The posture analysis showed an 18.0% improvement towards a more normal spinal curve.

The apparatus designed for this study has been reported to be portable and can be C-clamped to any table (Fox et al, 1984). It can be used for wheelchair bound as well as ambulatory individuals. The study could have been improved by testing a group without disabilities to assess differences in "balance and coordination" and "strength" of non-disabled individuals in pre-test and post-test scores.

Knowledge of how long the riders had been enrolled in a riding program prior to their participation in the study would be useful in assessing what role conditioning and/or fatigue played in the test score. Using an one hour class instead of a 90-120 minute riding class would have provided more valid information because most therapeutic riding sessions last one hour.

Therapeutic Horseback Riding Summary

Therapeutic horseback riding has a very long history. Contemporary therapeutic riding became popular when Liz Hartel of Denmark, a polio victim who rode her horse as part of her rehabilitation, won a silver medal in the 1952 Olympics. There are currently 331 centers in the United States and Canada associated with NARHA. These programs teach individuals with disabilities how to ride a horse. The physical therapist consults with the riding instructor on special equipment, mounting procedures, exercises, and games for the disabled rider.

Research concerning therapeutic horseback riding has focused on individual programs and the benefits of therapeutic horseback riding with little or no objective findings on these proposed benefits. Case studies and other descriptive literature has been concerned with describing programs and citing examples of riders' progress, either physically or emotionally. Predictive

research carried out at the University of Colorado showed that handicapped persons demonstrated an increase in "balance and coordination" and "muscle strength" after riding.

Motor Development

In this section on motor development, theoretical concerns and the effect of the environment on motor behavior will be addressed.

Theoretical Concerns

The present study employed developmental theory as a foundation for research. For this thesis, motor development was defined as an orderly sequence of changes in motor behavior as an organism interacts with its environment (Wickstrom, 1977). There are numerous motor development theories, all of which suggest the presence of developmental sequences. Two common theories are maturation theory and interaction theory.

Maturation is a process which refers to changes in the "underlying physical structures which make it possible for a structure to begin functioning or to function at progressively higher, more complex levels" (VanSant and Newton, 1985, p. 35). According to maturation theory, the environment does not determine sequences of motor

development. For example, Gesell (1940), a maturationist, wrote:

Environment inflects preliminary patterns; it determines the occasion, the intensity, and the correlation of many aspects of behavior; but it does not engender the basic progressions of behavior development. These are determined by inherent, maturational mechanisms. (p.13)

Shirley (1931), also a maturationist, hypothesized that motor development was a function of age and proceeded in an orderly and predictable sequence. She proposed that the rate of development was variable within individuals. Shirley wrote "that each baby progresses through the stages in the same order regardless of the speed at which he is developing" (p. 52).

In contrast, the interactionist theory of motor development, focuses on the organism's interaction with the environment as a cause of behavioral change. McGraw (1935), an interactionist, hypothesized that motor development was related to age, but not determined by age as proposed by Shirley (1931). As an interactionist, McGraw felt that the nervous system and the environment interacted to produce an appropriate behavior; that they were both facets of the fundamental process of growth and development. Although motor development theorists have various views of the role of the environment and the organism, all agree that developmental sequences exist.

For the present study, an interactionist developmental view is used as a theoretical basis for an analysis of children horseback riding at a walk. The three groups of children: five year old children who had never received formal riding lessons, seven- and eight-year-old children who had received six months or less of formal riding lessons, and nine- and ten-year-old children who had received seven months or more of formal riding lessons, had different amounts of exposure to "correct" riding form. By having three age groups with varied amounts of formal riding lessons, the differences in motor development levels may be attributed to the interaction between the individual and his environment; i.e., experience through formal riding lessons.

The Effect of the Environment on Motor Behavior

Since the present study is based on interactionist theory, both the age of the child and the time in formal riding lessons were taken into account. Therefore, the effects of training on motor performance is an issue.

McGraw's (1935) classic study of twin boys, Johnny and Jimmy, addressed childrens' motor performance and experience or practice. The purposes of her study were:

- (1) to study the process of development as it is manifested in the growth of particular behavior-patterns of the human infant and (2) to evaluate the influence of exercise or use of an activity upon its development. (p.22)

In her indepth study, the twin boys were brought into the laboratory five days a week from nine in the morning to five in the afternoon. Johnny was chosen to participate in the "intensive special daily exercise in particular activities because he was considered the 'weaker and less responsive baby'" (p. 40). Therefore, Jimmy, the more developed and responsive of the twins, was cast into the "passive" role which meant he was placed in a crib daily. The crib was behind a screen in a clinic nursery. He was never allowed more than two toys at a time and was left alone in his crib except for routine handling. Johnny, on the other hand, was exposed to many activities. McGraw studied two types of motor skills and wrote that a:

distinction has been drawn between those behavior-patterns of the human infant which are phylogenetically significant and those which are of ontogenetic origin. Phylogenetic activities are those which have functioned in the development of the species...Ontogenetic activities are those which an individual may or may not attain. (p. 42)

Activities such as rolling, crawling, creeping, sitting, erect locomotion were all considered phylogenetic activities, whereas diving, swimming, ascending and descending inclines, getting off of stools, and skating, were considered ontogenetic activities.

McGraw placed Johnny in situations in which he interacted with the environment, but she did not provide instruction for the "correct" way to perform an activity. For the phylogenetic activities, Johnny was stimulated to

perform phylogenetic behaviors whereas Jimmy was not. McGraw compared the boys development daily to examine developmental behavior patterns and the effects of exercise and repetition for both the phylogenetic and ontogenetic activities. McGraw found that in spite of the increased stimulation for Johnny, both boys achieved phylogenetic behavior patterns at approximately the same time; or that Jimmy, the untrained twin, was ahead of his brother in development of phylogenetic skills. In ontogenetic skills, such as swimming and diving, Johnny showed significant improvement in his performance during the time period in which he practiced. McGraw felt the reason for the improvement and for a cooperative attitude was due to "his more extensive experience in the situation" (p.136).

In comparing Johnny's and Jimmy's performance going up and down inclines, she wrote:

Johnny's experience through daily practice facilitated his development in these activities and Jimmy's lack of experience reduced his performance to something a little below that of other untrained infants of corresponding chronological age who had not been given special stimulation in this activity. (p. 147)

In other behaviors, such as roller skating, jumping off of stools or pedestals, and manipulation of stools, experience led to improved performance in Johnny in comparison to his brother Jimmy who was not afforded the opportunity to interact with his environment because he was

in the crib during the day while Johnny was stimulated.

Based on McGraw's concept of ontogenetic and phylogenetic skills, horseback riding is an ontogenetic activity. In this study the five year old children did not have experience riding as the older children did through riding lessons.

Motor Development Summary

Motor development theories, such as maturation and interaction theories, have developmental sequences as an integral part of the theory. The proponents of the maturation theory feel that the environment does not determine motor development whereas the proponents of the interactionist theory feel that development is age related, not age determined. McGraw (1935), an interactionist, did an in-depth study of twin boys, Johnny and Jimmy. In her study, one twin, Johnny was given numerous opportunities to interact with the environment and to practice various phylogenetic and ontogenetic skills, whereas, Jimmy, was left in his crib except for routine handling. The results of her study showed that experience led to improved performance within ontogenetic skills.

Methodological Issues

All motor development theories suggest developmental sequences. There are two types of motor development sequences: inter-task and intra-task developmental sequences (Robertson, 1978). Inter-task developmental

sequences outline the order of accomplishment of different tasks. Shirley (1931) studied inter-task development as she described the motor behavior of infants during the first two years of life. For example, she studied the sequence of motor behavior leading to walking: the children rolled before they sat up independently or crawled, and most of these activities occurred before the children walked.

In contrast, intra-task developmental sequences describe behavioral changes within a specific task. McGraw (1963) studied intra-task development as she described developmental phases within tasks such as rolling or swimming. For example, within the task of rolling from supine to prone, the infant goes through four phases termed: newborn, spinal extension, automatic rolling, and deliberation. This study of children's horseback riding represents an attempt to identify an intra-task developmental sequence.

In addition, the component model of intra-task motor development as proposed by Roberton (1977) has been used. The component model is based on the division of the body into regions called components (Roberton, 1977). She proposed that developmental change occurs at various rates throughout different regions of the body (Roberton, 1978). Roberton (1978) and her students, Williams (1980),

Langendorfer (1980), and VanSant (1983) have all used the component model to identify motor development sequences within motor tasks. They used film analysis of a task to form descriptions of different movement patterns believed to be developmental steps within each component for a given task. Then these categorical descriptions of movement patterns were ordered into developmental sequences using a variety of methods.

Robertson, Williams, and Langendorfer (1980) described a screening technique using cross-sectional data to test a hypothesized developmental sequence for a given task. One assumption they made about the task was that motor development was age related (A. VanSant, personal communication, March 1986). When using this screening method, the researcher first hypothesizes a developmental sequence for the selected task (Robertson et al, 1980). By graphing a proposed frequency of occurrence of developmental steps with respect to time, the hypothesized developmental sequence is portrayed (see Figure 9: Hypothesized Sequence). This affords visualization of a developmental sequence. If the sequence is correctly ordered, early appearing steps of the sequence, or movement patterns within body components, would be exhibited most frequently by the children at the youngest age studied. For the older children, the reader would expect a decrease in the early steps' frequency of occurrence and an increase

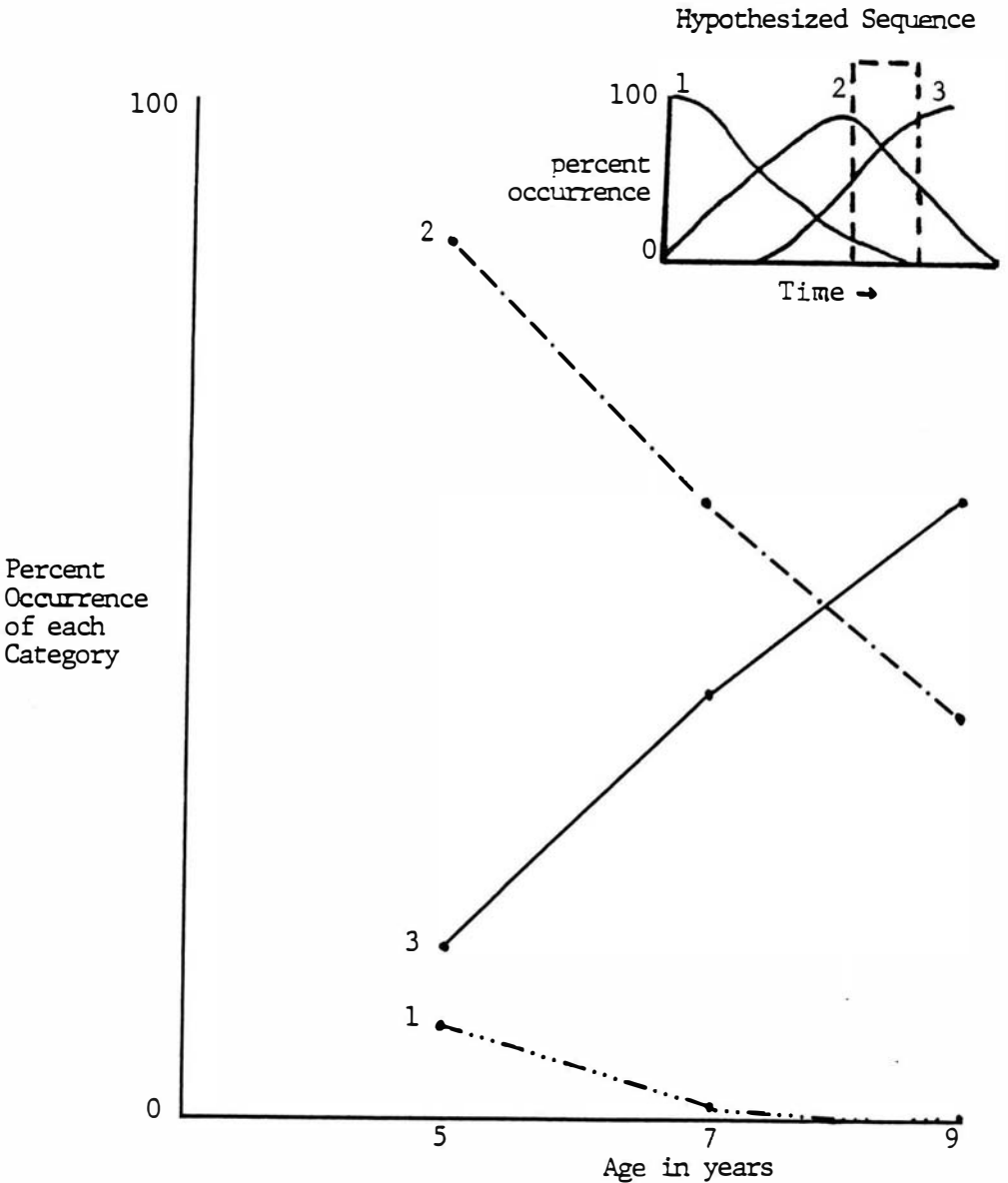


Figure 9. Graphs of hypothesized sequence of development of component categories and observed frequency of occurrence of component categories at three ages.

Note. From "Pre-longitudinal Screening of Motor Development Sequences" by M. A. Robertson, K. Williams, and S. Langendorfer, 1980, Research Quarterly for Exercise and Sport, 51 (4), p. 728. Copyright 1980 by Research Quarterly for Exercise and Sport.

in the frequency of later appearing steps of the sequence. The hypothesized longitudinal relationship between age and frequency of occurrence for each developmental step can be graphed (see Figure 9), and then compared to actual observed cross-sectional data to determine if the sequence is correctly ordered.

In using the screening technique for a three-step or three-level sequence, age groups should be chosen that fall within each one-third of the proposed longitudinal graph (Robertson et al, 1980). The researcher collects cross-sectional data for the age groups chosen. Graphs of the frequency of occurrence of each step at each age are used to illustrate "observed" age differences for each sequence. The graphs of "observed" age differences are then compared to the hypothesized graph. The ordering of the steps is assessed as is the form of the frequency curve. A close fit between observed and hypothesized graphs enable the formulation of a hypothesized developmental sequence for each component. For example, in Figure 9, the observed frequency of occurrence closely resembles the boxed-in area of the hypothesized form of developmental change. The observed data revealed that for this component, at age seven, the frequency of step one is approximately zero, category two's frequency is decreasing, and category three's frequency is rising. This supports the ordering of the hypothesized developmental sequence.

If the frequency of category three was declining and category one was rising, the hypothesis of the sequence of development within the arm component would have to be rejected.

This screening technique can be used for any sequence. There are two concerns however, when using the cross-sectional screening procedure (Robertson, 1980). One concern is subjects may be so variable in when they attain a level that hypothesizing a developmental sequence is of little value. For example, if 10, 12, and 15 year-old children are at the same level of development as five year old children, then hypothesizing a developmental sequence would be futile. The second concern occurs in choosing what ages to study or the size of the age intervals. For example, in a skill in which change occurs rapidly, a small age interval such as six months instead of a year would provide more accurate information about the developmental sequence.

Using Robertson's (1977) component method to analyze videotapes of children riding horseback allows for a more comprehensive description than is usually found in whole body movement descriptions. The screening technique used by Robertson, Williams, and Langendorfer (1980) permits the use of cross-sectional data to form a hypothesized developmental sequence for a given task. These techniques

have been employed within the methodology of this study.

Methodological Issues Summary

According to Robertson (1977), there are two forms of motor development sequences: inter-task and intra-task sequences. In the present study, an intra-task motor development sequence is proposed. This means that behavioral changes within a specific task, children's horseback riding, are described. Robertson (1977) proposed a component model of intra-task motor development. In this model, the body is divided into regions called components, and the descriptions of different motor patterns within a component within a given task are described. These are then placed into a developmental sequence. A screening technique using cross-sectional data can then be used to test the hypothesized developmental sequence for a given task by comparing an observed frequency of occurrence of component categories at different ages with that hypothesized to occur over time (Robertson et al, 1980).

Summary

In the review of literature, numerous topics have been addressed within the realms of horseback riding, therapeutic horseback riding, and motor development. The idea of the "correct" basic balance seat of riding comes from many "how-to" books on the subject, but no research has been found on the equitation of horseback riders. The old adage "head up, heels down" is still advocated as

proper form along with thumbs up, arms close to the rider's side, trunk "erect", and not "seeing your toes when you look down at your knee".

For the 331 centers in the United States and Canada teaching therapeutic horseback riding, the lack of research is as well recognized as are the numerous testimonials of the benefits of riding. The research that exists on therapeutic horseback riding is predominantly descriptive in nature, with most of the foreign literature dealing with hippotherapy. Case studies and surveys have been carried out which have been used to address the proposed benefits of improved posture, balance, muscle function, self-esteem, confidence, and motivation of handicapped riders.

One study conducted at the University of Colorado, attempted to measure some of the proposed physical benefits of riding by means of a balance beam on which appliances could be attached. This was connected to a potentiometer so objective measures could be obtained. The results showed an improvement in the disabled riders' "balance", "coordination", "strength", and "posture".

Motor development theory was reviewed as an interactionist view of motor development is employed here as a foundation for research. McGraw's (1935) study of Johnny and Jimmy addressed the relationship between the environment and the young child as well as the effects of

practice of an activity on the rate of development. Both phylogenetic and ontogenetic activities were compared. One boy received training and the other did not. It was found that the twins' performance did not vary significantly in phylogenetic skills, but that in ontogenetic activities, the trained twin had improved performance in comparison to his brother. Horseback riding is an example of an ontogenetic skill.

Robertson's (1977) component model of movement analysis has been used for a variety of motor tasks. Robertson's et al (1980) pre-longitudinal screening can be used to determine if a developmental sequence is ordered correctly.

CHAPTER III

Methods and Procedures

In this chapter information concerning subject characteristics, methods of data collection, and procedures used to reduce and analyze data are presented.

Research Questions

The research questions proposed for this study were:

- (1) What is the posture and movement of normal children in an English saddle while riding a horse at a walk?
- (2) Are developmental sequences hypothesized from horseback riding literature valid for each of the three components: the upper extremity, the lower extremity, and the head and trunk, of body posture and movement within the task of English horseback riding at a walk?
- (3) What are the differences between posture and movement of three groups while English horseback riding at a walk: five year old children who have never received formal riding lessons; seven- and eight-year-old children who have received six months or less of formal riding lessons; and nine- and ten-year-old children who have received seven months or more of formal riding lessons?

Subject Characteristics

Children were admitted to the study who met one of the following criteria: (1) five year old children who had never had formal horseback riding lessons, (2) seven- and eight-year-old children who had ridden for six months or less under the tutelage of a riding instructor, and (3) nine- and ten-year-old children who had received seven or more months of formal riding lessons. Subjects were recruited until there were ten subjects in each group. As the sample was one of convenience, no attempt was made to have an equal number of boys and girls. Five and six year old children were recruited from a private day care facility and personal friends. Seven-, eight-, nine-, and ten-year-old children were obtained through private riding stables (see Appendix B for an example of letters sent to find owners of stables willing to allow the study to be conducted on their premises with their horses and students).

