THE EFFECTS OF AQUATIC PERFORMANCE ON BALANCE OF CEREBRAL PALSIED CHILDREN

by

Pauline Ann Loeffler

A Thesis Submitted to
the Faculty of
the Consolidated University of North Carolina
in Partial Fulfillment
of the Requirements for the Degree
Master of Science in Physical Education

Greensboro
1960

Approved by

Adviser Celeste Ulrich

APPROVAL SHEET

This thesis has been approved by the following committee at the Woman's College of the Univeristy of North Carolina, Greensboro, North Carolina.

Thesis Adviser Celeste Ulrich

Orals Committee Members Ethel F. Martens

Adrian Solomon

John W. Kennedy

ACKNOWLEDGMENTS

The writer wishes to express sincere appreciation to Dr. Celeste Ulrich for her inspiring guidance, professional counsel, patience, enthusiasm, and encouragement, which have motivated the successful completion of this study.

A special word of appreciation is extended to the following graduate and undergraduate students who so willingly gave of their time and effort to help make this program possible: Shirley Perry, Margaret Kingston, Nancy Kearns, Martha Washington, Susan Collins, CeCe Moses, Ann Sherrill, Linda Malmros, Sally Robinson, Ann Thacker, Peggy Coleman, Martha Yates, Margie Acton, Martha Rutledge, and Brenda Bumgartner.

A special thank you is also extended to Mrs. Bennie C. Inman, Executive Director of the Cerebral Palsy School of Greensboro, North Carolina, Mrs. Carmen Wagoner, Chief Physical Therapist, and Miss Ute Ipsen, Second Physical Therapist, for their time, interest, and professional guidance, which have given the writer greater insight into the lives of those afflicted with cerebral palsy.

The writer also wishes to thank the following faculty members of the Department of Physical Education for their interest and help throughout the course of this study: Miss Ethel Martus, Dr. Rosemary McGee, Dr. Gail Hennis, Miss Ellen Griffin, and Miss Dorothy Davis.

A thank you is also extended to the children who were the subjects for this study, and whose participation in the program made this a fun experience for all concerned.

TABLE OF CONTENTS

LIST OF FIGURES

CHAPTER I

INTRODUCTION

The education of the cerebral palsied child has often been compared to making a telephone call on a disrupted switchboard. Only through a long process involving trial and error and repetition, can the call eventually be completed over another circuit.

So it is with the cerebral palsied individual. The neurological pathways facilitating movement have been disrupted by a lesion, origin oftentimes unknown in certain areas of the brain, resulting in imbalance and incoordination.

The normal individual obtains knowledge through the associations which he has with the physical world about him, this association being made possible through free body movement. Because the cerebral palsied individual is a prisoner of his affliction, he is not capable of having the same associations and experiences as the normal person. Since he can never be normal, a large portion of nature and the environment must be brought to him. In this way, he obtains knowledges and understandings about himself and of the world in which he lives.

Through the efforts of such men as Dr. Bronson Crothers of Boston, Dr. Winthrop Phelps of Baltimore, and Dr. Earl R. Carlson, author of Born That Way, and a victim of cerebral palsy himself, we have been able to gain greater insight into the neurological basis for cerebral palsy, new approaches to the diagnosis and treatment of the disability, and the education of those afflicted (46). A sincere effort is being made to

remove the many barriers inhibiting the progress and development of the cerebral palsied. Since restricted movement is the greatest barrier to progress, it is the area of physical rehabilitation with which the author has become concerned. For if physical freedom can be experienced, a certain degree of psychic freedom will also result.

Physical exercise to free the body of its limitations may be obtained by several different means. Physical therapy attempts to develop the larger movement patterns which in the normal individual develop naturally from birth. Occupational therapy attempts to improve the finer coordinations necessary for the activities of daily living. Still another form of physical exercise may be obtained through the stimulus of play.

Because of the limitations in body movement of the cerebral palsied, free play is restricted on land. Persons with this disability need another medium through which they can ease the burden of spastic, athetotic, and ataxic movements, and develop a "feel" for purposeful movement. Swimming may be this medium.

In the water, body weight is relieved. Relaxation is made possible due to the warmth and massaging effect of the water upon the body. Movements are made with greater ease and minimum effort because of the relaxation produced and the assistance which the water gives. With this ease of movement comes greater mobility of body parts, and performance of activities which ordinarily would be impossible (2).

Swimming for the cerebral palsied has been a controversial issue. The author was unable to find any evidence to prove, or disprove the

fact that swimming contributed to physical improvement of these individuals in terms of balance, strength, endurance, flexibility, coordination, and relaxation.