The parents of potential subjects were contacted by phone or letter which explained the purpose and procedure of the study (see Appendix C for example). Follow up was made as necessary via telephone or personal contact. All subjects had signed parental consent allowing them to participate in the study (see Appendix D). The consent form also contained a statement in which parents verified that their child had no medical or physical condition that

would interfere with horseback riding. Subjects were asked to wear close-fitting shirts, jeans, shoes, and hard hats unless the weather required coats or jackets.

Methods of Data Collection

In this section, equipment and taping procedures, procedures for the leader and sidewalker, instructions to the subjects, and the videotaping procedures are addressed.

Equipment and Taping Procedures

A video camera* and recorder** were used to record each subject while riding on a horse. The camera, mounted on a tripod, was elevated 1.22 meters from the ground and leveled. The camera was located 12.34 meters from the center of the field of action which was a 3.05 meter long straight-away of dirt or grass. The optical axis of the camera ran approximately perpendicular to the field of action (see Figure 10). Videotaping was performed outdoors for all subjects except for eight subjects who were videotaped in an indoor arena due to extreme cold.

* Omnipro PK-956N: Panasonic Co., Division of Matsushita, Electronic Cooperation of America, 1 Panasonic Way, Secaucus, N.J., 07094.

**Everex SV-680U and TU-68U: Everex Hitachi Denshi America, Ltd., 175 Crossways Park West, Woodbury, N.Y., 11797; and JVC 7300-U: Japan Victor Co., 41 Slater Drive, Elmwood Park, N.J., 07407.

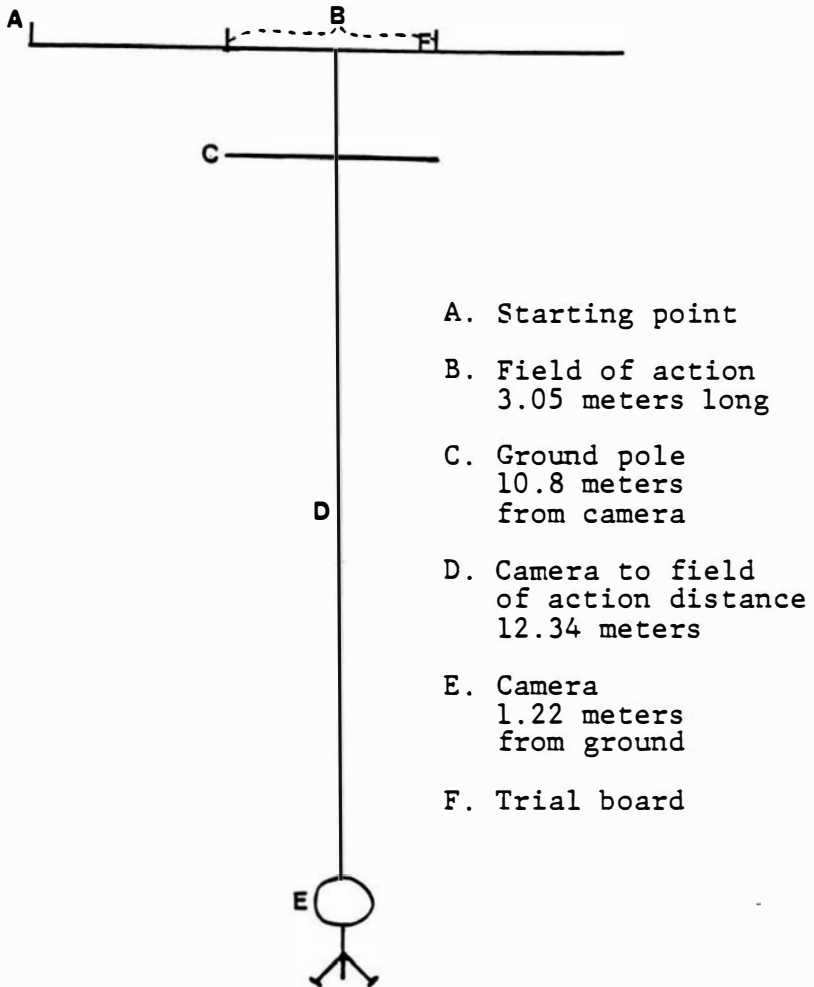


Figure 10. Overhead view of videotaping field.

For all except the five year old subjects, a pole was placed 10.8 meters from the camera. This pole enabled the subjects to all ride at a distance between 10.8 meters and 12.34 meters from the camera. A board was placed within the field of action containing subject and trial number.

The camera's power zoom lens was set at a speed of 20, and the focus was manually set on infinity. Light balance was achieved before videotaping began. The video cassette recorder was set on slow speed for all but five subjects. For these five subjects, the recorder was set on medium speed.

Procedures for Leader and Sidewalker

The five year old children who had not received formal riding lessons had a leader for the horse and a sidewalker on the side of the horse opposite the camera. The leader and sidewalker were used for safety reasons.

A leader is a person who walks beside the horse with a lead line connected to the horse's bridle in order to control the horse. The leader was instructed to walk the horse down the marked straight-away when the command "Ready, walk" was given.

The sidewalker is a person who holds onto the rider by means of a safety belt to help maintain the rider's balance. The sidewalker was instructed to walk beside the horse and rider on the side opposite the camera and assist

the child in maintaining balance as necessary while riding down the straight-away.

Instructions to Subjects

Each child had the procedure for the study explained and gave assent to participate in the study. Each child was then asked to ride the horse at a walk on a marked straight-away of 3.05 meters.

For the seven-, eight-, nine-, and ten-year-old children who had taken riding lessons, there was no leader or sidewalker. The instructions to these older riders were:

When I say "Ready, walk", you will ride your horse between the markers and the ground pole. Go all the way to the volunteer or marker before you slow your horse down. You will always start at this point (either a marker, standard, or person were used). You will ride your horse down this straight-away five times at a walk always starting at the same place and waiting until I say "Ready, walk" each time.

At this point, a volunteer or the investigator walked the straight-away for the subject pointing out the start and end points. Any questions the child had were then answered. No practice trials were given.

Videotaping Procedure

All subjects were videotaped riding the horse at a walk for five consecutive trials. Markers were used for the beginning and ending points of the field of action. Videotaping started before the horse and rider entered the field of action and ran continually until the subject had

cleared the field of action. At least a 3.05 meter walkway between the starting point for the horse and rider and the beginning of the field of action was provided to allow for a consistent walk from the horse. The field of action of 3.05 meters was estimated to provide sufficient distance for at least two complete gait cycles for the horse. A gait cycle was the interval between the horses' right front hoof strikes. Each of the four legs of the horse completed a stance and a stride in one gait cycle. Strides were counted starting the moment the right front hoof began its first full swing or stance phase and continued until two strides were completed.

Data Reduction

In the data reduction section, the process of category formation is described first. This is followed by an inter- and intra-rater objectivity and inter-rater reliability section. The process for establishing developmental sequences for the posture and movement of children while riding and determining the posture and movement of children while riding are presented next. Lastly, the data reduction method used to determine age and experience differences of the children while riding will be addressed.

Formation of Categories

The tapes were viewed using a slow motion, stop action videotape player-recorder and a television monitor. While observing the videotapes, a written description of posture and movement within a single component was generated for all subjects during each complete gait cycle. There were two gait cycles per trial. The first gait cycle of the first trial was described for each subject before the second gait cycle of the second trial. The first gait cycle of the second trial was described next. This pattern of analysis was continued until all the cycles were described. Ten cycles were available for all but three subjects. These subjects (indicated in Appendix F, Table 9) kicked their horse during a gait cycle therefore invalidating that particular cycle. There were a total of 295 gait cycles available for study.

Categories of the component posture and movement of the upper extremity, the lower extremity, and the head and trunk were established based on the similarities and differences in the descriptions of posture or movement for all gait cycles, trials, and subjects. The categorical descriptions were refined during inter-rater reliability studies for each component.

* RCA VMT 390: RCA Corporation, Consumer Electronics Division, 600 North Sherman Drive, Indianapolis, Indiana.

Inter- and Intra-Rater Objectivity and Reliability

A rater was trained to analyze component posture and movement and classify performance based on the descriptive categories. This rater then categorized 30 gait cycles which were randomly selected from all available subjects and trials. The trained rater's categorizations were then compared with the investigator's categorization of the same cycles. Inter-rater agreement was calculated as the percent of exact agreement between the rater and the investigator. Eighty-five percent exact agreement was necessary for a category to be considered "objective" for the purposes of this study. If 85% agreement was not reached, the rater and the investigator met in order to clarify and refine categories of component posture and movement or generate decision rules to improve inter-rater objectivity. Then, another set of 30 gait cycles were randomly selected and categorized by the trained rater. These categorization's were then compared to those obtained by the investigator when using the refined categories and decision rules. The percentage of inter-rater agreement was then re-calculated. After 85% or greater exact agreement was attained within a component, a Kappa statistic (Cohen, 1960) was calculated to portray inter-rater reliability.

Intra-rater objectivity was established after first viewing the tapes and categorizing component posture or movement for all subjects, cycles, and trials using the refined categories and the decision rules. Thirty randomly selected gait cycles were then recategorized by the investigator. Ninety percent exact agreement was considered necessary for intra-rater objectivity to be established.

Developmental Sequence for Posture and Movement of Children while Riding

Developmental sequences for the posture and movement of the children while horseback riding were hypothesized after having described categories of posture and movement within each component. Using horseback riding literature that described the "correct" English riding posture, the categories were ordered in a developmental sequence for each component which then represented an "hypothesized developmental sequence". This sequence was then graphed as it might appear if one plotted frequency of occurrence of each category across time.

The frequency of occurrence of each category for each age group was then determined within each component and converted to a percentage of gait cycles for that particular age group. Graphs of the frequency of occurrence of each category in each age group were used to

illustrate "observed" age and experience differences for each component. The graphs of the "observed" age and experience differences were compared to the hypothesized graph of development for that component by assessing the ordering of the categories and by observing the slope of the frequency curve and the direction of the curve.

Determining the Posture and Movement of Children while Riding

A gait cycle profile is that combination of upper extremity, head and trunk, and lower extremity component categories exhibited by a subject during a single gait cycle of the horse. All gait cycles of all trials were used to generate gait cycle profiles except for those gait cycles in which a kick occurred. The most common, or modal, gait cycle profile across all subjects and cycles was then determined after counting the frequency of occurrence of each gait cycle profile. The percent occurrence of other common gait cycle profiles across all possible cycles were calculated in order to represent variability of the postures and movements of children while English horseback riding.

Age and Experience Differences in Posture and
Movement of Children while Riding

The mode of all gait cycle profiles was determined across all cycles and subjects within each age group. The percent occurrence of each profile was calculated within each age group. The variability of the modal gait cycle profiles was determined by counting the number of different profiles within each age group. Differences in percent occurrence of the profiles between the age groups were calculated.

CHAPTER IV

Results

In this chapter, the results of the study are presented. First, subject information is provided including the ages of the children and the amount of formal riding instruction. Then the categories of component posture and movement are described. Next, the results of the objectivity tests of the categories, for both inter-rater and intra-rater agreement are given. The Kappa statistic (Cohen, 1960) for the inter-rater reliability is provided.

The hypothesized developmental sequences for each component are reported with the graphs of the hypothesized developmental sequences following. Then, the observed frequency of each component category at each age is graphed, and the observed developmental sequence is compared with the hypothesized longitudinal graph.

Next, the posture and movement of children horseback riding is described. In this section, the gait cycle profiles that occurred most frequently are reported. Lastly, the age and experience differences in posture and movement of children while riding are presented. In this section, the modal gait cycle profile for each age group is given along with its' percent occurrence within that age group. Also, the second most common profile within each

age group is given with its' frequency of occurrence. Within this section, there is also information concerning the gait cycle profiles within an age group and their occurrence in other age groups.

Subject Information

Thirty children participated in the study. There were 23 girls and 7 boys. The five year old children ranged in age from 60 months to 69 months with a mean age of 62.6 months. There were five boys and five girls in this youngest group. The seven- and eight-year-old children ranged in age from 89 to 101 months with a mean age of 96.9 months. There were two boys and eight girls in the seven- and eight-year-old group. The nine- and ten-year-old group consisted only of girls and ranged in age from 112 months to 131 months with a mean age of 122.50 months. The seven- and eight-year-old children had received an average of 3.9 months of formal riding lessons. The nine- and ten-year-old children had received an average of 25.9 months with a range of seven months to 72 months.

Categories of Component

Posture and Movement

Categories of posture and movement were formed for each component: the right upper extremity, the right lower extremity, and the head and trunk. There were five upper

extremity component categories. Table 5 presents a description of each of the upper extremity categories and Figure 11 presents illustrations of each category. There were five categories for the lower extremity component. These lower extremity categories are described in Table 6 (see Figure 12 for illustrations). In the head and trunk component, there were five categories. A written description of the head and trunk categories can be found in Table 7. Illustrations of the categories can be found in Figure 13.

Objectivity and Reliability of Categories

The results of inter-rater objectivity, inter-rater reliability, and intra-rater objectivity tests are provided in this section.

Inter-Rater Objectivity

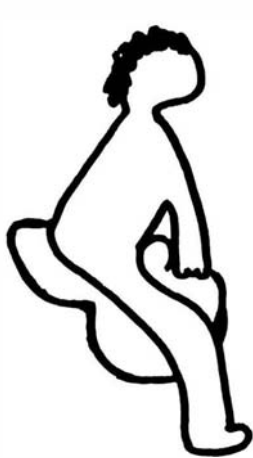
For the upper extremity component, 90% exact agreement was achieved between the investigator's initial categorization and the second rater's categorizations. For the lower extremity component, three objectivity tests had to be performed in order to achieve an inter-rater objectivity of 90%. For the head and trunk component, two objectivity tests had to be performed in order to achieve an inter-rater objectivity of 93.3%. Categories were refined and decision rules established in order to obtain inter-rater objectivity (see Appendix E for decision rules).

TABLE 5.

Upper Extremity Component Categories

Category

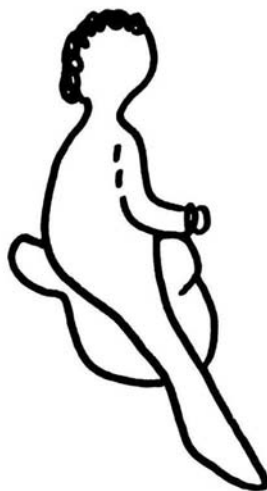
- E HAND ON SADDLE OR HORSE
The hand is resting on the saddle or horse's neck or gripping onto the saddle, or the rider is not holding the rein in his hand.
- A ELBOW EXTENSION WITH PRONATION
The arm is held at mid-chest or higher with the elbow moderately to fully extended. The forearm is pronated.
- B ELBOW FLEXION WITH PRONATION
The arm is held below mid-chest with the elbow moderately flexed. The forearm is pronated and may be in front of the body (i.e. shoulder internal rotation). The forearm may also be moving up and down.
- C ELBOW EXTENSION WITH NEUTRAL FOREARM
The arm is held at mid-chest or higher with the elbow moderately to fully extended. The forearm is in neutral.
- D ELBOW FLEXION WITH NEUTRAL FOREARM
The arm is held below mid-chest with the elbow moderately flexed. The forearm is in neutral.



Category E:
Hand on saddle
or horse



Category A:
Elbow extension
with pronation



Category B:
Elbow flexion
with pronation



Category C:
Elbow extension
with neutral
forearm



Category D:
Elbow flexion
with neutral
forearm

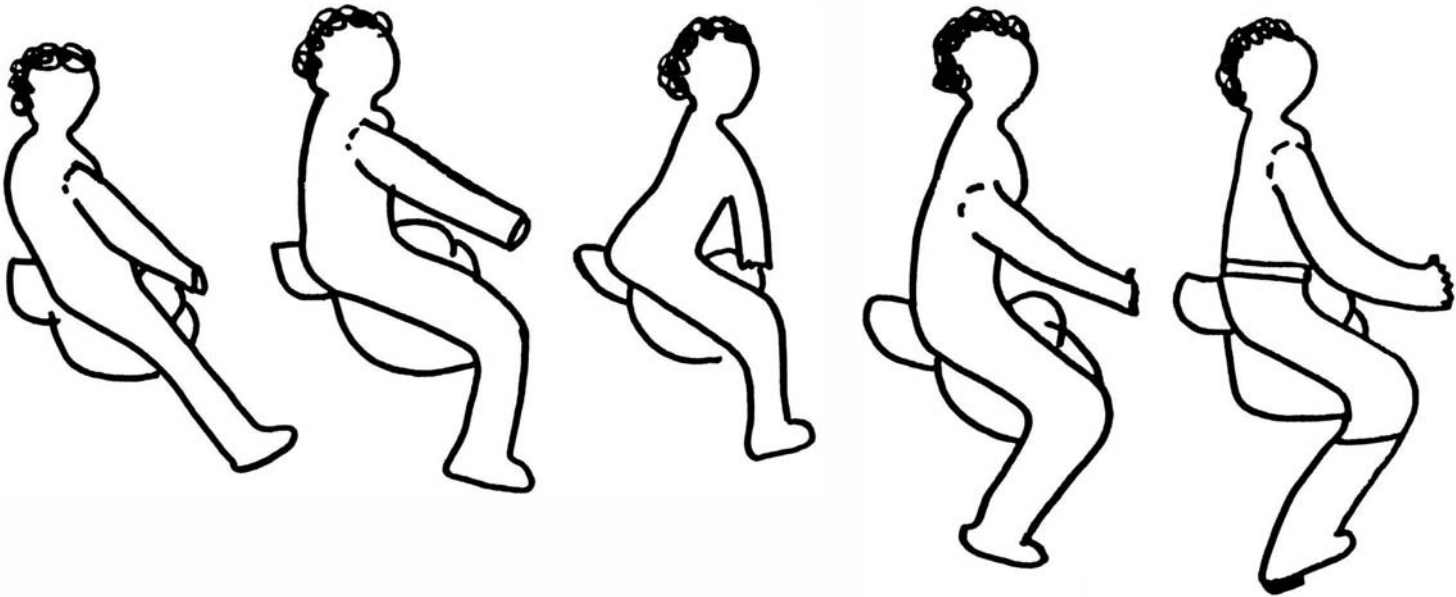
Figure 11. Upper extremity component categories.

TABLE 6.

Lower Extremity Component Categories

Category

- A HEEL IN FRONT OF KNEE
The heel of the foot is in front of the knee.
The foot can be in dorsiflexion, neutral or
plantarflexion.
- B FOOT BELOW KNEE WITH HEEL UP
Some part of the foot, from the ball of the foot
to the back of the heel, lies directly below the
knee. The heel of the foot is above the toes.
- C FOOT BELOW KNEE WITH HEEL DOWN OR FOOT LEVEL
Some part of the foot, from the ball of the foot
to the back of the heel, lies directly below the
knee. The heel is lower than (or level to) the
toes.
- D TOES AT OR BEHIND KNEE WITH HEEL UP
The toes are under or behind the knee with the
heel of the foot above the toes.
- E TOES AT OR BEHIND KNEE WITH HEEL DOWN
OR FOOT LEVEL
The toes are equal to or behind the knee with the
heel of the foot below (or level to) the toes.