Keeping this in mind in the study, the writer attempted to determine the effects of certain individually prescribed swimming skills upon the kneeling, sitting, standing, and walking balance of twelve cerebral palsied children who had problems of imbalance. As a secondary purpose, the author was interested in the apparent psychological changes that occurred within the child as a result of his swimming experiences. Detailed case histories were kept on each subject.

CHAPTER II

STATEMENT OF PROBLEM

The primary purpose of this study was to make an objective analysis of the effects of an aquatic program of individually selected skills upon static equilibrium of twelve cerebral palsied children with problems of imbalance.

Preliminary tests of kneeling, standing, sitting, and walking, were administered on the basis of balance progress made by each child up to the start of the swimming program. These same tests were again administered following the final swimming session. A comparison was made between the first and final test scores to determine if balance ability had increased, remained the same, or decreased.

A slow-motion movie was made of individual walking patterns. By selecting ten different frames for analysis, gait patterns were analyzed for all phases of the walk. More specifically, each frame was analyzed in terms of the following:

1. Deviation of seventh cervical vertebra from the midline of the body.
2. Vertical difference between the shoulders.
3. Vertical difference between the hips.
4. Vertical difference between right shoulder and right hip.
5. Vertical difference between left shoulder and left hip.
6. Body rotation.

A second movie was made following the close of the program. The same phases of the walk were again analyzed for comparison with the preliminary films.

The children who were unable to walk were filmed while standing in a stabilizer. The number of times that balance was lost posteriorally and laterally was recorded and a comparison made between the first and second filming.

The secondary purpose of the study was to make a subjective analysis of case reports as tape recorded by instructors at the conclusion of each swimming session. Progress was analyzed on the basis of the following:

I. Skills learned
   - A. Assistance
   - B. No assistance

II. Individual adjustments
   - A. Fear
   - B. Self-confidence
   - C. Withdrawal tendencies
   - D. Apprehensiveness
   - E. Attitude towards self and others
   - F. Responses in various situations

III. Special motivational devises

IV. Techniques used in the teaching of skills

V. Physical improvements
   - A. Strength
   - B. Endurance
   - C. Range of motion
   - D. Coordination
   - E. Balance in water
   - F. Relaxation
   - G. Control of spasticity and stretch reflex
   - H. Control of athetotic movements
   - I. Body awareness of the ataxic
   - J. Movement coordination
   - K. Control of breathing

The twelve subjects participating in this study were carefully selected by two registered physical therapists, an attending physician, and the director of the Cerebral Palsy School in Greensboro, North Carolina.

CHAPTER III

REVIEW OF LITERATURE

Cerebral palsy is one of the most complicated and involved disabilities occurring in childhood. At one time, this condition was thought to be a hopeless one. Families of cerebral palsied children who did not understand the nature of the handicap, sheltered these children from society, or sent them to mental institutions, considering them to be a "curse on the family" (9:2).

In recent years, through broad rehabilitation programs, cerebral palsied individuals have finally been given the opportunity to make a significant contribution to our society. They have been given the opportunity to say "helpless, yes--- but not hopeless!"

Definition

"Cerebral", as the name implies, refers to a condition having its origin in the brain. "Palsy" refers to a disturbance in the functioning of the muscles of the body. Hence, cerebral palsy is the proper name for a group of crippling disorders having their origin in the brain (36).

It is difficult to give an accurate and complete definition of cerebral palsy due to the complexity of the condition. Dr. John Little, an English orthopedist, was the first to describe cerebral palsy as being a condition of severe involvement with an accompanying mental retardation (18).

Pohl (13:1) gave the following definition:

> Cerebral palsy is the term used to designate a group of neuromuscular disorders in which there is impairment or loss of muscular control due to a lesion of the brain.

Minear (32:841) quoted a practical definition given by Denhoff:

> One component of a broader brain damage syndrome comprised of neuromotor dysfunction, psychological disfunctions, convulsions, and behavior disorders of organic origin.

Cunningham (23:824) gave the following definition:

> Cerebral palsy is a descriptive term applying to a group of motor disorders of young children in whom full function of one or more limbs is prevented by paresis, involuntary movement or non-coordination.

A definition by Deaver (8:3) stated:

> A neuromuscular disability caused by lesions in the motor centers of the brain - before birth, at birth, or during infancy and childhood.

Burton and Bradley (21:82) quoted the definition as stated by the American Academy of Cerebral Palsy:

> Cerebral palsy is any abnormal alteration of movement or motor function arising from defect, injury or disease of the nervous tissues contained in the cranial cavity.

This pathological condition was originally known as "spastic paralysis" or "Little's Disease", being named by John Little in England in 1861 (21). "Spastic paralysis" has now been replaced by cerebral palsy in light of the fact that spastic refers to only one form of the disability.