Category A: Heel
in front of knee

Category B:
Foot below
knee with
heel up

Category C:
Foot below
knee with
heel down or
foot level

Category D:
Toes at or
behind knee
with heel up

Category E:
Toes at or
behind knee
with heel down
or foot level

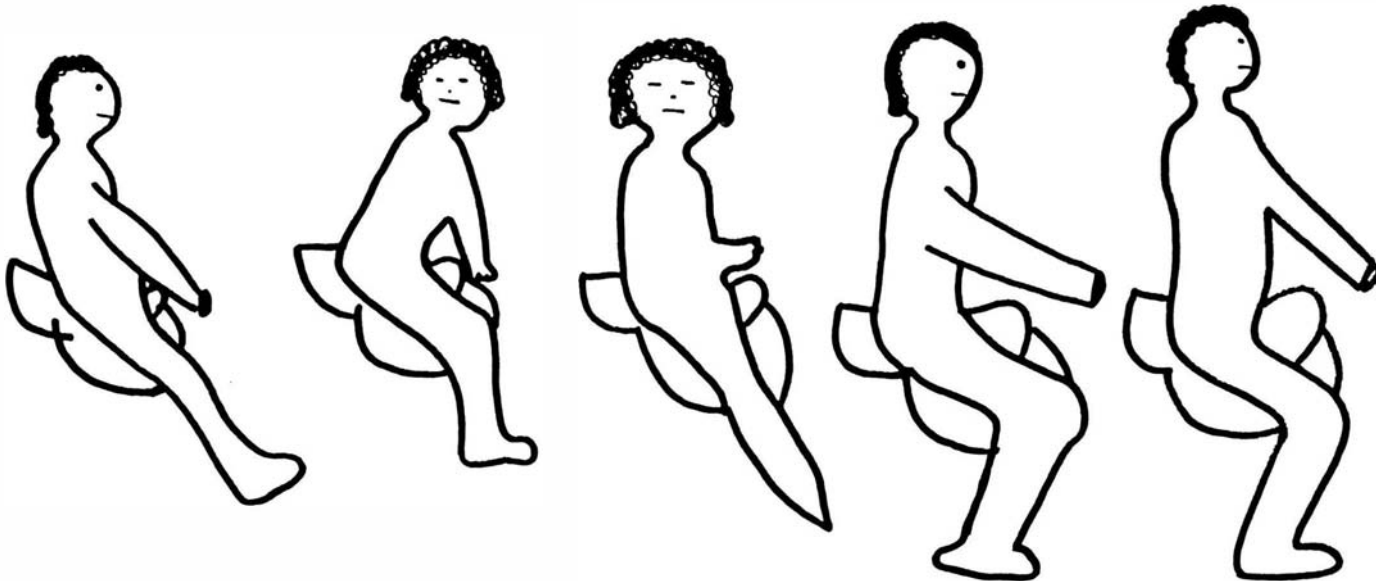
Figure 12. Lower extremity component categories.

Table 7.

Head and Trunk Component Categories

Category

- A **BACKWARD LEANING**
The shoulder is posterior to the hip joint. The head may be moving about or held in midline.
- B **FORWARD INCLINATION WITHOUT HEAD ALIGNMENT**
The shoulder is anterior to the hip joint. It is not uncommon for the spine to have a lumbar or thoracic kyphosis. The head is rotated or flexed for at least part of the gait cycle.
- C **TRUNK VERTICAL WITHOUT HEAD ALIGNMENT**
The shoulder is directly above the hip joint. The head is rotated or flexed for at least part of the horse's gait cycle.
- D **FORWARD INCLINATION WITH HEAD ALIGNMENT**
The shoulder is anterior to the hip joint. The head is in midline and erect.
- E **TRUNK VERTICAL WITH HEAD ALIGNMENT**
The shoulder is directly above the hip joint. The head is in midline and erect.



Category A:
Backward leaning

Category B:
Forward
inclination
without head
alignment

Category C:
Trunk vertical
without head
alignment

Category D:
Forward inclination
with head alignment

Category E:
Trunk vertical
with head alignment

Figure 13. Head and trunk component categories.

Inter-rater Reliability

The Kappa statistic (Cohen, 1960) was used to determine inter-rater reliability for each component. The Kappa statistics ranged from .84 for the lower extremity to .91 for the head and trunk component. Table 8 contains the Kappa statistic for the tests of inter-rater reliability.

Intra-Rater Objectivity

For the upper extremity component, 93.3% exact agreement was achieved on the test of intra-rater objectivity. For the lower extremity, after refinement of the categories and establishment of decision rules, 90% exact agreement was obtained on the intra-rater objectivity test. In the head and trunk component, after refining the categories, 90% exact agreement was achieved on the test of intra-rater objectivity.

Developmental Sequences

The hypothesized developmental sequence for each of the components are presented first in this portion. This is followed by a section on the observed frequency of each component category at each age.

Hypothesized Developmental Sequence

One of the research questions for this study was:

Are developmental sequences hypothesized from horseback riding literature valid for each of the three components: the upper extremity, the lower extremity, and the head and trunk, of body posture and movement within the task of English horseback riding at a walk?

Table 8.

Inter-Rater Reliability:Kappa Statistics

<u>Component</u>	<u>Kappa Statistic</u>
Upper Extremity	.86
Head and Trunk	.91
Lower Extremity	.84

Using the available horseback riding literature and previous experience with children horseback riding, the investigator hypothesized developmental sequences for each component after categories were formed. The hypothesized developmental sequence for the upper extremity in successive order was:

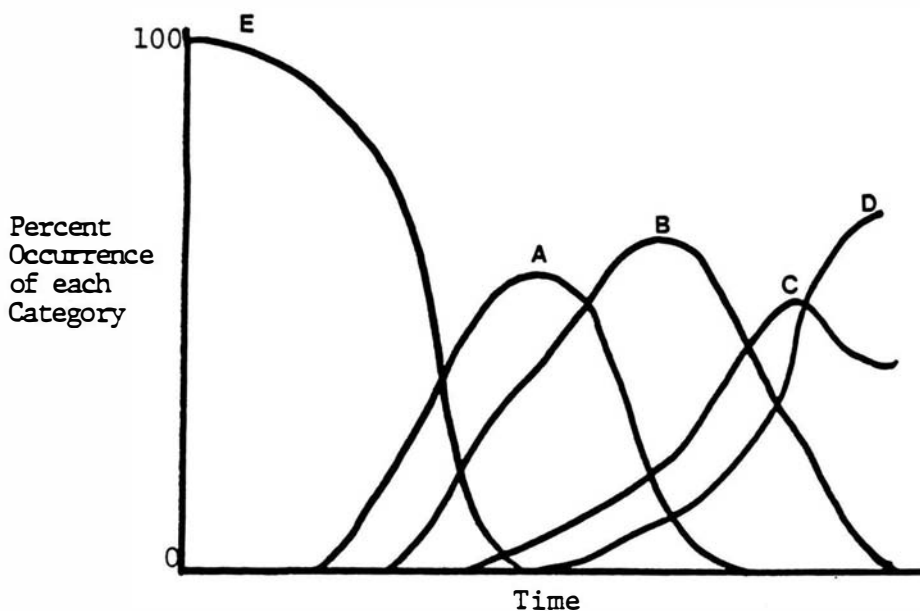
- CATEGORY E: HAND ON SADDLE OR HORSE,
- CATEGORY A: ELBOW EXTENSION WITH PRONATION,
- CATEGORY B: ELBOW FLEXION WITH PRONATION,
- CATEGORY C: ELBOW EXTENSION WITH NEUTRAL FOREARM,
- CATEGORY D: ELBOW FLEXION WITH NEUTRAL FOREARM.

Figure 14 contains a graph of the hypothesized sequence of the upper extremity categories as it was projected to appear across time.

For the lower extremity, the hypothesized developmental sequence in successive order was:

- CATEGORY A: HEEL IN FRONT OF KNEE,
- CATEGORY B: FOOT BELOW KNEE WITH HEEL UP,
- CATEGORY C: FOOT BELOW KNEE WITH HEEL DOWN OR FOOT LEVEL,
- CATEGORY D: TOES AT OR BEHIND KNEE WITH HEEL UP,
- CATEGORY E: TOES AT OR BEHIND KNEE WITH HEEL DOWN OR FOOT LEVEL.

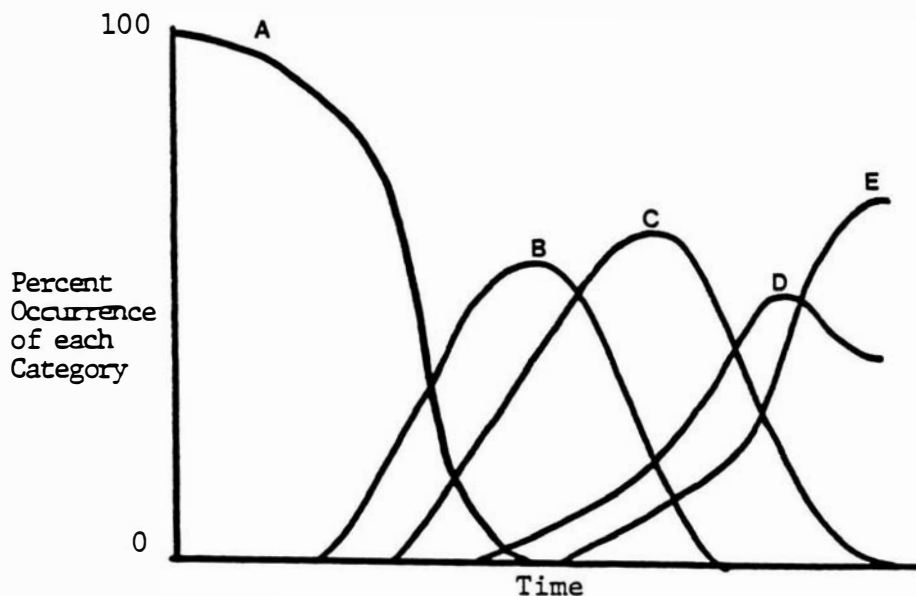
Figure 15 presents a graph in which the hypothesized sequence of lower extremity development for riding at a walk is shown as it would appear across time.



Categories Listed in Successive Order:

- E Hand on saddle or horse
- A Elbow extension with pronation
- B Elbow flexion with pronation
- C Elbow extension with neutral forearm
- D Elbow flexion with neutral forearm

Figure 14. Hypothesized developmental sequence for the upper extremity component categories.



Categories Listed in Successive Order:

- A Heel in front of knee
- B Foot below knee with heel up
- C Foot below knee with heel down or foot level
- D Toes at or behind knee with heel up
- E Toes at or behind knee with heel down or foot level

Figure 15. Hypothesized developmental sequence for the lower extremity component categories.

For the head and trunk component, the categories were arranged into a developmental sequence as follows:

CATEGORY A: BACKWARD LEANING,

CATEGORY B: FORWARD INCLINATION WITHOUT HEAD
ALIGNMENT,

CATEGORY C: TRUNK VERTICAL WITHOUT HEAD ALIGNMENT,

CATEGORY D: FORWARD INCLINATION WITH HEAD ALIGNMENT,

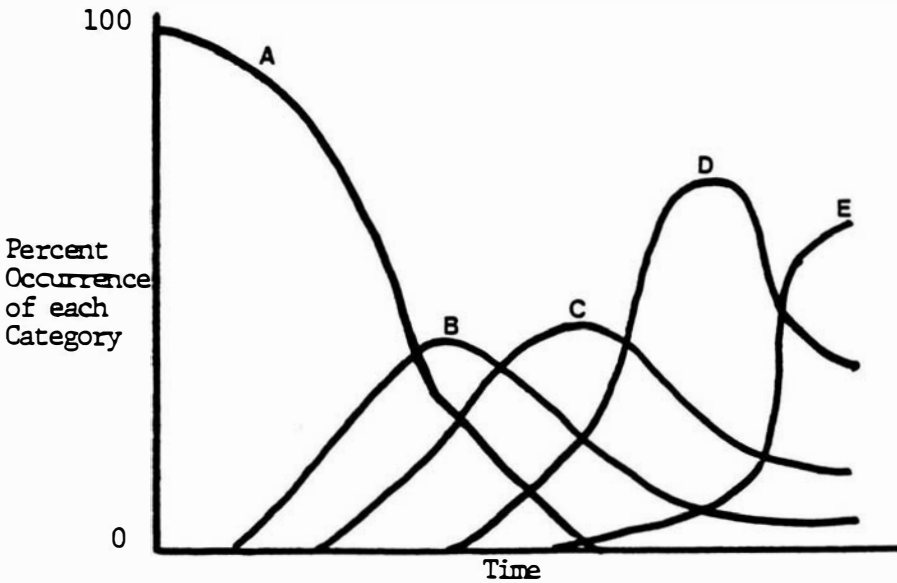
CATEGORY E: TRUNK VERTICAL WITH HEAD ALIGNMENT.

A graph of the hypothesized sequence for the head and trunk component is presented in Figure 16.

In the upper extremity, the higher developmental steps include slight flexion patterns as the shoulders are to be close to the body, elbows bent slightly and the hands held low according to most riding authorities (de Romaszkan, 1937/1967; Froissard, 1971/1979).

For the lower extremity component, all riding authorities (Froissard, 1967, 1971/1979; Museler, 1937/1981; de Romaszkan, 1937/1967; Kulesza, 1966) agree that the heels must be down, and therefore, dorsiflexed when riding "correctly". The hips and knees are bent so that the rider can influence the horse with his lower extremities.

For the head and trunk component, movement of the head is considered developmentally low because, according to all the available literature (Froissard, 1967, 1971/1979; Museler, 1937/1981; McTaggart, 1951), the head is to be



Categories Listed in Successive Order:

- A Backward leaning
- B Forward inclination without head alignment
- C Trunk vertical without head alignment
- D Forward inclination with head alignment
- E Trunk vertical with head alignment

Figure 16. Hypothesized developmental sequence for the head and trunk component categories.

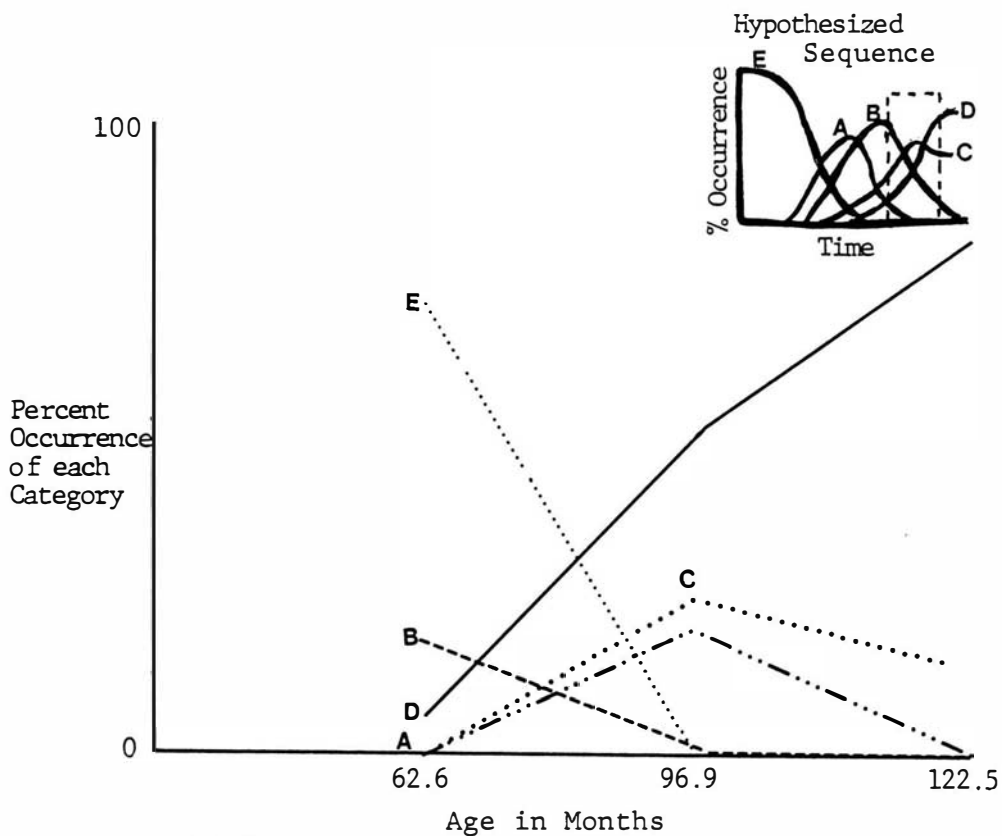
held erect and in midline. The trunk should be vertical when using a basic balance seat and "erect" (Froissard, 1967).

Observed Frequency of each Component Category at each Age

In this section, the observed occurrence of the upper extremity, the lower extremity, and the head and trunk component categories is compared to the hypothesized developmental sequence.