Incidence and Prognosis

The incidence of cerebral palsy is high. Phelps (34), after long study, concluded that seven children out of every 100,000 popula-

tion are born with cerebral palsy. Of these seven, one dies during infancy or early childhood, and of the six remaining, two will be mentally defective. Deaver (8) stated that of every two hundred live births one child will be born with a brain injury at a rate of approximately one every fifty-three minutes. Taylor (16) concluded of all the cases of cerebral palsy at least half will have an associated mental deficiency. Schlesinger (39), in summarizing a study done by Perlstein, said that the death rate in cerebral palsy is 15%.

Of the five classifications of the disability, spasticity has the highest incidence at 66%. This is followed by athetosis - 4%, rigidity - 4%, tremor - 2%, ataxia - 8%, and mixed type - 1% (8).

Plum (37) in a study of 540 patients, found that survival seems to be good after the fourth year.

Cerebral palsy is the concern of all socio-economic groups regardless of race, creed, color, or nationality. In fact, "wealthier classes have almost as many, if not as many, cases of cerebral palsy as do the poor classes" (36:210).

Cerebral palsy is incurable, but many of its victims, with proper care including special education and training, will be able to make an adequate life adjustment. Those who are classified as untrainable or uneducable will be destined for home or custodial care (25).

Physiology of Cerebral Palsy

Etiology

Cerebral palsy may result from illnesses or ailments in the

mother as well as birth injuries, but not exclusively from birth injury as was earlier believed (27).

The condition may develop from causative factors occurring in three stages of the development of the child. The prenatal stage comprises 20% of the cerebral palsy population. Factors arising during the natal stage comprise 70% of the total. And the postnatal factors comprise the remaining 10% (14).

Prenatal causes may include: failure of the brain to develop properly, infection in the mother, anoxia, cerebral hemorrhage, presence of the RH factor in the blood, or metabolic distrubances in the mother. Natal causes include anoxia, cerebral hemorrhage, faulty use of forceps, rapid delivery, and prematurity. Of those listed, anoxia and cerebral hemorrhage comprise the majority of natal injuries. The causes of postnatal injuries are accidents, infections of the central nervous system, meningitis, encephalitis, brain abcess, and a cutting off of oxygen to the brain (7). These are only a few of the etiological factors resulting in brain injuries, but they are probably the most common.

Physiological Classification

The function of muscles is contraction. This contraction brings about movement in the joints causing motion of the body.

> Brain injured children lack the possibilities of motor activity, which has been recognized as the main means of acquiring knowledge of the outside world. Locomotion influences the experience and sensory perception. The child who is deprived of locomotion, therefore, develops quite differently from the average, and the lack of locomotion deprives a child of the most important source of information which other children have at

> their disposal. It is well known that blind and deaf children have difficulties in mentation and have to compensate for the lack of one source of information through other channels. It is, however, little realized that the inactive child is a tactile "blind" or "deaf" child whose area of perception is extensively curtailed (4:534).

A complete classification of cerebral palsy is not a simple one. For medical purposes, the classification is based upon a complete diagnosis of factors involved. Minear's (32) classification includes: motor classification, topography (body parts involved), etiology, capabilities of the patient (motor, sensory, intellectual, emotional, visual, speech, and hearing status), and, if the pathology in the brain has been accurately determined, a statement of the structural condition is made (neuroanatomical diagnosis).

For practical purposes, the classification is made as to motor classification, topographical involvement, and degree of severity.

Pathology and Motor Classification

The pathological evidence of cerebral palsy reveals the complexity of the condition. It is not described as a disease, but as "a series of clinical syndromes" (44:104) which result from an injury to the central nervous system, namely the brain. Since one of the outstanding characteristics of the cerebral palsied is uncoordinated, involuntary movement, the condition is often called "a paralysis of lost coordinations" (15:298).

There are five major types of cerebral palsy: spasticity, athetosis (of which there are twelve different types), tremor (two types), ataxia, and rigidity. Of these five, spasticity, athetosis, and ataxia appear most frequently. Although it is not too uncommon for

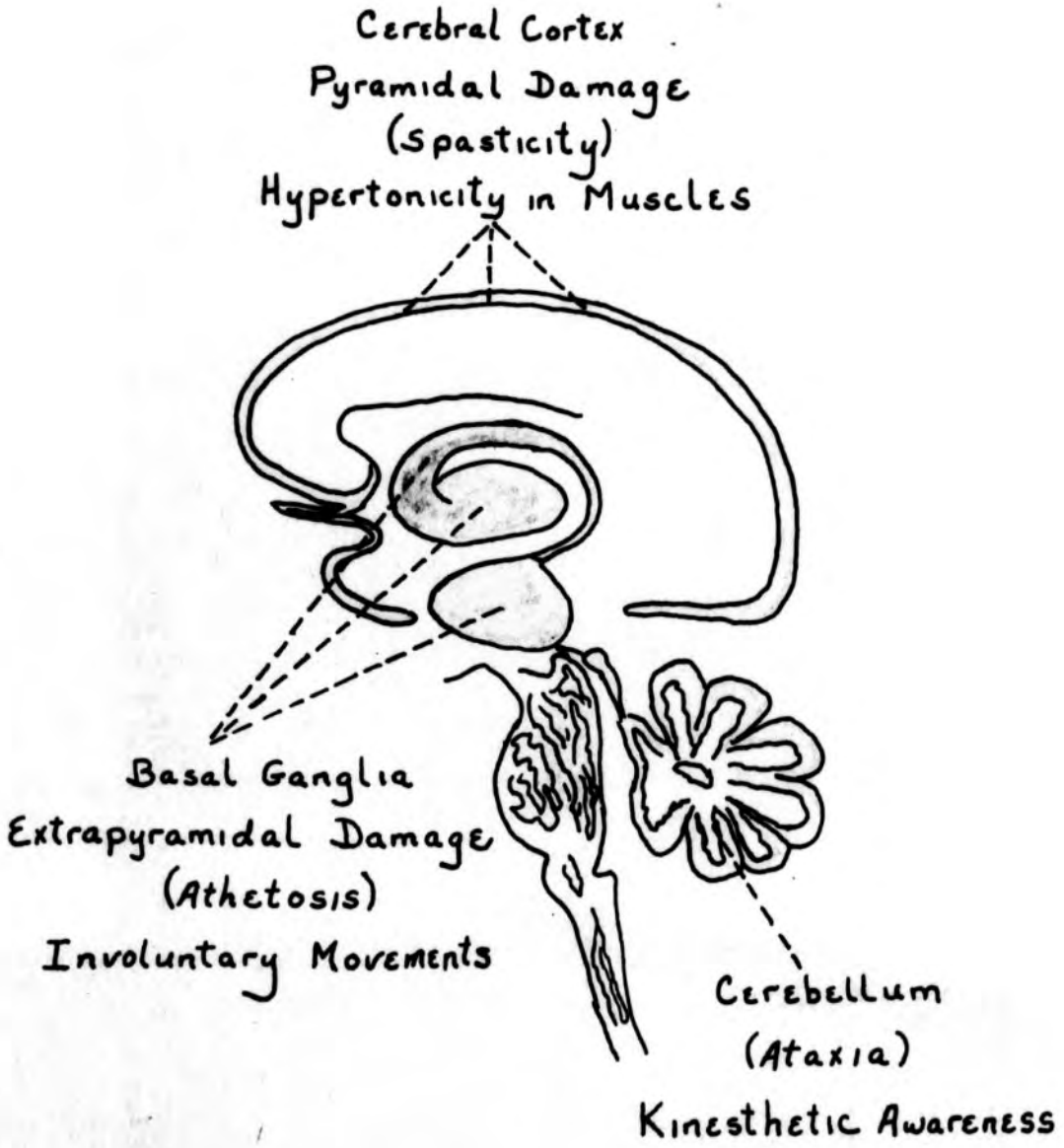
two or more types to be characterized in one individual, the types usually appear in one form.

Spasticity results from damage to the cerebral cortex of the brain which controls the conscious will to move. It is characterized by slow stiff movements due to increased reflexes and the action of the stretch reflex. When a spastic makes an attempt at movement, the antagonistic muscle groups, when subjected to stretch, are also stimulated, causing a block in the proposed movement (32). A German word which describes this resulting action is Schaltung meaning the presence of two reflexes as a result of only one stimulus (19).

Athetosis is the result of damage to the basal ganglia of the brain, which control voluntary movement. The condition is characterized by uncontrollable, jerky, irregular, purposeless, twisting movements, in the muscles of the limbs and face (27). An athetoid is capable of voluntary movement, but when a voluntary action is attempted, it is superimposed upon by involuntary movements, causing the observeable relaxed, floppy trunk and extremities (35). In other words, "The contraction of unnecessary muscles detracts from the perfection of the resultant motion" (35:116). The athetoid is conditioned to this type of activity and will usually initiate movements rapidly, so as to complete them before the athetosis sets in (35).