Upper Extremity Component

Comparing the graph of the frequency of occurrence of each upper extremity component category at each age with the graph of the hypothesized developmental sequence for the upper extremity component (see Figure 17) revealed the following. Category B had a lower frequency of occurrence than Category E for the five year old children and did not increase in frequency in the seven-, eight-, nine-, and ten-year-old children. Therefore, Category B could be a modal category at an earlier age than five. If Category B had been hypothesized as the first developmental step, so that the sequence would have been Categories B, E, A, C, and D, in successive order, the hypothesized order of development would not be supported because Categories A and C did not appear frequently enough to hypothesize that either would be a modal category. If Categories A and C were combined due to their similar pattern of frequency of occurrence, the new combined category would still never be



Legend:

Categories listed in successive order:

B Elbow flexion with pronation -----

E Hand on saddle or horse

A Elbow extension with pronation -...-...-

C Elbow extension with neutral forearm

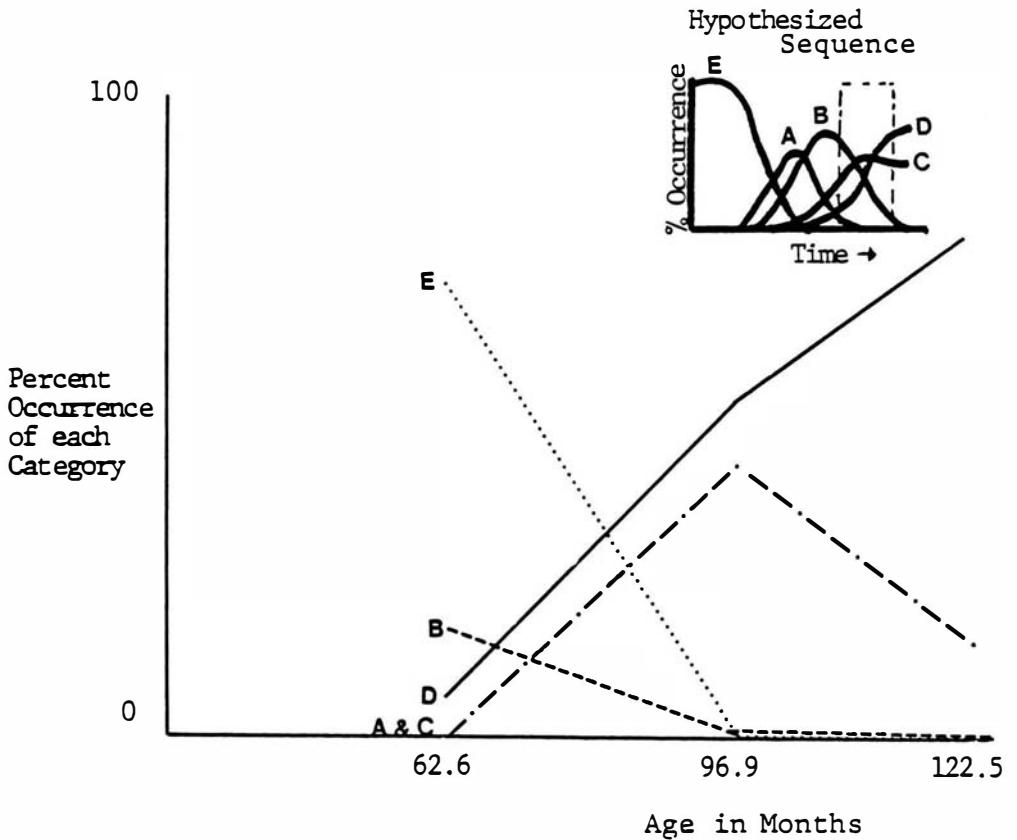
D Elbow flexion with neutral forearm ——

Figure 17. Observed frequency of occurrence of the upper extremity component categories in each age group.

modal (see Figure 18). Category D was the modal category for both the intermediate age group and the older group of children. However, it would be expected that each category at some point in time would be a modal category if the category is a developmental step. Thus, the sequence of upper extremity component development was not supported.

Lower Extremity Component

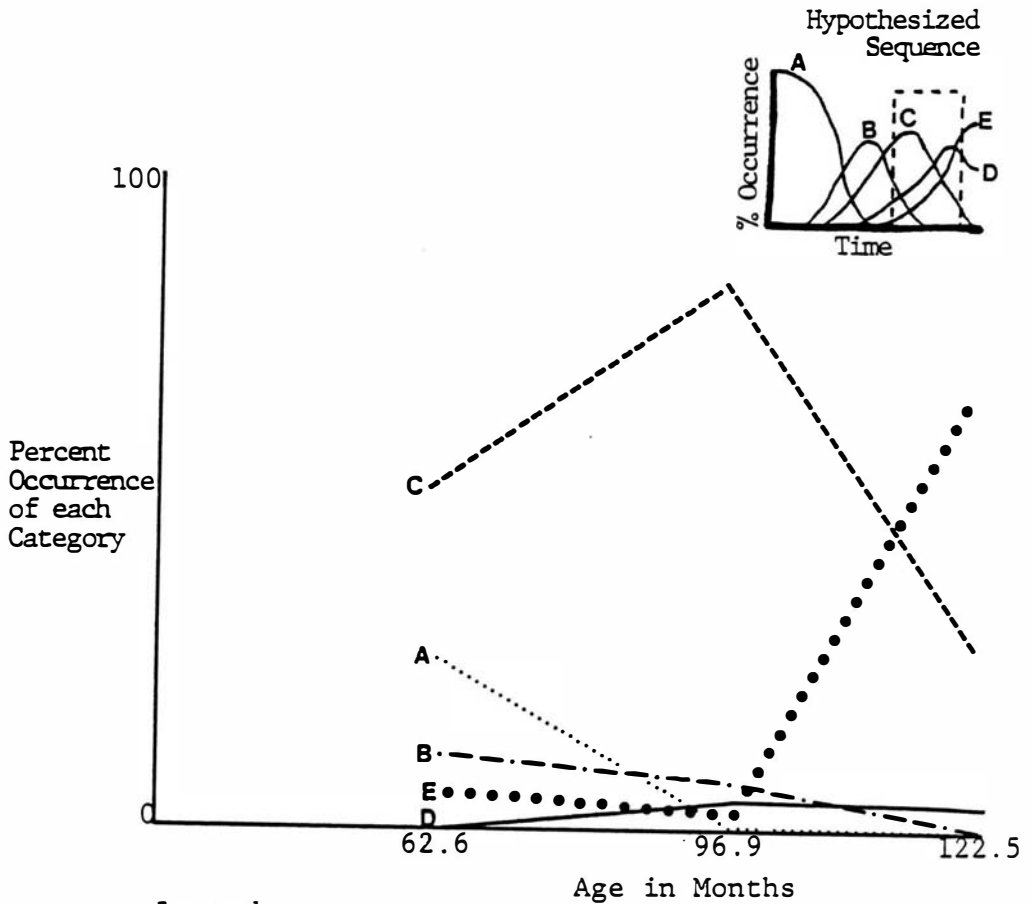
For the lower extremity component, the hypothesized developmental sequence of Categories A, B, C, D, and E, in successive order, was not supported. In comparing the observed developmental sequence to the hypothesized developmental sequence (see Figure 19), it can be seen, based on the observed frequency of occurrence, that Categories A, B, and D were never modal in this sample of children. It appears that Category A and Category B could be modal at an earlier age than five, and that Category D, if a developmental step, must be modal at some later age than ten years old. However, combining Categories D and E might be appropriate due to Category D's low frequency of occurrence and the similar knee position observed in the two categories (see Figures 12 and 20). These findings suggest that a more likely hypothesis for the order of development would be Categories B, A, C, with D and E as a final step.



Legend:

- Categories listed in successive order:
- B Elbow flexion with pronation-----
- E Hand on saddle or horse
- A and C Elbow extension with pronated or neutral forearm .-.-.-.-.
- D Elbow flexion with neutral forearm—

Figure 18. Frequency of occurrence at each age of the upper extremity component categories with categories A and C combined.



Legend:

Categories listed in successive order:

B Foot below knee with heel up - - - - -

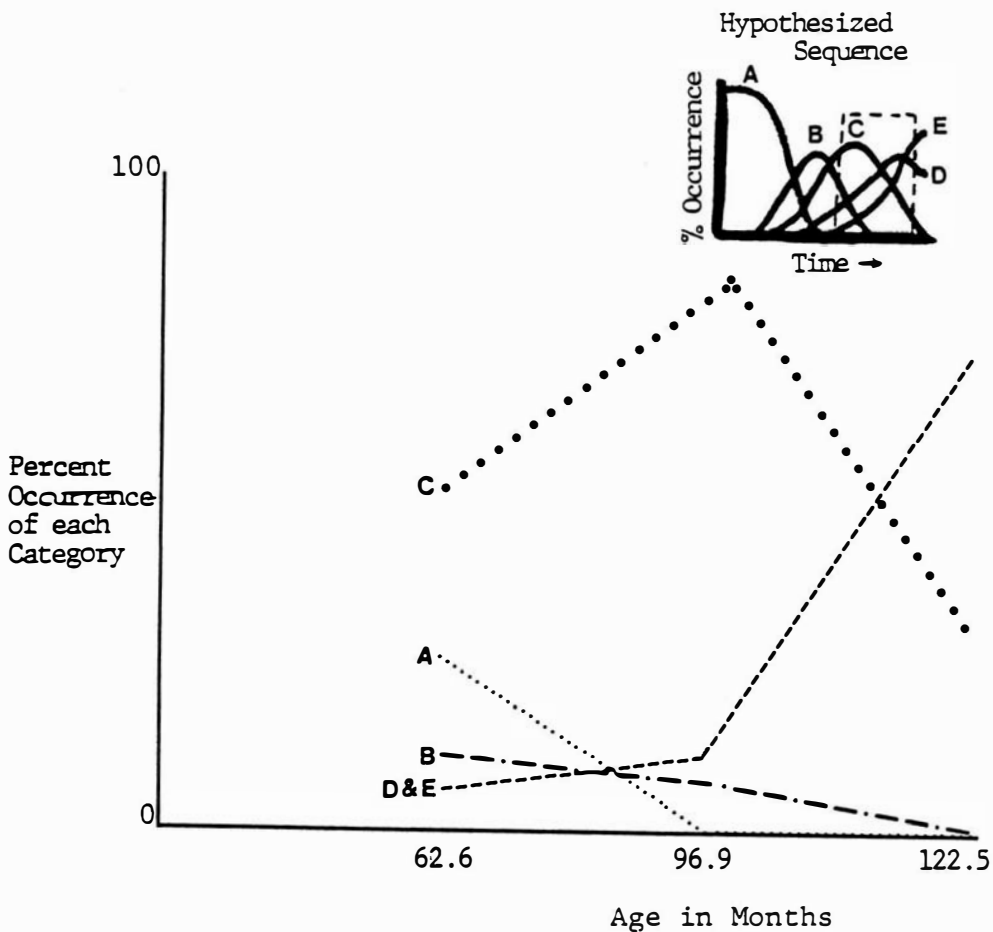
A Heel in front of knee

C Foot below knee with heel down
or foot level - - - - -

E Toes at or behind knee with heel
down or foot level •••••

D Toes at or behind knee with heel up

Figure 19. Observed frequency of occurrence of the lower extremity component categories in each age group.



Legend:

Categories listed in successive order:

B Foot below knee with heel up — — — — —

A Heel in front of knee ·········

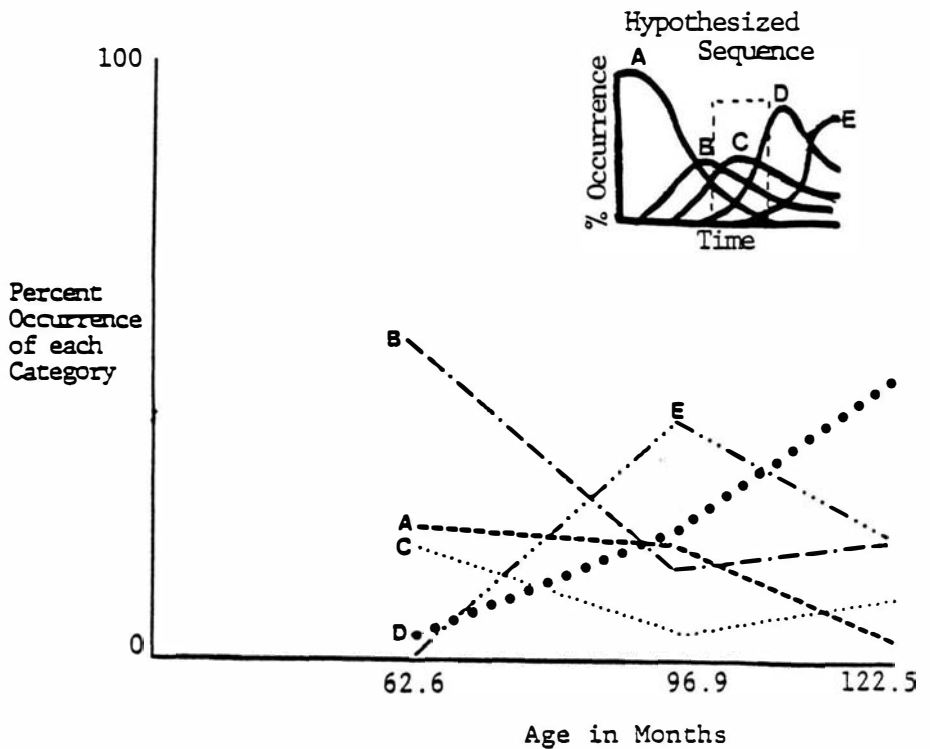
C Foot below knee with heel down
or foot level ·········

D and E Toes at or behind knee with
heel up, down, or foot level — — — — —

Figure 20. Frequency of occurrence at each age of the lower extremity component categories with categories D and E combined.

Head and Trunk Component

For the head and trunk component, the hypothesized developmental sequence was: Category A, Category B, Category C, Category D, and Category E in successive order. The graph of the observed frequency of each category at each age is presented in Figure 21. Category C had the lowest frequency of occurrence in the five year old children followed by Category A. Categories B and C parallel each other in that the percent occurrence is greatest in the five-year-olds, least in the seven- and eight-year-old children, and then increases in percent occurrence slightly in the oldest group of children. If Categories B and C were combined due to their similar frequencies of occurrence, then the hypothesis that Categories A, B, and C are early developmental steps would be supported (see Figure 22). Category E is modal for the seven- and eight-year-old riders, but then declined in frequency in the older age group while Category D steadily increased in frequency which is the reverse order of the original hypothesized ordering of Category D and then E. The results indicate that the original hypothesis should be rejected. The probable order of development is Category A, combined B and C, E, and finally D.



Legend:

Categories listed in successive order:

C Trunk vertical without head alignment

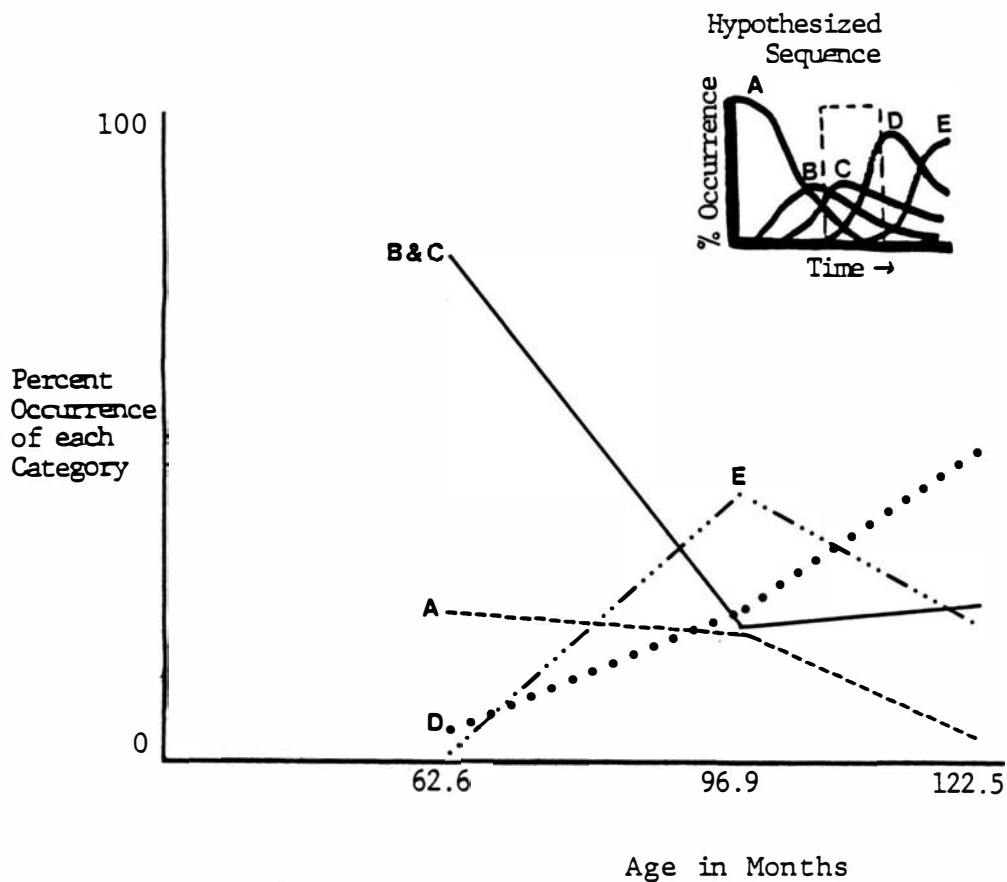
A Backward leaning

B Forward inclination without head alignment

E Trunk vertical with head alignment

D Forward inclination with head alignment

Figure 21. Observed frequency of occurrence of the head and trunk component categories in each age group.



Legend:

Categories listed in successive order:

A Backward leaning

B and C Trunk inclined forward or trunk vertical without head alignment

E Trunk vertical with head alignment

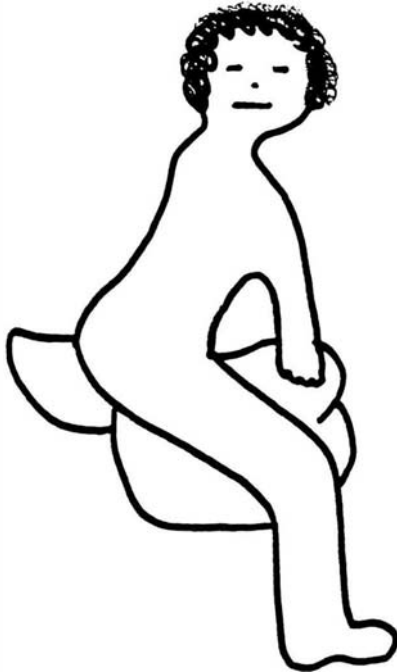
D Forward inclination with head alignment

Figure 22. Frequency of occurrence at each age of the head and trunk component categories with categories B and C combined.

Posture and Movement
of Children Horseback Riding

A gait cycle profile is that combination of upper extremity, head and trunk, and lower extremity components that describes the posture and movement of a subject while English horseback riding at a walk. A total of 54 different profiles appeared in 295 gait cycles studied (see Appendix F, Table 10 for raw data of profiles across all subjects and cycles and Table 11 for profiles' frequency of occurrence).

The most common, or modal, gait cycle profile across all subjects and cycles was: upper extremity Category E: Hand on saddle or horse; head and trunk Category B: Forward inclination without head alignment; and lower extremity Category C: Foot below knee with heel down or foot level (see Figure 23 for an illustration of profile EBC). The frequency of occurrence for the modal gait cycle profile EBC was only 10.5%. Next most frequent, was the gait cycle profile DEC which occurred in 26 of the 295 or 8.8% of the available gait cycles. This profile consisted of: upper extremity Category D: Elbow flexion with neutral forearm; head and trunk Category E: Trunk vertical with head alignment; and lower extremity Category C: Foot below knee with heel down or foot level (see Figure 24). The third most frequent profile was characterized by the upper extremity component exhibiting Category D: Elbow flexion

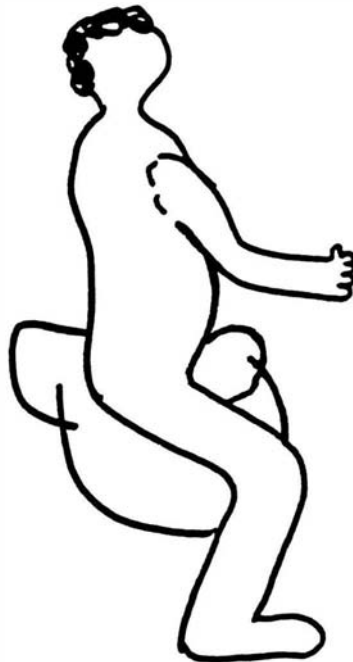


Upper Extremity Category E: Hand on saddle or horse

Head and Trunk Category B: Forward inclination without head alignment

Lower Extremity Category C: Foot below knee with heel down or foot level

Figure 23. Modal profile for the five year old children.