Spasticity and athetosis are often undistinguishable. The differentiation between the two may be explained in terms of the tension in the muscles. A voluntary attempt by a spastic to move produces involuntary tensions due to the stretch to which the antagonist

FIGURE 1. PATHOLOGY OF CEREBRAL PALSY



ADAPTED FROM GRAY'S (10) ANATOMY

is subjected (34). For this reason, spastics should make slow controlled movements to prevent stimulation of the stretch reflex (31). The athetoid, who experiences constant involuntary motion, produces voluntary tension in the muscles to control the movements (34). In spasticity, the tension stretch reflex causes an automatic resistance. But in athetosis, tension can be shaken loose (31).

Ataxia is a primary disturbance of balance (17) due to loss of the kinesthetic and proprioceptive sense resulting from damage in the cerebellum, the cerebellar tract, or the eighth nerve. "The muscles most affected are those which enter into the maintenance of position and balance" (35:122). The ataxic is unaware of body position. He is unable to control his muscles to make movements in intended directions. Ataxics usually have an accompanying visual involvement called nystagmus, or vibrating of the eyes. Since the eyes are important in aiding balance, the eye movements cause dizziness with resulting imbalance and nausea (17).

Rigidity is characterized by hypertonicity of the muscles resulting in contractures. It is often referred to as "lead pipe" (32:813) rigidity. This condition resembles spasticity, but there is no relaxation as the force of the movement is increased (6). A severe extensor thrust may be present in this type of cerebral palsy. There is muscle tension, the head is thrown back, and the back is arched. This makes sitting impossible unless the individual is forced into the position (40).

The tremor type is characterized by a shaking motion caused by

alternate muscular contractions. The movements are involuntary and uncontrollable. When the muscular contractions occur due to a voluntary effort to move, the resulting condition is an intention tremor. When the muscular contractions are present all of the time, the condition is a nonintention tremor (7).

Topographical and Functional Classification

Cerebral palsies are also classified in relation to which body parts are involved. Monoplegia involves one limb only. Paraplegia is a condition in which only the legs are involved. Hemiplegia denotes involvement on one side of the body. Triplegia is characterized by involvement in three of the four extremities, usually both legs and one arm. Quadriplegia is an involvement in all four of the extremities. Diplegia refers to involvement in like parts on either side of the body (the right and left arm) (32).

Classification is also made according to functional capacity, or severity of the condition. Those who are able to get about without assistance, who have control of speech, and need no special care, are placed in the category of mild severity. When the condition limits locomotion and performance of activities for daily living, there is difficulty in speech, and the individual needs special guidance, the involvement is said to be of moderate severity. The condition is said to be severe when the individual has no control of the body parts, inhibiting participation in useful activity, and he is confined to a wheelchair or to a bed (32).

When the motor classification, topographical classification, and

functional classification have been made, one individual with cerebral palsy may briefly be described. i.e. Spastic paraplegia with moderate involvement. This denotes the presence of spasticity in the muscles, major involvement in the legs, and that the patient is able to maneuver about with assistance.

Associated Disorders

Cerebral palsy is not an orthopedic disability as is so often believed. The name itself indicates a neurological disorder. With this in mind, it is easy to see the possibilities of having numerous other conditions present at the same time which may further inhibit the progress of the individual (28).

The extent and location of the brain lesion presents complications in the adjustment and learning capacity of the child(22). For this reason, it is not uncommon for mental deficiencies to appear in a large percentage of cerebral palsied individuals. Phelps (33) and Deaver (8) said that approximately thirty to thirty-three per cent of all cases are mentally deficient.

Speech difficulties may range from normal in one child to complete loss of the speech mechanism in another (13). Other disorders commonly associated with cerebral palsy are auditory problems, most often found in the athetoids, and visual disturbances (8).

Personality and Psychological Adjustment

> "The disorder of motor control is only one, and often the least, of the difficulties which face these children." (5:2) "Above

> all, these children grow and develop and the struggle for independence, which is one essential element of development, may be distorted, not only by their own disability, but in some cases by the efforts of adults to help them." (5:2)

With all of the previously mentioned factors contributing to the complexity of the cerebral palsy problem, it is possible to see what will influence the eventual social adjustment of the child. "The handicapped is forced to live in a world created for others and to which he is adapted neither by structure nor emotional make-up" (35:112).

Because of the nature of their handicap, cerebral palsies have difficulty in making personality adjustments. Different types of cerebral palsies react in different ways toward their handicap, toward people, and toward society in general.

The spastic is fearful in new situations. He is afraid of loud or sudden noises and of losing his balance because he knows that he cannot control his body should he fall. He is generally in unhappy moods and wants to be away from people, although he may gain some degree of satisfaction from being with a few of his own chosing. He is impatient because he is inhibited by a lack of free movement.