Upper Extremity Category D: Elbow flexion with neutral forearm

Head and Trunk Category E: Trunk vertical with head alignment

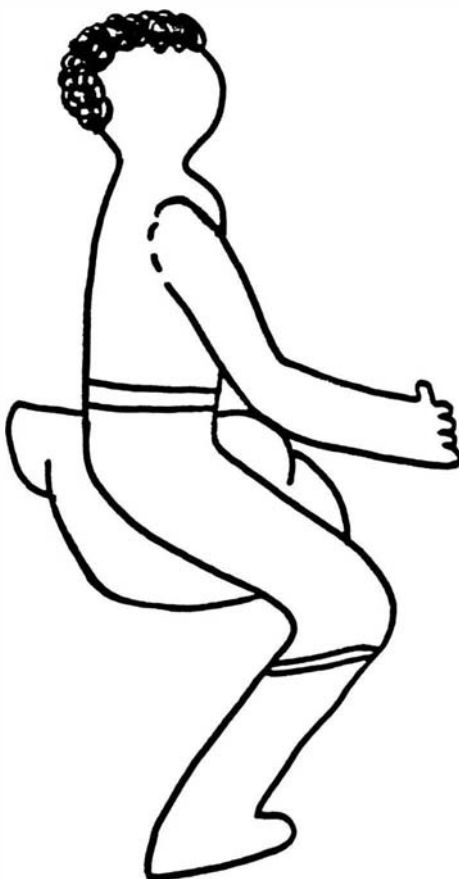
Lower Extremity Category C: Foot below knee with heel down or foot level

Figure 24. Modal profile for the seven- and eight-year-old children.

with neutral forearm; the head and trunk component Category D: Forward inclination with head alignment; and the lower extremity component Category E: Toes at or behind knee with heel down or foot level (see Figure 25 for illustration of profile DDE). This profile occurred in 8.1% of the gait cycles.

Differences in Posture and Movement of
Children of Different Age and Experience Levels

The group of five year old children who had never received formal riding lessons, demonstrated 21 different gait cycle profiles. Thirteen of these profiles were seen in less than three cycles (see Table 12 in Appendix G). The modal gait cycle profile of the five-year-old's was EBC and occurred in 31% of the observed gait cycle profiles (see Figure 23). This profile was also the modal gait cycle profile across all subjects and trials. The next most common gait cycle profile of the five year old children was EBA which occurred in 10% of the gait cycles. This profile, EBA only differs from the most common profile, EBC, in the lower extremity component category. Thus, in the five-year-olds, while the hand was on the saddle or horse and the trunk was inclined forward, the foot was either below the knee or it was in front of the knee.



Upper Extremity Category D: Elbow flexion with neutral forearm

Head and Trunk Category D: Forward inclination with head alignment

Lower Extremity Category E: Toes at or behind knee with heel down or foot level

Figure 25. Modal profile for the nine- and ten-year-old children.

For the seven- and eight-year-old children, who had received six months or less of formal riding lessons, there were 28 different gait cycle profiles (see Appendix G, Table 12). Sixteen of the 28 various profiles occurred in less than three gait cycles. The gait cycle profile most commonly seen was DEC which occurred in 21.2% of the seven- and eight-year-old riders' gait cycles (see Figure 24). The next most common gait cycle profile was CDC: Elbow flexion with pronation, forward inclination with head alignment, and foot below knee with heel down or foot level. This profile occurred in 10.1% of the gait cycles.

For the nine- and ten-year-old children, who had received seven months or more of formal riding lessons, there were 16 different gait cycle profiles (see Appendix G, Table 12). Six of the 16 gait cycles occur in less than three gait cycles. The modal gait cycle profile was DDE which occurred in 25% of all the nine- and ten-year-old children's gait cycles (see Figure 25). This profile, DDE, is characterized by elbow flexion with a neutral forearm, forward inclination of the trunk with head alignment, and the toes at or behind the knee with the heel down or foot level. The next most frequently occurring gait cycle profile is DEE which occurred in 16.7% of the available gait cycles for the nine- and ten-year-old group of children. This profile varies from the group's modal profile only in the head and trunk component category. In

the modal profile, the child is inclined forward, whereas in the next most common profile, the child has attained a vertical trunk alignment.

In comparing the groups of children, it was found that the modal gait cycle profile, EBC, of the sample as a whole, never occurred in the seven-, eight-, nine-, or ten-year-old children. Of the 21 gait cycle profiles of the five year old children, only three gait cycle profiles occurred in other age groups; therefore 85.7% of the gait cycle profiles present in the five-year-olds were unique to this age group.

The seven- and eight-year-old children demonstrated the largest variety of body profiles. Of the 28 different profiles present in the seven- and eight-year-old group of children, only nine were seen in other age groups. In addition, the modal profile for the seven- and eight-year-old group, DEC, was not present in the five year old group of children. However, this profile did appear in 5.2% of the gait cycles of the nine- and ten-year-old children.

It is also noteworthy, that the modal gait cycle profile for the nine- and ten-year-old children, DDE, never occurred in the younger children. Fifty percent of the profiles observed in nine- and ten-year-old children occurred only within that age group.

Summary

Five categories were formed for each component. The categories were found to be objective descriptors of children's postures and movement while horseback riding. Developmental sequences hypothesized from horseback riding literature were not supported by the observed data. Some of the categories were never modal, and therefore, must be modal at some age other than the ages of the subjects in this study. For example, elbow flexion with pronation and foot below knee with heel up must have been modal at some age younger than age five. Also, in both the lower extremity and head and trunk component categories, the two hypothesized to be latest appearing were reversed. For example, Category D: Forward inclination with head alignment was modal for the nine- and ten-year-olds and Category E: Trunk vertical with head alignment was the modal category for the seven- and eight-year-old riders. In the horseback riding literature, which was used to hypothesized developmental sequences, the "correct" riding form is described instead of the beginner rider's form, and therefore, may account for the lack of support for the hypothesized sequence from the observed data.

The modal gait cycle profile for all subjects and cycles was characterized by the hand on the saddle or horse, the trunk was inclined forward without head alignment, and the lower extremity was positioned with the

foot below the knee with the heel down or a level foot. This postural alignment was seen only in the five-year-olds. The second most common gait cycle profile across all subjects and cycles consisted of elbow flexion with neutral forearm, the trunk was vertical with the head aligned, and the foot was below the knee with the heel down or the foot level. This gait cycle profile was the modal gait cycle profile for the seven- and eight-year-old children. The third most frequent gait cycle profile consisted of elbow flexion with neutral forearm, the trunk inclined forward with the head aligned, and the toes at or behind the knee with the heel down or the foot level. This profile, which was only seen in the nine- and ten-year-old children, was also that group's modal profile, and occurred in 25% of their gait cycles.

CHAPTER V

Discussion and Conclusions

In this chapter, there are six main sections. In the first section, the posture and movement of children while riding is addressed. In the next section, various factors that might have affected the children's riding postures are presented. In the third and fourth section, the developmental sequences are discussed and the newly hypothesized sequences are presented. This section is followed by a discussion of the clinical implications; and recommendations for further study are presented. Lastly, the conclusions and a summary of the study are provided.

Posture and Movement of Children while Riding

In this section, the variability of component categories is addressed first. This is followed by a discussion of gait cycle profiles.

Variability Within Component Categories

During data analysis it was found that the head and trunk component was the most variable component within subjects. Some children "rocked" their trunk when riding, or turned their head to look about. This variability could be due to a number of factors. First, the young subjects turned their heads to observe the environment, and therefore, may have changed their head and trunk categories from one "with head alignment" to one "without head alignment". Secondly, the variability may be an

Secondly, the variability may be an indirect result of subjects using the upper extremities and lower extremities to stabilize their body on the horse. The upper and lower extremity components were basically stable across the subjects and cycles. By holding on or putting weight into the feet, subjects may have prevented movement of the upper and lower extremity components therefore reducing variability in these components. It appeared that the children tried to maintain a posture with their upper and lower extremities, but moved their heads or trunks in response to the horse's movement or the environment.

Gait Cycle Profiles

The profiles were very characteristic of the various age groups. For example, the modal profile across all subjects and all cycles was not truly representative of the entire group as this profile only occurred in the five year old children. The profiles of the older children were seen in more than one group, but were still most representative of a particular age group. For example, the nine- and ten-year-olds showed the least amount of variability in their gait cycle profiles as there were only 16 different profiles exhibited by that group. That the profiles were very representative of an age group in this study may have been due to the amount of formal riding lessons that a group had received, the age of the children in a particular group, or a combination of the two as predicted in the

interactionist theory of motor development.

Factors Affecting Children's Riding Posture

There were numerous factors affecting the children's riding posture. Conditions surrounding the five-year-olds videotaping, speed of the horse's walk, stirrup length, saddle size, amount of riding outside of formal riding lessons, and the Hawthorne effect are addressed in this section.

Conditions Surrounding the Five-year-olds' Videotaping

The five-year-olds' profiles may have been effected by specific environmental factors. The conditions surrounding data collection were different for the five year old children in that these children had a leader and sidewalker, and a dog running about. This seems to have particularly affected the axial component. Head rotation observed in the axial component may have been due to the child interacting with the sidewalker or leader, or turning to watch the dog. For example, the sidewalker changed the trial number at the end of the trial, and would often let go of a child at that time. These five year old children would usually turn their head to look at the sidewalker changing the number. The dog also caused some distraction as he followed behind the horse during the videotaping. These variables could account for the head not being aligned.

Speed of Horse's Walk

One of the assumptions for the study was that the speed of the horse's walk would not affect the rider's posture and movement. However, the speed of the horse's walk did seem to effect the rider's posture and movement. It appeared that the slower the horse walked, the more the younger riders rocked their trunks in an anterior-posterior fashion possibly urging the horse to move faster. A few older riders were observed to be rocking their trunk in concert with the horse's movement. The advanced riders could have been using their seat and body weight to drive the "slow" horse forward.

Stirrup Length

Another limitation recognized prior to this study was that the length of the stirrup leathers affects the position of the lower extremity. However, stirrup length was not controlled in this study. In any future research the stirrup length should be controlled. If the stirrup is too long, it would encourage extension at the knee and plantarflexion at the ankle in order to keep the foot in the stirrup. On the other hand, stirrups so short that the knees have to be greatly flexed in order to get the feet in the stirrups would also effect the lower extremity's position. According to de Romaszkan (1937/1967), a stirrup, one-inch below the medial malleolus, allows for mild flexion of the hip, knee, and ankle without extremes

of either flexion or extension.

Saddle Size

A factor that was not considered prior to data collection was the size of the saddle. Many riding books mention that the saddle must fit the rider as well as the horse correctly and where the rider is to sit in the saddle, but the authors do not explain how the saddle should fit the rider (Churchill, 1965; Edwards, 1963; Prince & Collier, 1974; Spooner, 1965).

For all the five year old children, the same 15 inch flat English saddle was used. Yet, a smaller saddle might have fit some of these children better. Also, none of the older riders' saddles were measured prior to riding.

Amount of Riding Outside of Formal Riding Lessons

A limitation of this study was that the amount of riding at times other than during formal riding lessons was not considered. For example, some children may have had less than six months of formal riding lessons, but have ridden daily for years on their own horses. This could have an effect on their riding postures. Videotaping children who have equal riding experience without formal instruction would provide clearer insight into the effects of formal instruction on riding posture.

Hawthorne Effect

Many of the older riders, some whom have ridden in horse shows, know the importance of riding with the "correct" form in front of the judge. They may have viewed the investigator and the videotaping equipment as the "judge" and ridden accordingly. Or, maybe all of the children, regardless of their horse show experiences, rode in the best position attainable for them because they were being videotaped; therefore, the Hawthorne effect probably occurred (Todes, McKinney, & Ferguson, 1977; George, 1968). Also, several times during the videotaping, when a subject's riding instructor was watching the videotaping, they might tell the student to "sit up straight" or "get your heels down" which did cause the rider to change their posture or movement.

Developmental Sequences

English riding is a very formal style of riding. There are definite standards, though seemingly arbitrary, for "correct" riding form. In hypothesizing the developmental sequences, knowledge of the horseback riding literature was used to propose a developmental order for each component. This process was not successful. One reason this could have occurred is because the horseback riding literature describing correct form was interpreted as the most advanced categories, and probably, later appearing. Indeed, the categories most often misordered

were those categories originally hypothesized to appear in the older children, but were observed to occur more commonly in the younger children.

In the upper extremity component, Category B: Elbow flexion with pronation, must have occurred more frequently at a younger age than five (see Figure 14). It had been hypothesized that Category E, hand on saddle or horse, would appear more frequently at the youngest age level because it was thought that the children would hold onto the horse or saddle for security. And even though, the hand on the saddle or horse category did occur most frequently for the five-year-olds, elbow flexion with pronation would be the first developmental level because it continued to decrease in frequency from age five on to age ten; therefore, Category B must have occurred more frequently at a younger age than five. The reason for this occurrence could be that elbow flexion with pronation might represent a mild form of "high-guard". According to McGraw (1963), high guard is used as a protection mechanism for the child. This may be the reason this category was seen most frequently in the youngest children studied.

The categories appear to cover the spectrum of childrens' riding abilities. However, even those nine- and ten-year-old children with more than one year of formal riding lessons should not be considered "advanced" riders

even though they can walk, trot, and canter the horse. They apparently know "correct" riding form, but are not proficient in this riding form. Evidence for this can be seen in the head and trunk component. It was hypothesized that the latest appearing category would be characterized by a vertical trunk with head alignment. However, this posture occurred most frequently in seven- and eight-year-old children while the nine- and ten-year-old children more frequently demonstrated forward inclination of the trunk with head alignment.

Forward inclination of the trunk with head alignment could have been more frequent in the nine- and ten-year-old group of riders due to the older children riding frequently without feedback from a riding instructor admonishing the child to assume "correct" form; or having been taught Hunt-seat riding, in which the rider inclines their trunk forward. It is proper to use a Hunt-seat form of riding for jumping the horse instead of the basic balanced seat which requires a vertical trunk alignment.

The finding that a vertical trunk alignment was most frequent for the intermediate ages may be due to all or most of the seven- and eight-year-olds' exposure to horseback riding occurring only during their formal riding lessons in which the basic balanced seat is taught, and so, they are exhibiting the "correct" position.

Newly Hypothesized Developmental Sequences

Based on the observed data, the following alternative developmental sequences for the upper extremity, the lower extremity, and the head and trunk components are proposed. For the upper extremity, the categories in successive order would be: Category B: Elbow flexion with pronation; Category E: Hand on saddle or horse; combined Categories A and C: Elbow extension with pronated or neutral forearm; and Category D: Elbow flexion with neutral forearm. For the lower extremity, the categories would be ordered from earliest to latest appearing when presented as follows: Category B: Foot below knee with heel up; Category A: Heel in front of knee; Category C: Foot below knee with heel down or foot level; and lastly, combined Categories D and E: Toes at or behind knee with heel up, down, or foot level. Finally, for the head and trunk, the categories in progression from earliest to latest appearing would be ordered: Category A: Backward leaning; combined Categories B and C: Forward inclination or trunk vertical without head alignment; Category E: Trunk vertical with head alignment; and Category D: Forward inclination of trunk with head alignment.

The newly hypothesized sequences are based on both the horseback riding literature and the results of this study, and therefore, should more accurately portray children's horseback riding. The literature describes the ideal

riding position, and this study shows the actual riding position of 30 children. Children taking riding lessons learn "correct" form and attempt to achieve this form. Since the oldest children in this study were nine- and ten-year-old riders with about 26 months in formal riding lessons, it should not be assumed that they have attained "correct" riding form. It had been originally hypothesized that the developmental sequence for each component would have the most advanced, i.e., "correct", form occurring last in the sequence. Yet, the intermediate age group demonstrated a greater frequency of "correct" form categories than the older group of riders. The newly hypothesized sequences with "correct" form appearing as the intermediate steps should be a more accurate description of children riding.

Implications and Recommendations

In this section, the clinical implications and the recommendations for further study are provided.

Clinical Implications

This study was conceived in anticipation that the findings might eventually be used to compare "normal" and "disabled" riders' posture and movement. Many physical therapists working with therapeutic horseback riding programs are not familiar with riding postures and movements, and may think some postures or movements they

observe in a disabled rider are a result of their disability. This is particularly true for "extension" postures. It was found in this study that non-disabled children use a variety of postures and movements including those characterized by extension. Extension postures were originally hypothesized to occur early in the developmental sequence, and the observed frequencies of occurrence at the youngest ages studied support this hypothesis. For example, backward leaning of the trunk occurred most frequently in younger subjects. The results of the study support the concept that extension is an early appearing, but "normal" postural pattern.

Often disabled riders hold on or rest their hands on the saddle or horse. This was also observed in the "normal" five-year-olds studied here who had no riding experience. It seems that both types of riders may be stabilizing themselves on a moving object. The physically disabled riders may therefore not be exhibiting an abnormal postural pattern, but instead, may be stabilizing themselves in the same way non-disabled children do.

Recommendations for Further Study

The implications for further study are numerous. Research on riders with and without disabilities are valuable to both physical therapists working with therapeutic horseback riding programs as well as riding instructors teaching non-disabled or disabled children to

ride.

A study on physically disabled riders of the same age and experience level as the riders in this study could be performed to see if the categories formed for this study are useful for describing riding postures of the disabled population.

Also, since therapeutic horseback riding programs have riding classes for disabled adults, many whom have never ridden, a study of adult beginners could be carried out to determine if there are differences in component posture and movement between children and adult beginners. This investigator proposes that beginner adults will look different from beginner children when horseback riding. Specifically, in the upper extremity component, the adult beginner would be predicted to have extreme elbow flexion with shoulder abduction. In the lower extremity, the heel would be up or the foot would be level. The stirrup would be under the instep instead of the ball of the foot.

Future studies could include one to describe the posture and movement of riders at faster gaits: the trot and canter in which the posture or movement of the rider's trunk would be different. As the horse increases in speed there is often an increase in the forward inclination of the rider's trunk which is expected in the Hunt-seat form of riding, but may not be expected in dressage's basic

balance seat (Ensminger, 1969). A study of the rider during the above gaits, especially the trot, could be beneficial to therapeutic horseback riding programs because many children after becoming proficient at a walk are taught to ride the horse at a trot. Some physically disabled children are able to ride at a canter.

With a distance of 12.34 meters for the subject-camera distance, the distal parts of the extremities, the hand and foot, were difficult to see especially when gloves or dark boots or shoes were worn while riding a dark horse. In one instance, a subject had to be retaped. In a future study, white tape placed at points along the right outside leg seam of the child's jeans or jodphurs as well as on the heel of the boot or shoe might be helpful. This would allow for easier viewing and possibly more accurate descriptions. It might also be beneficial to use film instead of videotape to allow for a "crisper" picture of the foot and hand during still or slow motion viewing.

Another study should investigate the effect of stirrup length on the lower extremity position as all riding authorities agree that the stirrup must be at the correct length for the rider even though they may disagree on what length that is (de Romaszkan, 1937/1967; Froissard, 1971/1979; McTaggart, 1951; Museler, 1937/1983). Controlling the length of the stirrup leather would also allow for a more accurate portrail of the lower extremity

posture or movement in that at least all the subjects would have the stirrup at the same point. It would also be advantageous to have the saddle fitted for each subject, or at least use a children's saddle for the youngest group.

Research on individuals without disabilities should include a study of children of various ages who had never ridden. The purpose of such a study would be to determine the role age related factors play in horseback riding postures. Another study, could be conducted to determine if the categories formed and the gait cycle profiles seen in this study would occur in children who had not received lessons. This study would reveal information about the role instruction and formal riding lessons, plays in the rider's posture and movement. A leading question would ask if developmentally similar categories were present regardless of formal riding lessons.

Conclusions and Summary

In this last section, the conclusions and a summary of the study are presented.

Conclusions

The conclusions of this study are as follows:

1. The component categories formulated in this study are representative of posture and movement patterns seen in children of the same age and experience levels while English horseback riding at a walk.

2. Developmental sequences for a component cannot be formed from the descriptions of "correct" riding form.
3. The developmental sequence for the upper extremity component is hypothesized to be Category B, Category E, combined Categories A and C, and Category D in successive order.
4. The developmental sequence for the lower extremity is hypothesized to be Category B, Category A, Category C, and combined Categories D and E in successive order.
5. The developmental sequence for the head and trunk component is hypothesized to be Category A, combined Categories B and C, Category E, and Category D in successive order.
6. Five year old children exhibit postures and movements while riding that are generally unique to that age group.
7. Seven and eight year old children are more variable in the postures exhibited while riding than are five year old or nine and ten year old children.

Summary of the Study

In this study, Robertson's component model of movement analysis was used to describe children's equitation and propose developmental sequences for three components of

body action. Five-, seven-, eight-, nine-, and ten-year-old children with increasing levels of experience rode a horse at a walk. Body posture was described in terms of three components: the upper extremity, the lower extremity, and the head and trunk. Component categories were formed summarizing the posture or movement patterns of the children. Then, using information from horseback riding literature and the investigator's experience, these categories were arranged into a hypothesized developmental sequence for each component. The observed frequency of occurrence of the different component categories at each age were then graphed and compared to the hypothesized developmental sequence. The hypothesized developmental sequences were not supported.

The posture and movement of children riding varied in age and experience levels. The most common gait cycle profile across all subjects and gait cycles only occurred in the five year old children. The next most common profile across all the subjects was also the modal profile for the seven- and eight-year-old children. The third most frequent gait cycle profile across all subjects and cycles occurred only in the nine- and ten-year-old group of children.

Future research could include a study of physically disabled riders, adult beginners, inexperienced riders of various ages, or riders of the same age with varying amounts of formal riding lessons. The latter two studies would assess the role maturation or experience plays in the rider's posture and movement while English horseback riding at a walk.

It was concluded that: (1) the component categories formulated for this study are representative of children's posture or movement while riding a horse at a walk, (2) developmental sequences cannot be formed from descriptions of "correct" riding form, and (3) age and experience differences exist in children's riding posture.

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Appendix A
Exercises and Games Commonly used
in Therapeutic Horseback Riding Programs

Exercises

1. Hands to knees
2. Arms abducted to 90-180 degrees
3. Balance with stick in hands
4. Hands crossed over chest
5. Upper extremities swing alternately
6. Clapping hands in front and behind
7. Toe touch
8. Bend forward and touch horse's ears; bend backwards and touch horse's rear
9. Around the world (go 360 degrees in the saddle)
10. Stand in stirrups
11. Arms over head
12. Twist from waist
13. Arm circles
14. Ankle circles

Games

1. Basketball on Horseback (shooting ball into net)
2. Musical Stalls
3. Red Light, Green Light
4. Tag
5. Follow the Leader
6. Simon Says
7. Hokey Pokey
8. Potato Race
9. Relay Race
10. Treasure Hunt
11. Obstacle Course

Appendix B

Example of Letter to Facility

January 4, 1986

Dear Sir or Madam,

I am a graduate student at the Medical College of Virginia working on a Master of Science degree in physical therapy. I am planning to do my thesis on the equitation of children riding English at a walk. This research will use videotape to record the position of the child as the horse walks a straight-away of 20 feet.

My interest in horseback riding stems from two concerns: first, even though there are many books and a general consensus on correct English equitation, there has been no research in this area; and secondly, I plan to work with children in therapeutic horseback riding programs and feel that knowing the equitation of normal children riding English is important when teaching a handicapped child to ride.

I have all the necessary video equipment, but am in search of ten seven year old children who have ridden for approximately five to eight months and ten nine year old children who have ridden for approximately a year and one-half. I also need a facility where I may videotape and the use of a school horse.

The child would be asked to ride in an all-purpose English saddle. They would ride the horse at a walk on a 20 foot straight-away five times. I would like to videotape anytime in January, February, or March of 1986 at the riders' and facility's convenience.

Would you and your riders be willing to allow my to videotape them while riding, or could you suggest a facility that might? I would be responsible for contacting the parents of children who would be willing to participate and would obtain signed parental consent before allowing them to participate in the study.

Appendix B
Example of Letter to Facility
continued

January 4, 1986

I would be more than happy to come and talk with you about my study in detail at your convenience. If you have any questions, feel free to call me at 329-8698 in the evenings after 8:00 or in the morning from 6:00 to 7:30, or you can reach me during working hours at 254-5586. Thank you so much for your time. I will contact you in a week or so if we haven't already spoken. I look forward to talking with you.

Sincerely,

Mary Katherine Belissary

Appendix C

Example of Letter to Parents

February 8, 1986

Dear Parents,

I am a graduate student at the Medical College of Virginia working on my Master of Science degree in physical therapy. I am planning to do my thesis on the position of children while horseback riding English at a walk. This study will benefit those who work with therapeutic horseback riding programs where handicapped children are taught to ride horseback.

I would like to videotape your child riding English at a walk on February 22nd. Your child will ride his usual mount at Stillmeadows Farm either before or after their regular riding lesson. Your child would be asked to wear a turtleneck or close-fitting shirt, jeans, and shoes. Boots and/or jodphurs are not required, but a hard hat will be furnished for each child while they are riding for the study. The child will be asked to ride a 20 foot straight-away at a walk five times at which time they will be videotaped.

Your child's identity will be held confidential, and the tape will only be used for teaching and research purposes. If, for any reason, and at any time, your child does not want to participate, he/she will be allowed to withdraw from the study.

Appendix C
Example of Letter to Parents
continued

February 8, 1986

I would be more than happy to talk with you in more detail at your convenience and answer any questions you or your child might have. My telephone number is 329-8698; I can be reached after 7:30 p.m. or from 6:00 to 7:30 a.m. on the weekdays and anytime on the weekend. If your child would be willing to participate, and you would be willing to allow them, please fill out and sign the attached consent form and return it by mail in the enclosed stamped, self-addressed envelope. Thank you so much for your time.

Sincerely,

Mary Katherine Belissary

Appendix D

Consent Form

Permission is granted to Mary Katherine Belissary to include my child in a study concerned with riding horseback in an English saddle at a walk. I understand my child's identity will be held confidential and that the videotape will only be used for teaching and research purposes. I have explained to my child that he/she may refuse to horseback ride for this study and thereby withdraw from the study at any time and for any reason. To my knowledge, there are no medical or physical conditions that would prevent my child from riding horseback at a walk. The purpose of the study and the procedure to be used have been explained to me and my child. All of my questions have been answered, and permission is granted to include my child in this study.

Date

Signature of Parent/Guardian

Child's name

Witness

Child's date of birth

When Riding Lessons Started
(included for all subjects
except for five-year-olds)

Appendix E
Decision Rules

1. In cases where the right arm position is below the mid-chest, but the elbow is not moderately flexed, but extended, the arm position will be used to determine the category.
2. In cases where the shoulder is in significant internal rotation, with the elbow flexed, it will be placed in Category B: Elbow flexion with pronation.
3. If the head is "bobbing", but is held in midline, it will be considered to be "midline and erect".
4. If there is kyphosis or lordosis present, the head and trunk component category will be determined by the relationship of the shoulder to the hip.
5. In cases where the heel of the shoe or boot is below the level of the toes, the heel will be considered to be below the level of the toes.
6. Anytime a subject kicks their horse within a gait cycle, that cycle will be considered invalid.
7. When two categories are exhibited during the same gait cycle, the category hypothesized to be the lower one developmentally will be assigned for that trial.

Appendix F

Table 9

1
Gait Cycle Profiles across
All Subjects and Trials

(N=300)

Trial:	1		2		3		4		5	
Cycle:	1	2	1	2	1	2	1	2	1	2
Subject:										
1R	BDB	BBB	BBB	BCB	BCB	BCB	BCB	BCB	BCB	BAB
3	CDC	CDC	CDC	CDC	CDC	CDC	CDC	CDC	CBC	CBC
3R	EBC	EBC	BAC	BBC	BCC	BBC	ECC	ECC	ECC	EAC
*6	***	DDE	DDE	DDE	DDE	DDE	DDE	***	DDE	***
6R	EBC	EBC	EBC	EBC	EBA	EBA	EBC	EBC	EBC	EBC
8	EBA	EBA	EBA	EBA	EBA	ECA	EAA	EBA	ECA	EAA
9	EBC	EBC	ECC	ECC	ECC	EBC	ECC	EBC	EBC	DBC
10	ADC	ADC	ADC	AEC	ABB	ADC	CEC	CEC	ACB	AAB
*11	DEC	DEC	DEC	DEC	DEC	DEC	DEC	DEC	DEC	DEC
19	CEC	DEC	CED	DED	CEE	DEE	CDD	CED	CEE	CFE
20	ADE	CDE	CDE	CDE	DDC	DDC	CDE	CDE	DDE	DDE
21	DDE	DDE	DDE	DDE	DEE	DEE	DDE	DDE	DDE	DDE
22	DEE	DEE	DDE	DEE	DEE	DEE	DDE	DDE	DAE	DAE
23	DAA	DAA	EAA	EBA	DAA	DAA	BAA	BAA	BAA	BAA
24	DAA	BAA	EAA	EAA	EAA	EAA	EAC	EBC	DDC	DDC
26	DBC	DBC	DBC	DEC	DCC	DBC	DBC	DAC	DCC	DCC
27	EBC	EBC	EBA	EBB	EBC	EBC	ECC	EBC	EBB	EBC

1 Profile represents the combination of upper extremity, head and trunk, and lower extremity action for a single gait cycle. Thus, CED of Subject 31 refers to upper extremity Category C, head and trunk Category E, and lower extremity Category D.

* Subject stable across all components for all gait cycles

*** Gait cycle not used due to rider kicking the horse

Appendix F

Table 9, continued
 1
Gait Cycle Profiles across
All Subjects and Trials
 (N=300)

Trial:	1		2		3		4		5	
Cycle:	1	2	1	2	1	2	1	2	1	2
Subject:										
28	EBC	EBC	EBE	EBE	EBE	EBE	EBC	EBE	EBE	EBE
29	EBC	EDC	ECC	EBC	EEC	EBC	EBC	EBC	EDC	EBC
30	DDC	***	DDC	DDC	DEC	DDC	DEC	DDC	DCC	DBC
31	CED	CDD	CDD	CDE	CDD	CDD	ABE	CBE	CDE	CDE
32	DCE	DCE	DCE	DCE	DBE	DBE	DBE	DBE	DBE	DBE
33	DEE	DDE	DDE	DDE	DEE	DEE	DDE	DEE	DEE	DEE
34	DBE	DBE	DEE	DEC	DBC	DCC	DEE	DEE	DEC	DAC
35	AAC	AAC	BAC	AAC	AEC	ACC	BAC	BAC	AAC	AAC
36	DDC	CBC	***	DBB	DDB	DBC	DBC	DBC	DDD	DBD
37	DCC	DBC	DEC	DDC	DEB	DDC	DEC	DDC	CAC	DAC
38	DAC	DBC	DAC	DBB	DAC	DCC	DEC	DCC	DCC	DAC
39	DDC	DDC	CEC	CDC	CEC	CBC	AEC	CDB	DEC	CDC
40	DAC	DAC	DAC	DEC	DCE	DEC	DEC	DEC	DCC	DEC

1 Profile represents the combination of upper extremity, head and trunk, and lower extremity action for a single gait cycle. Thus, CED of Subject 31 refers to upper extremity Category C, head and trunk Category E, and lower extremity Category D.

*** Gait cycle not used due to rider kicking the horse

Appendix F

Table 10

Frequency of Occurrence of
Gait Cycle Profiles

(N=295)

PROFILE	NUMBER OF CYCLES	PROFILE	NUMBER OF CYCLES
EBC	31	BBB	2
DEC	26	BBC	2
DDE	24	DAE	2
DEE	17	DBB	2
DDC	15	EAC	2
DBC	13	EBB	2
CDC	10	ECA	2
DAC	10	EDC	2
DCC	10	AAB	1
EBA	10	ABB	1
ECC	9	ABE	1
CDE	8	ACB	1
DBE	8	ACC	1
EAA	7	ADE	1
EBE	7	BAB	1
BCB	6	BCC	1
AAC	5	BDB	1
BAA	5	CAC	1
CDD	5	CBE	1
CEC	5	CDB	1
DAA	5	DBD	1
ADC	4	DDB	1
BAC	4	DDD	1
CBC	4	DEB	1
DCE	4	DED	1
AEC	3	EEC	1
CED	3		
CEE	3		

- 1 Profile presents the combination of upper extremity, head and trunk, and lower extremity action for a gait cycle.

Appendix G

Table 11

Percent Occurrence of Gait CycleProfiles within Age Groups

(N=100 for the five year old children)
 (N=99 for the seven- and eight-year-old children)
 (N=96 for the nine- and ten-year-old children)

Five year old children		Seven- and eight-year-old children		Nine- and ten-year-old children	
Profile	%	Profile	%	Profile	%
EBC	31.0	DEC	21.22	DDE	25.0
EBA	10.0	CDC	10.10	DEE	17.0
ECC	9.0	DAC	8.08	CDE	8.3
EAA	7.0	DDC	6.06	DBE	8.3
EBE	7.0	AAC	5.05	DBC	7.3
BCB	6.0	CEC	5.05	DDC	7.3
BAA	5.0	DBC	5.05	DCC	5.2
DAA	5.0	DCC	5.05	DEC	5.2
BBB	2.0	ADC	4.04	CDD	4.2
BBC	2.0	CBC	4.04	DCE	4.2
DDC	2.0	AEC	3.03	DAC	2.0
EAC	2.0	BAC	3.03	DAE	2.0
EBB	2.0	CEE	3.03	ABE	1.0
ECA	2.0	CED	2.02	ADE	1.0
EDC	2.0	DBB	2.02	CBE	1.0
BAB	1.0	AAB	1.01	CED	1.0
BAC	1.0	ABB	1.01		
BCC	1.0	ACB	1.01		
BDB	1.0	ACC	1.01		
DBC	1.0	CAC	1.01		
EEC	1.0	CDB	1.01		
		CDD	1.01		
		DBD	1.01		
		DDB	1.01		
		DDD	1.01		
		DEB	1.01		
		DED	1.01		
		DEE	1.01		

Appendix H

Publishable Article

Age and Experience Differences in Posture and Movement in Children while English Horseback Riding at a Walk.

Mary Katherine Belissary

Dr. Ann F. VanSant

Ms. Belissary was a student in the master's degree program, Department of Physical Therapy, School of Allied Health Professions, Medical College of Virginia, Virginia Commonwealth University, Richmond, Va, when this study was conducted. She is a staff physical therapist at Retreat Hospital, Richmond, Va.

Dr. VanSant is Associate Professor, Department of Physical Therapy, Box 224, Medical College of Virginia, Virginia Commonwealth University, Richmond, VA 23298-0001 (USA).

This study was completed in partial fulfillment of the requirements for Ms. Belissary's Master of Science degree, Medical College of Virginia, Virginia Commonwealth University.

ABSTRACT

AGE AND EXPERIENCE DIFFERENCES IN POSTURE AND MOVEMENT OF CHILDREN WHILE ENGLISH HORSEBACK RIDING AT A WALK

The purposes of this study were to: (1) describe posture and movement of non-disabled children English horseback riding at a walk, (2) propose a developmental sequence for each of three components of body posture and movement, and (3) describe age differences seen in the subjects.

Thirty children without disabilities were videotaped horseback riding at a walk. Posture and movement of the three components were each described in writing and categories were established. A developmental sequence was proposed for each component. The frequency of occurrence of each category in each age group was determined and graphed with respect to age.

Five categories of posture and movement were formed for each of the components. The children demonstrated 54 different combinations of component posture and movement. None of the developmental sequences proposed were supported by the data. However, age differences observed in this study enabled proposing new developmental sequences for component posture and movement.

INTRODUCTION

All physically handicapped individuals that participate in a therapeutic horseback riding program run under the auspices of the North American Riding for the Handicapped Association (NARHA) are required to have a doctor's referral and a physical therapy evaluation before they begin the program. The role of the physical therapist is to recommend to the riding instructor appropriate adaptive equipment, necessary characteristics of the horse for a particular rider, mounting and dismounting procedures, and therapeutic exercises to be carried out by the rider while on the horse.¹ Since physical therapists have an integral role in therapeutic horseback riding, it is important that they gain knowledge of the postures and movements of individuals while horseback riding. Even though there are numerous books on English style horseback riding and the rider's position on horseback, there is a lack of research describing that riding position. The purposes of this study were: (1) to describe the posture and movement of normal children seated in an English saddle while riding a horse at a walk, (2) to propose a developmental sequence for each of three components of body posture and movement: the upper extremity, the head and trunk, and the lower extremity, and (3) to describe the differences between age groups with various levels of experience.

REVIEW OF LITERATURE

Horseback Riding

There are numerous books written on equitation, the art of riding. These texts describe the way a rider should look on horseback. In English style riding, a basic balance seat is used. In this form of riding, the arms are held close to the body and form an obtuse angle with respect to the forearms.² A straight line from the bit of the horse's bridle, through the reins, hands, wrists, and forearms, to the elbows is proposed to allow efficient and effective control of the horse.³ The head and trunk posture are important as the rider uses his body weight and his trunk to influence the horse to change gaits⁴ and to maintain equilibrium with the horse.⁵ In the basic balance seat position, the head and the trunk should be held erect and vertical. According to Heipertz,⁶ the rider while astride the horse sits on the os ischii and os pubis allowing adaption to the horse's movements. The lower extremities are used to control the horse's hindquarters.⁴ The thigh is maintained in contact with the saddle with the hip and knee flexed, but the angle between the thigh and the leg will vary according to the rider's leg⁵ and thigh length and the curvature of the horse's body. The heels of the rider are down and the rider should not be able to see his toes while astride the horse. A rider in the

"correct" position, could have a vertical line drawn through the ear lobe, the tip of the shoulder, and the hip joint.⁷ The line should fall behind the knee and ankle joint (see Figure 1).