In contrast, the athetoid is the exact opposite, although there may be exceptions. He shows little or no fear towards people or new situations. In fact, he has a tendency to become overly affectionate. In general, he is a very happy child (33). The personality of the ataxic much resembles that of the athetoid.

The adjustments which these children must make is partially dependent upon the attitudes which society has towards them. The parents' attitude is of particular importance, for if the parents have an

unfavorable attitude towards the child, the progress of the child will also be handicapped (24).

> "Perhaps the most difficult problem arises when parents are convinced that cerebral palsy is a disease which can be cured if enough pressure is exerted. They then adopt a perfectionist point of view and expect more than the handicapped child can deliver" (5:269).

In cerebral palsy, the "basis problem in management is one of assisting the child in learning to live with his handicap and to develop behavior patterns compatible with somedegree of social adjustment" (45:64).

Therapy and Treatment

The successful treatment of the cerebral palsied is dependent upon cooperative efforts of many agencies including experts in the fields of psychology, neurology, orthopedics, physiotherapy, occupational therapy, and speech therapy (38). Dr. Winthrop Phelps of Baltimore, Maryland, has been the leading contributor to the knowledge of diagnosis and treatment of the cerebral palsied individual (8).

Although there may be similarity between cases in terms of type and degree of involvement, there are no two cases alike. This makes the treatment of the cerebral palsied a real challenge to all personnel involved in carrying out the rehabilitation program.

The only methods which have been found to be successful in the treatment of cerebral palsy are surgery, certain drugs, use of braces, and muscle re-education which is accomplished by the physical and occupational therapist. Through this treatment program, it is hoped that

these children will be helped to help themselves (13).

Muscle Re-education

Since the most important factor to remember in the treatment program is to help the children to help themselves, muscle re-education and balance training may be said to have the greatest influence on functional development. This is accomplished through the physiotherapy and occupational therapy program.

The physical therapist is concerned primarily with training of larger muscles which are essential in normal big muscle movements. Once these basic movements can be performed with some degree of efficiency, occupational therapy is introduced. Here the therapist is not only concerned with the training of the larger muscles, but in the development of the finer coordinations for increased control of muscles, which is so necessary in performing the skills of everyday life.

Physiotherapy has two major aims - that of preventing and reducing deformity, and to teach correct posture and movement (26). The principles of the treatment program are to secure muscular relaxation, to train voluntary muscular control, and to build developmental patterns (13).

The primary aim in athetosis is to develop conscious relaxation. In spasticity, the primary objective is motor re-education, or voluntary muscular control aided by surgery and braces. In ataxia, the major objective is to develop the kinesthetic and proprioceptive senses which are responsible for the imbalance of the child (34).

Balance

The most important factor to consider in the treatment program of the cerebral palsied is the development of the gait pattern until balance is learned.

Balance is controlled by the eyes, the eighth nerve of the cerebellum, and the semicircular canals in the ear. To effectively maintain balance, there must also be an equal distribution of muscle strength, control, and relaxation (43).

Gravity with bodily movement effects the relationship of a muscle to its antagonist. Changes in movement cause the muscles to contract, thereby increasing tone. At the same time, the antagonists relax. This cooperative act between muscle groups makes the maintenance of balance possible. The cerebral palsied must be taught to balance because they are unable to do so voluntarily. This is accomplished in the training program by the use of "conditioned motion."

There are six phases in the progression of balance training. Head control is considered to be most essential. Following logically in order are balance in sitting, crawling, kneeling, and standing. Once control in these has been established, gait training begins.

Athetoids, due to their involuntary movements, must learn how to contract muscles voluntarily in order to maintain balance. Spastics must learn a finer balance sense because the involvement lies directly in the muscles. When a spastic loses his balance, he waits too long to regain it. The stretch produced in the opposing muscle groups results in a stretch reflex. However, if he learns to respond at the moment of

the imbalance, the muscle contraction needed for control will not result in a stretch reflex. In ataxia, although there is no involvement of joint or muscle, there is balance damage. Ataxics learn more quickly when their balance is disturbed intentionally. Through the use of tough and vision, a "sense of balance" is taught (9).

Balance Testing

Several simple tests for balance are administered in the physical therapy program (11).

1. The number of seconds or minutes the child can sit or stand unsupported.
2. The number of steps taken without falling.
3. The number of seconds or minutes to walk a measured distance.

These tests can be made more difficult or modified depending on the progress of the child. For example: If a child progresses well in walking and is not having difficulty in maintaining balance, the next step may be to step over objects in his path. Backward walking may eventually be included. And, finally, walking on a board or plank would be introduced to those who have progressed to good balance control.

The results of these tests can be recorded on functional ability graphs and used to show progress, or to indicate necessary changes in treatment.