Motor Development

Motor development was viewed as an orderly sequence of changes as an individual interacts with the environment.⁸ The present study employed the interactionist developmental theory as a foundation for research. In the interactionist theory, the nervous system and the environment interact to produce an appropriate behavior.⁹ This study of horseback riding represents an attempt to identify a developmental sequence within the task of English horseback riding.

The component model of movement analysis was used in this study to describe the posture and movement of children riding horseback.¹⁰ Roberton developed the component model to propose motor development sequences for specific body segments, or components of the body, within a single task. Using this model, categorical descriptions of the patterns of movement were formulated for each component. These categories were then ordered into a developmental sequence for that component.

Roberton, Williams, and Langendorfer¹¹ described a screening technique using data gathered from a cross-sectional survey of different age groups to test a hypothesized developmental sequence for a given task. This

screening procedure was used in this study. A developmental sequence was proposed from horseback riding literature and the first author's experience. If a sequence was correctly ordered, early appearing steps of the sequence should be exhibited most frequently by the youngest children. A decrease in the early steps' frequency of occurrence and an increase in the frequency of later appearing steps of the sequence is expected in older age groups. The expected longitudinal relationship between age and frequency of occurrence for each developmental step can be graphed. This is then compared to data collected in a cross-sectional study of children of different ages. Since no one has described posture and movement of children while horseback riding, this became the first step of this study.

METHOD

Subjects

Three groups of ten children, with different age and horseback riding experience levels, were videotaped English horseback riding at a walk. The first group included five year old children, with a mean age of 62.6 months, who had never received formal horseback riding lessons. The second group comprised seven- and eight-year-old children ranging in age from 89 to 101 months with a mean age of 96.6 months, who had received six months or less of formal

horseback riding lessons with an average of 3.9 months of riding lessons. The last group, the nine- and ten-year-old children, had received seven months or more of formal horseback riding lessons. This oldest group ranged in age from 112 months to 131 months with a mean of 122.5 months. They had received an average of 25.9 months of riding lessons with a range of 7 months to 72 months. All subjects had signed parental consent allowing them to participate in the study. Parents verified that their child had no medical or physical condition that would interfere with horseback riding.

Procedure

I used a video camera and recorder to document the subject's posture and movement on the horse walking. The camera was mounted on a tripod 1.22 meters above the ground and located at 12.34 meters from the field of action. The power zoom lens was set at a speed of 20 with the focus on infinity. The field of action was 3.05 meters wide with 3.05 meters additional walkways before and after the action field. This allowed for a consistent walk from the horse. The optical axis of the camera ran approximately perpendicular to the field of action.

Owners of two riding stables in Richmond, Va., and one stable in Darlington, S. C., provided riding students, their school horses, and facilities for this study. I videotaped five consecutive trials with two gait cycles of

the horse available from each trial. A gait cycle was the interval between right front hoof strikes.

Instructions

For the five-year-olds, a leader for the horse and a sidewalker for the rider were used to insure safety. These procedures are used routinely with novice riders enrolled in therapeutic horseback riding programs. The first author instructed the leader to walk the horse down the field of action when the command "Ready, walk" was given. The sidewalker was instructed to hold onto the safety belt as necessary to assist the child in maintaining their balance.

All the other children were asked to walk their horse down the walkway through the field of action five times. They were instructed to wait until the command "Ready, walk" was given before they started to ride. Any questions the rider had were answered, but no practice trials were given.

Data Reduction

The tapes were viewed using a slow motion, stop-action, video cassette recorder and television monitor. Written descriptions of posture or movement within a single component were generated for all subjects during each complete gait cycle. This procedure was repeated for each component: the upper extremity, the head and trunk, and the lower extremity. Categorical descriptions of component

posture and movement were established based on the similarities and differences in the written descriptions of posture or movement. The descriptions of all the subjects during each gait cycle were used to form these component categories. The categories were subjected to inter- and intra-rater objectivity tests before they were used to classify all the subjects' posture and movement.

The first author trained the second author to analyze component posture or movement of the children horseback riding and to classify performance using the categorical descriptions. Inter-rater and intra-rater objectivity tests were performed for all components. We decided that 85% exact agreement would be a criterion for inter-rater objectivity tests and that 90% exact agreement would be necessary for intra-rater objectivity tests. As we performed the inter-rater objectivity study, the categorical descriptions were refined and decision rules generated to clarify the categorization of the riders' posture. A Kappa statistic¹² was calculated for the inter-rater reliability of each component.

Data Analysis

The first author used information from the horseback riding literature and her knowledge of horseback riding to propose a sequence of development for each component with the categories serving as developmental steps. After forming the categories of posture and movement, we then

graphed the proposed developmental sequence for each component as it would be expected to appear across time (see Figure 2). The first author then calculated and graphed the actual percent occurrence of each category in each age group within each component. Next, we compared the graphs of the hypothesized sequence and the observed frequency of occurrence of each category in each age group.

In order to describe children's riding, the combination of upper extremity, head and trunk, and lower extremity component categories exhibited by the subjects during each gait cycle was determined. The modal gait cycle profile was determined across all subjects and for each age group.

RESULTS

Formulation of Categories

Five categories describing the riders' posture and movement were formed within each component. See Tables 1, 2, and 3 for a description of each category for the upper extremity, the head and trunk, and the lower extremity components, respectively.

Inter-rater and Intra-rater Tests

Inter-rater objectivity tests revealed 90% exact agreement between the first and second author in the upper extremity and lower extremity components. We reached 93.3% exact agreement for the head and trunk component. The

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Kappa statistic revealed an inter-rater reliability of .86 for the upper extremity, .91 for the head and trunk and .84 for the lower extremity. In the tests for intra-rater objectivity of the first author, 93.3% exact agreement for the upper extremity, and 90% for both the head-trunk and lower extremity components were attained.

Developmental Sequences

Upper Extremity Developmental Sequence

Graphs of both the hypothesized developmental sequences and the observed frequency of occurrence of categories at each age for the upper extremity are presented in Figure 3. The hypothesized developmental sequence: hand on saddle or horse, elbow extension with pronation, elbow flexion with pronation, elbow extension with neutral forearm, and elbow flexion with neutral forearm, was not supported. The data revealed that elbow extension with pronation, elbow flexion with pronation, and elbow extension with neutral forearm were never modal categories for any of the age groups studied. It appears that elbow flexion with pronation may have been more frequently observed in children younger than five years old.

Head and Trunk Developmental Sequence

For the head and trunk component, the graphs of both the hypothesized developmental sequence and the frequency of occurrence of each category at each age are presented in

Figure 4. The hypothesized sequence was not supported. The data supported a developmental sequence of: trunk vertical without head alignment, backward leaning, forward inclination without head alignment, trunk vertical with head alignment, and forward inclination of the trunk with head alignment. In this instance, Category C: trunk vertical without head alignment and Category E: trunk vertical with head alignment were more prevalent in younger subjects.

Lower Extremity Developmental Sequence

For the lower extremity, the frequency of occurrence of the categories at each age is presented in Figure 5. This ordering does not support the hypothesized developmental sequence. Category B: foot below knee with heel up and Category E: toes at or behind knee with heel down or foot level were more prevalent in younger subjects. It is possible that Category A: heel in front of knee and Category B: foot below knee with heel up could be the most common postures at some point earlier than age five, and that Category D: toes at or behind knee with heel up would be most common at some age beyond ten years old.

Gait Cycle Profiles

A gait cycle profile is that combination of upper extremity, head and trunk, and lower extremity component action that together describes the posture and movement of a subject while English horseback riding at a walk. A

total of 54 different profiles appeared across the 30 subjects studied. The modal gait cycle profile across all subjects and all cycles was: upper extremity Category E: Hand on saddle or horse; head and trunk Category B: Forward inclination without head alignment; and lower extremity Category C: Foot below knee with heel down or foot level (see Figure 6). This profile occurred in 10.5% of all gait cycles across all trials, but was only seen in the five year old children.

The next most common gait cycle profile occurred in 8.8% of the gait cycles. This profile consisted of: upper extremity Category D: Elbow flexion with neutral forearm; head and trunk Category E: Trunk vertical with head alignment; and lower extremity Category C: Foot below knee with heel down or foot level (see Figure 7). The third most common gait cycle profile was characterized by the upper extremity Category D: Elbow flexion with neutral forearm; head and trunk Category D: Forward inclination with head alignment; and lower extremity Category E: Toes at or behind knee with heel down or foot level (see Figure 8). This combination of component action occurred in 8.1% of the gait cycles across all subjects. However, this latter profile was only seen in the nine- and ten-year-old children.

Age and Experience Differences

There were age and experience differences in the posture and movement of children English horseback riding at a walk (see Table 4). For the five year old children, who had never received formal horseback riding lessons, 21 different gait cycle profiles were observed. Of these profiles, 18 never occurred in the older children. The most common gait cycle profile for the five year old children is illustrated in Figure 6. This profile occurred in 31% of the five-year-olds' gait cycles and was never observed in the other age groups.

For the seven- and eight-year-old children, who had received six months or less of formal riding lessons, 28 different gait cycle profiles were seen. Only nine of the gait cycle profiles seen in the seven- and eight-year-old riders were seen in other age groups. The gait cycle most commonly seen is illustrated in Figure 7. It occurred in 21.2% of the seven- and eight-year-old riders' gait cycles. This profile was never seen in the five-year-olds and was only seen in five gait cycles of the nine- and ten-year-old riders.

For the nine- and ten-year-old children, who had received seven months or more of formal riding lessons, 16 different gait cycle profiles were observed. Of the 16 various profiles observed in the nine- and ten-year-old

riders, half never occurred in other age groups. The modal gait cycle profile of the nine- and ten-year-old children is illustrated in Figure 8. This profile occurred in 25% of this group's gait cycles.

DISCUSSION

Posture and Movement of Children while Riding

Gait Cycle Profiles

The profiles were very characteristic of the various age groups. For example, the modal profile of the five year old children was not seen in older subjects. The profiles seen in the five year old children could be different from the older children for three reasons: (1) they had never received formal riding lessons, (2) they were the youngest age group, and/or (3) the conditions surrounding data collection were different for this age group including a leader and a sidewalker.

The profiles of the older children were more commonly seen in more than one age group. However, the older riders are still very representative of their particular age group as exhibited by the results of the study. That a profile is very representative of an age group in this study may be due to the amount of formal riding lessons they have received, the age of the child, or the combination of the two as I would propose based on the interactionist theory.

Developmental Sequences

English riding is a formal style of riding. There are definite standards, though seemingly arbitrary, for "correct" riding form. In hypothesizing the developmental sequences, knowledge of the horseback riding literature was used to propose a developmental order. The lack of support for the developmental sequences could be due to the horseback riding literature addressing the "correct" form; not addressing the beginning rider's posture. For example, in the upper extremity component, the category containing the posture of elbow flexion with pronation, was observed to occur more frequently in younger riders than the category containing the posture of hand on saddle or horse. It had been originally hypothesized that in the hand on the saddle or horse category, the child would stabilize himself by holding onto the horse or saddle. The posture of forearm flexion with pronation with the shoulders held close to the body could be a mild form of "high-guard". High guard can be exhibited in varying degrees, from full shoulder abduction, retracted scapulae, elbows flexed with pronated forearms and fistled hands, to retracted scapulae only, and is frequently observed when children initially attempt a new postural task such as standing or walking.

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In the head and trunk component, initially the latest occurring category was hypothesized to be Category E: Trunk

vertical with head alignment. However, Category E was most frequently seen in seven- and eight-year-old children and Category D: Forward inclination with head alignment occurred more in the nine- and ten-year-old children. Seven- and eight-year-old riders may have had all or most of their exposure to horseback riding occurring only during their formal riding lessons, and therefore, they were exhibiting the "correct" position described in horseback riding literature. The forward leaning observed more frequently in the older riders could be due to: riding more frequently without feedback from a riding instructor, or using a Hunt-seat form of riding instead of the basic balance seat. The Hunt-seat position is used when jumping the horse and is commonly taught to riders as they are usually taught how to jump the horse after mastering the walk, trot, and canter.

Revised Developmental Sequences

In hypothesizing revised developmental sequences, I would combine upper extremity Categories A and C, elbow extension with pronation and elbow extension with neutral forearm respectively, due to their similar postural form and their similar frequencies of occurrence (see Figure 3). This would allow for elbow extension to be the determining factor in category placement regardless of forearm position. I would combine the head and trunk Categories B

and C which both lack head alignment, regardless of the trunk being vertical or inclined forward, because of their similar head position and graph forms (see Figure 4). This combined category would then be placed as the second earliest developmental step (see Table 5). In the lower extremity component, I would combine Category D: Toes behind knee with heel up and Category E: Toes behind knee with heel down or foot level due to Category D's low frequency of occurrence and the similar position of the knee. In other words, any time the toes were behind the knee, regardless of the heel being up, down, or the foot level, that posture would be placed in the combined category (see Table 5).

Implications and Recommendations

Clinical Implications

Many physical therapists working with therapeutic horseback riding programs are not familiar with riding postures and movements, and may think some postures or movements they observe are due to a rider's disability. However, we found through this study that "normal" children do use a variety of postures and movements while riding. Some postures are characterized by extension patterns often considered to be abnormal. For example, one five year old subject, exhibited an extensor pattern in the trunk and lower extremity much like disabled riders. In this posture, the trunk is leaned backwards and the knees are

extended. In other words, the rider's posture may not solely be a result of the disability, but also related to their age or level of experience.

Recommendations for Further Studies

Research on riders with and without disabilities could be valuable to both physical therapists working with therapeutic horseback riding programs and riding instructors. A study of physically disabled riders of the same age and experience level as the riders in this study could be used to determine if the riding posture and movement of the disabled can be described using the categories established in this study.

Other research could determine if variability exists between children of different ages who have no experience horseback riding. The purpose of such a study would be to determine the role age related factors have in horseback riding postures. Another study could be conducted to determine if the categories formed and the profiles seen in this study would occur in children who had ridden horses, but never received formal riding lessons. This study would reveal information about the role instruction has in the rider's posture or movement. A leading question would ask if developmentally similar categories were present regardless of formal riding lessons.

Conclusions

The conclusions of this study are as follows:

1. The component categories formulated through this study are representative of posture and movement patterns seen in children of the same age and experience levels while English horseback riding at a walk.
2. Developmental sequences cannot be formed from descriptions of "correct" riding form.
3. Age and experience differences exist in children's riding posture.
4. For all age groups, at least 50% of the profiles exhibited by that group are unique to that age grouping.

Summary

The purposes of this study were to describe the posture and movement of non-disabled children seated in an English saddle riding the horse at a walk; to propose a developmental sequence for each of three components of body posture and movement; and to describe differences in age and experience levels. In this study, Robertson's component model of movement analysis was used to describe children's equitation. Component categories were formed based on the posture and movement patterns of the children. Then, using the information from horseback riding literature and the first author's riding experience, the categories were arranged into a hypothesized developmental sequence for each component. The observed frequency of occurrence of

the different component categories in each age group did not support the hypothesized developmental sequences. Each age group demonstrated a different combination of component action while riding.

Future studies could include a study on physically disabled riders of the same age and experience levels as the riders used in this study. Other studies could assess the maturation of the child or the formal instruction received on the rider's posture and movement while English horseback riding at a walk. It was concluded that the component categories formulated for this study could be used to classify postures or movement patterns while riding a horse at a walk in other individuals of the same age and experience levels.

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Table 1.
Upper Extremity Component Categories

- E HAND ON SADDLE OR HORSE
The hand is resting on the saddle or horse's neck or gripping onto the saddle, or the rider is not holding the rein in his hand.
- A ELBOW EXTENSION WITH PRONATION
The arm is held at mid-chest or higher with the elbow moderately to fully extended. The forearm is pronated.
- B ELBOW FLEXION WITH PRONATION
The arm is held below mid-chest with the elbow moderately flexed. The forearm is pronated and may be in front of the body (i.e. shoulder internal rotation). The forearm may also be moving up and down.
- C ELBOW EXTENSION WITH NEUTRAL FOREARM
The arm is held at mid-chest or higher with the elbow moderately to fully extended. The forearm is in a neutral position.
- D ELBOW FLEXION WITH NEUTRAL FOREARM
The arm is held below mid-chest with the elbow moderately flexed. The forearm is in a neutral position.

Table 2.
Head and Trunk Component Categories

- A **BACKWARD LEANING**
The shoulder is posterior to the hip joint. The head may be moving about or held in midline.
- B **FORWARD INCLINATION WITHOUT HEAD ALIGNMENT**
The shoulder is anterior to the hip joint. It is not uncommon for the spine to have a lumbar or thoracic kyphosis. The head is rotated or flexed for at least part of the gait cycle.
- C **TRUNK VERTICAL WITHOUT HEAD ALIGNMENT**
The shoulder is directly above the hip joint. The head is rotated or flexed for at least part of the horse's gait cycle.
- D **FORWARD INCLINATION WITH HEAD ALIGNMENT**
The shoulder is anterior to the hip joint. The head is in midline and erect.
- E **TRUNK VERTICAL WITH HEAD ALIGNMENT**
The shoulder is directly above the hip joint. The head is in midline and erect.

Table 3.
Lower Extremity Component Categories

- A HEEL IN FRONT OF KNEE
The heel of the foot is in front of the knee. The foot can be in dorsiflexion, neutral, or plantarflexion.
- B FOOT BELOW KNEE WITH HEEL UP
Some part of the foot, from the ball of the foot to the back of the heel, lies directly below the knee. The heel of the foot is above the toes.
- C FOOT BELOW KNEE WITH HEEL DOWN OR FOOT LEVEL
Some part of the foot, from the ball of the foot, to the back of the heel, lies directly below the knee. The heel is lower than, or level to, the toes.
- D TOES AT OR BEHIND KNEE WITH HEEL UP
The toes are under or behind the knee with the heel of the foot above the toes.
- E TOES AT OR BEHIND KNEE WITH HEEL DOWN OR FOOT LEVEL
The toes are equal to or behind the knee with the heel of the foot below, or level to, the toes.