Postural balance includes static equilibrium and dynamic equilibrium. Sway is one aspect of static equilibrium (42) which may be measured in several ways. In a study by Houtz and others (29), a moving kymograph was used to record antero-posterior and lateral body sway.

In the same study, an analysis was made of movement patterns by making drawings from selected moving picture frames which were projected on a microfilm reader. The results were used in program planning and as a guide to the progress of individuals.

Miles (30) stated that M. H. Romberg was one of the first to make tests of body sway. The study included patients with tabes dorsalis, or damage to the spinal cord. Patients had to stand with feet together and eyes closed without extreme body sway. This study aroused further interest in the relationship between equilibrium, motor control, and disease. Since there is some body sway even with normal persons, Romberg had no objective measures, only subjective judgment in basing his conclusions.

Miles (30) developed two measuring devises for recording body sway. The ataxiagraph was primarily for measuring motionlessness rather than the ability to keep the body centered. The results were difficult to interpret because of the confusion of the lines which were recorded. Miles stated that Wallen used the ataxiagraph in a study of mentally defective children. Hancock used the instrument to study motor ability of children, and Bullard and Brackett used the devise to measure static equilibrium of 187 men undergoing a competitive physical examination.

The second instrument devised was called the Miles' ataxiameter. This was developed so that even the slightest antero-posterior and lateral sways would be recorded while standing or sitting.

Travis (41) constructed a test for measuring a person's ability to maintain steady balance while standing on an unstable platform.

For the purposes of this study, simple tests of kneeling, crawling, sitting, standing, and walking were used because they could be modified to meet the individual progress and needs of each child.

Hydrotherapy

Water has been used as a therapeutic medium since primitive times. Hippocrates advocated water therapy in the treatment of muscle and joint disease. In the 1900's, Sigmund Hahn recommended water therapy for leg sores and itch. And, today, hydrotherapy is used extensively by the medical profession in the treatment of various orthopedic conditions and other physical disorders (12).

Because of the buoyancy of the body, increased range of motion, massaging action, and the mild resistive form of exercise produced by the resistance of water to movement, it is possible to increase the functioning of musculature and bring about greater physiological efficiency of the body through a less restricted type of movement (7).

Hydrotherapy and a carefully organized swimming program are closely related. The underlying objectives are basically the same, but are arrived at in a slightly different way. Hydrotherapy is concerned with a "series of either related and/or unrelated body movements done in a liquid medium" (20:14). Their function is "to help patients re-educate impaired muscles, correct or prevent deformities and restore muscle function" (12:2). In swimming, "all movements are related and culminate in an activity which is purposeful and enjoyable" (20:14). The body parts are exercised through the use of arm and leg strokes employed in various swimming strokes which may be modified according to

individual needs. Neither hydrotherapy nor swimming should be used unless medically advised and approved (7).

The conditions which seem to benefit most from pool therapy are arthritis, post traumatic and post operative conditions, cerebral palsy, postural deviations, bone and joint infections, neurologic diseases, and polio. Of these, polio can be benefited most due to the strengthening of atrophied muscles (12).

Swimming in the Rehabilitation Program for the Handicapped

Swimming is but one phase of the total conditioning program and, then, only when the physician recommends it. If the swimming program is well organized and carried out on an individual basis, swimming has specific values which may be attained over a period of time.

Physiological Values

Swimming may help to develop or maintain organic strength and vigor. If skills are properly selected according to individual needs, it is possible to move affected body parts. This will aid in the strengthening of them, and the prevention of further atrophy in the areas of involvement.

Skills performed in water will provide for increased joint movement. Due to the buoyancy of the body in water, body weight is reduced when in this medium. This allows for a greater range of movement in the joints as a result of the cushioning effect of the water. Pressure is reduced in the joint and, therefore, upon movement, there is less pain.

As a result of exercise, circulation is improved. Because of the limitations in bodily movement placed upon the handicapped individual on land, exercise is limited. This results in poor circulation. If the swimming program is well planned, the need for this exercise may be satisfied.

Breathing and respiration may be improved due to the pressure of the water on the trunk. This added pressure of the water, and breathing at regular intervals help to promote deeper breathing which is of value to the circulation.

In swimming, since all movements are related and purposeful, muscular control and coordination may also be improved.

If the water temperature permits, the effect of exercise and the effects of the water bring about a feeling of relaxation. This decreases muscular tension and allows movement which might not ordinarily be possible.

Those individuals capable of taking part in a more active type program also have an opportunity to strengthen weakened abdominal muscles through the use of specified strokes.