 Table 4.
 Frequency of Occurrence of Component
 Categories for each Age Group

UPPER EXTREMITY COMPONENT CATEGORIES:

Category	Total	Five year old children	Seven- and eight-year- old children	Nine- and ten-year- old children
E	73	73	0	0
A	20	0	18	2
B	22	19	3	0
C	39	0	25	14
D	146	8	54	84

LOWER EXTREMITY COMPONENT CATEGORIES:

Category	Total	Five year old children	Seven- and Eight-year- old children	Nine- and Ten-year- old children
A	29	29	0	0
B	20	12	8	0
C	159	52	81	26
D	11	0	6	5
E	76	7	4	65
*(Kick)	5	0	1	4

HEAD AND TRUNK COMPONENT CATEGORIES:

Category	Total	Five year old children	Seven- and Eight-year- old children	Nine- and Ten-year- old children
A	43	21	18	4
B	85	55	13	17
C	34	17	7	9
D	77	5	24	48
E	61	1	38	22

 Table 5.
 Gait Cycle Profiles by age groups and
 frequency of occurrence within age group

Order: Upper extremity, Head and Trunk, Lower Extremity

Five year old children		Seven and eight year old children		Nine and ten year old children	
Profile	#	Profile	#	Profile	#
EBC	31	DEC	21	DDE	24
EBA	10	CDC	10	DEE	16
FCC	9	DAC	8	CDE	8
EAA	7	DDC	6	DBE	8
EBE	7	AAC	5	DBC	7
BCB	6	CEC	5	DDC	7
BAA	5	DBC	5	DCC	5
DAA	5	DCC	5	DEC	5
BBB	2	ADC	4	CDD	4
BBC	2	CBC	4	DCE	4
DDC	2	AEC	3	DAC	2
EAC	2	BAC	3	DAE	2
EBE	2	CEE	3	ABE	1
ECA	2	CED	2	ADE	1
EDC	2	DBB	2	CBE	1
BAB	1	AAB	1	CED	1
BAC	1	ABB	1	KICKS	4
BCC	1	ACE	1		
BDE	1	ACC	1		
DBC	1	CAC	1		
EEC	1	CDB	1		
		CDD	1		
		DBD	1		
		DDB	1		
		DDD	1		
		DEB	1		
		DED	1		
		DEE	1		
		KICK	1		
TOTALS:	100		100		100

Table 6.
Developmental Sequences

Upper Extremity Component Categories:

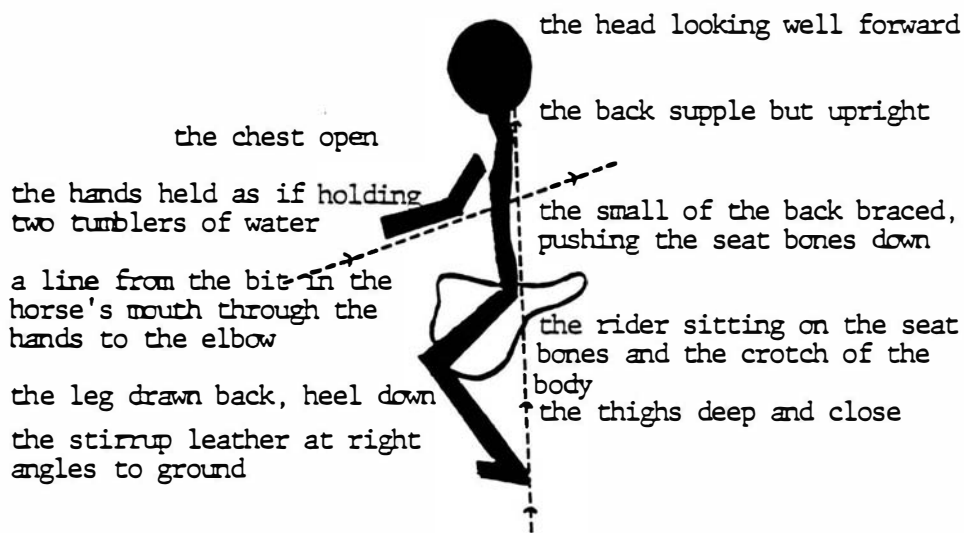
<u>Hypothesized</u>	<u>Observed</u>	<u>Revised</u>
Category E	Category B	Category B
Category A	Category E	Category E
Category B	Category A	Categories A & C
Category C	Category C	Category D
Category D	Category D	

Head and Trunk Component Categories:

<u>Hypothesized</u>	<u>Observed</u>	<u>Revised</u>
Category A	Category C	Category A
Category B	Category A	Categories B & C
Category C	Category B	Category E
Category D	Category E	Category D
Category E	Category D	

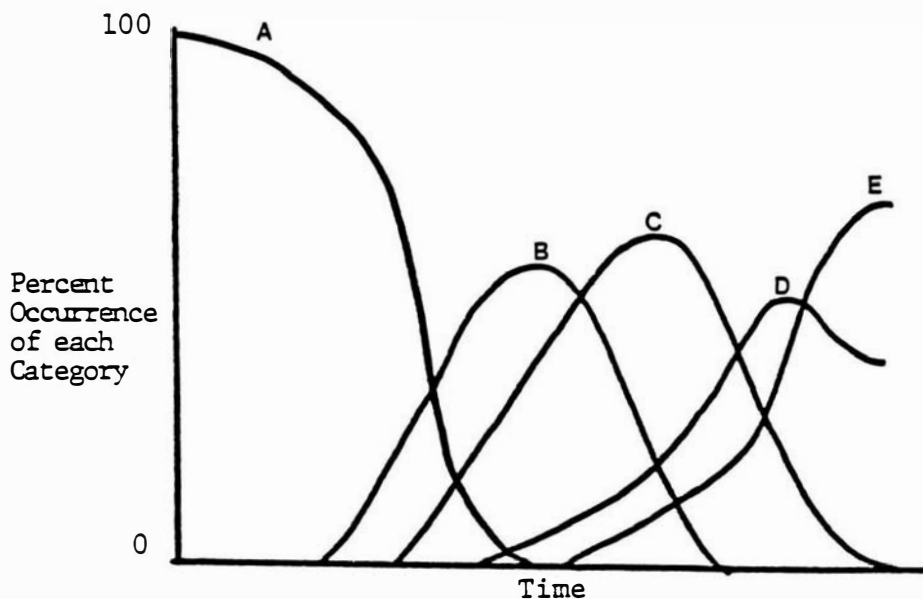
Lower Extremity Component Categories:

<u>Hypothesized</u>	<u>Observed</u>	<u>Revised</u>
Category A	Category B	Category B
Category B	Category A	Category A
Category C	Category C	Category C
Category D	Category E	Category D & E
Category E	Category D	



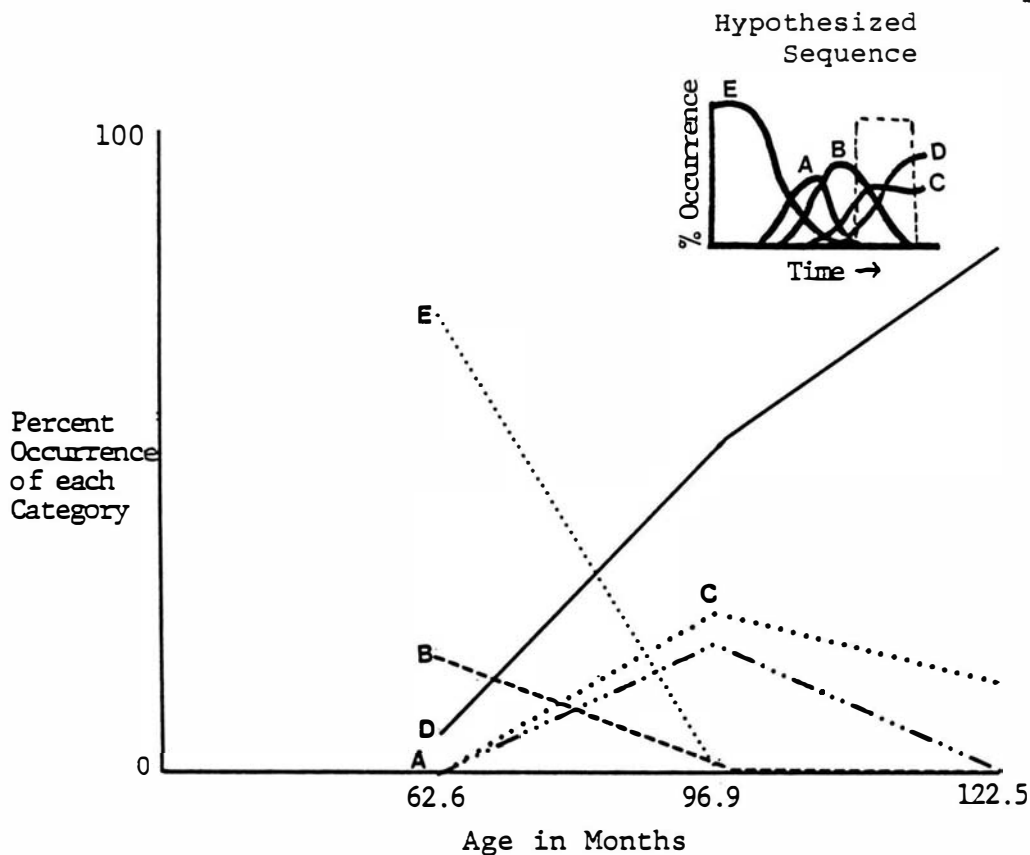
a line from heel, hip, and shoulder

(the lines are given to help in the maintenance of the correct position.)



Categories Listed in Successive Order:

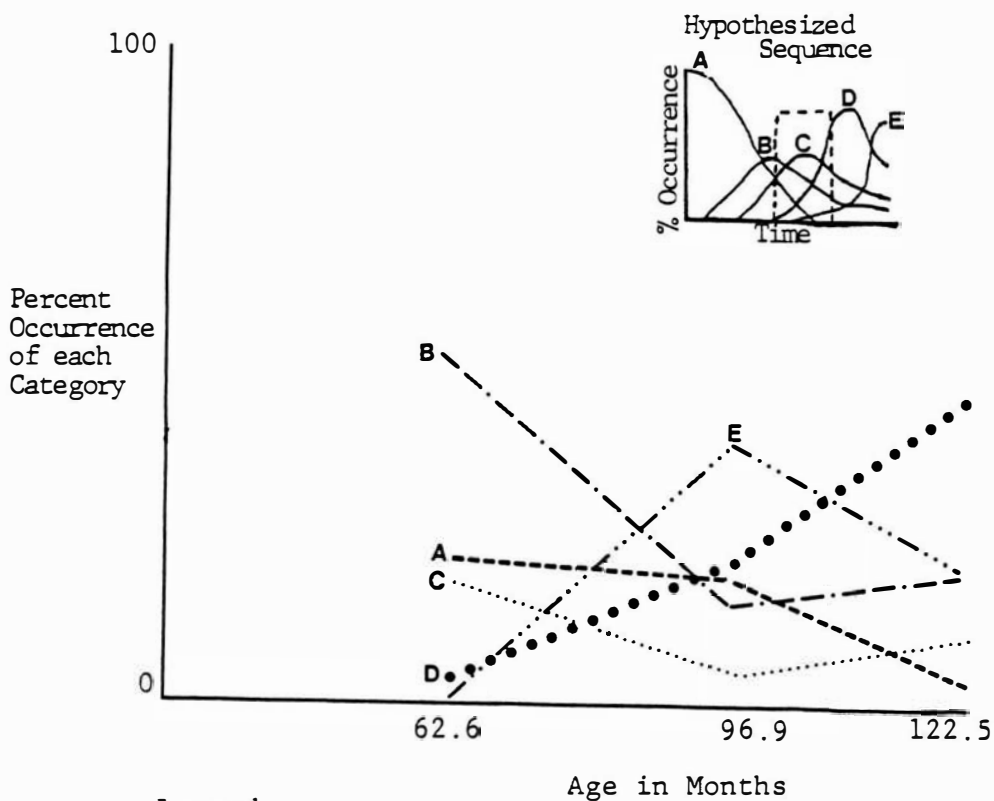
- A Heel in front of knee
- B Foot below knee with heel up
- C Foot below knee with heel down or foot level
- D Toes at or behind knee with heel up
- E Toes at or behind knee with heel down or foot level



Legend:

Categories listed in successive order:

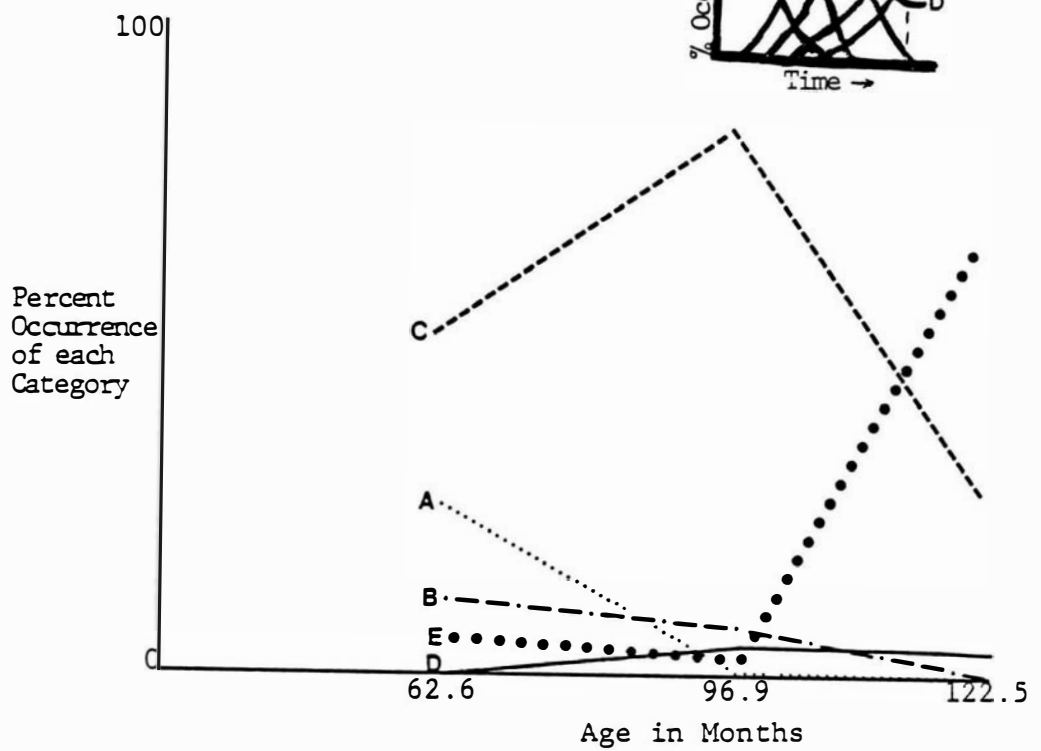
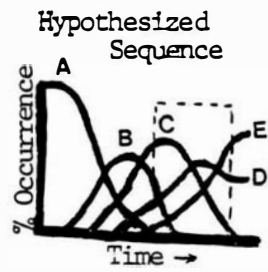
- B Elbow flexion with pronation-----
- E Hand on saddle or horse
- A Elbow extension with pronation-...-...-
- C Elbow extension with neutral forearm.....
- D Elbow flexion with neutral forearm——



Legend:

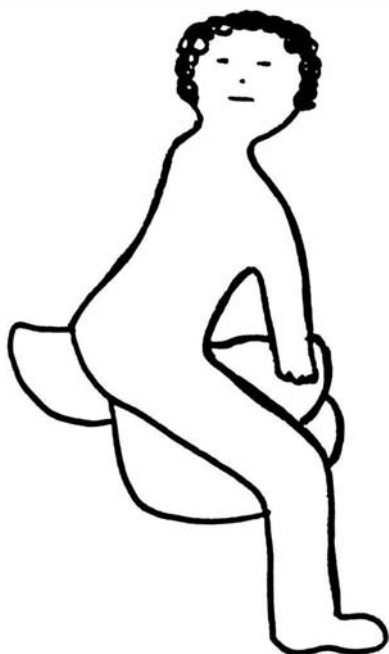
Categories listed in successive order:

- C Trunk vertical without head alignment
- A Backward leaning
- B Forward inclination without head alignment
- E Trunk vertical with head alignment
- D Forward inclination with head alignment



Legend:

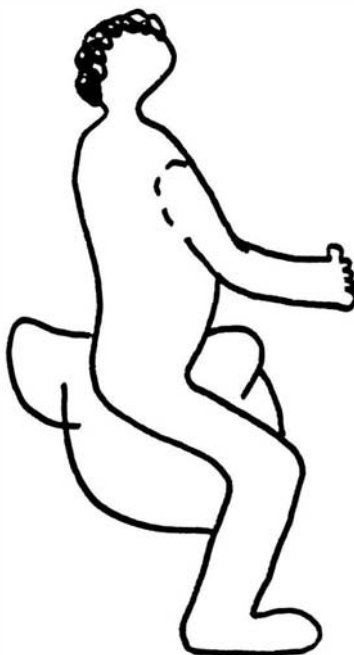
- Categories listed in successive order:
- B Foot below knee with heel up - - - - -
 - A Heel in front of knee ······
 - C Foot below knee with heel down or foot level - - - - -
 - E Toes at or behind knee with heel down or foot level ······
 - D Toes at or behind knee with heel up —



Upper Extremity Category E: Hand on saddle or horse

Head and Trunk Category B: Forward inclination without head alignment

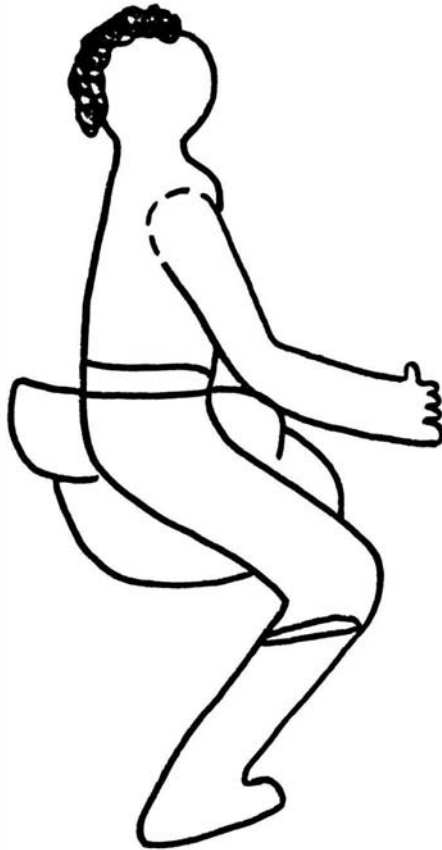
Lower Extremity Category C: Foot below knee with heel down or foot level



Upper Extremity Category D: Elbow flexion with neutral forearm

Head and Trunk Category E: Trunk vertical with head alignment

Lower Extremity Category C: Foot below knee with heel down or foot level



- Upper Extremity Category D: Elbow flexion with neutral forearm
- Head and Trunk Category D: Forward inclination with head alignment
- Lower Extremity Category E: Toes at or behind knee with heel down or foot level

Legend

Figure 1. Basic balance seat. (Reprinted by permission from Churchill P, Progressive Steps in Riding, New York, Arco, 1965, p 32.)

Figure 2. Hypothesized developmental sequence for the lower extremity component categories.

Figure 3. Observed frequency of occurrence of the upper extremity component categories in each age group.

Figure 4. Observed frequency of occurrence of the head and trunk component categories in each age group.

Figure 5. Observed frequency of occurrence of the lower extremity component categories in each age group.

Figure 6. Modal profile for the five year old children.

Figure 7. Modal profile for the seven- and eight-year-old children.

Figure 8. Modal profile for the nine- and ten-year-old children.

VITAE