Psychological Values

Probably the greatest single psychological barrier for the handicapped individual is the handicap itself. Those individuals who have very limited free movement on land are able to experience greater physical freedom in the water. Together with this physical freedom, comes a degree of mental freedom and enjoyment from the ability to be able to move. The fact that the handicap is less apparent in the water,

may eventually also bring about an improved attitude towards the individual's condition. Swimming can present challenging experience by providing skills which will divert the handicapped's thoughts from his condition, thereby providing an opportunity for adjustment to self.

Once skills are learned, they are not easily forgotten and, therefore, provide many hours of enjoyable, healthy activity. Because of the ability to obtain freedom of movement in the water, the desire for physical activity is fulfilled. The handicapped individual is then able to understand that in spite of his handicap, he too is able to enjoy recreational activity. The success that these individuals experience may develop interests in other areas of activity. It is even possible that some handicapped persons will have the opportunity to compete on even terms with normal individuals. Due to the mental and physical freedom experienced, social barriers are eliminated, not only in the water, but in normal daily living (1).

In summary, swimming is valuable in the sense that it "makes possible muscular control and coordination, range of motion from very limited to full movement, and the progressive development of strength and endurance" (7:197). Swimming also provides a fun experience and an opportunity to be a member of a group.

Objectives of the Swimming Program

The following objectives were listed by Daniels (15:200) as acceptable in accordance with the values of swimming:

1. To aid in the restoration of function.

2. To aid in improving strength, endurance, and organic vigor.

3. To contribute to the aquatic, safety, and recreational skill needs of the students.
4. To contribute to psychological and social adjustment.
5. To broaden the students' skill, knowledge and interests in other areas of aquatic activity such as diving, fishing, sailing, boating, and canoeing.

To fulfill these objectives, teachers of the handicapped must first realize that "the student is first a person and then handicapped" (20:15).

Implications of Swimming for the Cerebral Palsied

There has been little study concerning the use of pool therapy for cerebral palsied patients, and it is still a controversial issue (3).

Therapeutic exercise in the water was first used in 1911 by Dr. C. L. Lowman who treated cerebral palsies in bathtubs. Today, treatment pools are used extensively in the Orthopedic Hospital of Los Angeles and at the Spaulding School for Crippled Children in Chicago (12).

The treatment program in pool therapy should work for functional improvement in terms of sitting, standing, balancing, and the use of arms and hands (12). If swimming skills are modified to meet the needs of each individual and serve the same or similar function as therapeutic exercises used in hydrotherapy and physical therapy, then swimming is a natural follow-up to these programs for those who may benefit.

In spasticity, the aim is for conscious relaxation, passive,

assistive, active, and resistive movement. This is accomplished by stressing slow movements to avoid the stretch reflex. Such exercises should reduce spasticity and strength and coordination consequently should be increased.

The aim in ataxia is to strive for increased muscular strength and development of a kinesthetic awareness by stressing a "sense of feel." Balance and coordination should be improved as a result.

If in athetosis, the aim is to strive for relaxation, involuntary movements should be decreased. Over a long period of time, the athetoid can learn to consciously learn to control his involuntary actions.

Swimming has many physiological, psychological, and social implications in the rehabilitation of the cerebral palsied. The greatest desire of those afflicted is to be able to experience free movement. If this goal can be attained through the aquatic experiences of these individuals, then swimming has a definite contribution to make in the total rehabilitation program.

CHAPTER IV

PROCEDURE

The purpose of this study was to determine what effects an aquatic program of selected skills would have upon the kneeling, sitting, standing, and walking balance of cerebral palsied children. As a secondary purpose, the study was interested in swimming skills which can be accomplished by cerebral palsies, and to what extent relaxation and free movement can be obtained.

Selection of Subjects

The subjects for this study were seven boys and five girls, five to fourteen years of age, from the Cerebral Palsy School in Greensboro, North Carolina. Their involvements ranged from mild to severe. After carefully considering the case histories and individual balance difficulties of the children at the school, Mrs. Bennie C. Inman, the Executive Director of the school, Mrs. Carmen Wagoner, Chief Physical Therapist, Miss Ute Ipsen, second Physical Therapist, and Dr. Eulyss R. Troxler, Orthopedic Surgeon and medical consultant for the school, selected the twelve children who were physically able and whom they hoped might benefit most from such a program.

Parental Interviews

The home address and telephone numbers of parents or guardians of the children were obtained from Mrs. Inman, who also contacted the homes informing them of the plans for the proposed swimming program in which

their children had been selected to participate. All of the parents were receptive, enthusiastic, and eager to learn more of the details of the program.

A personal interview schedule was arranged by the author to meet the parents to see the type of home environment from which each child came, to observe parents' attitudes, to briefly describe the program procedure, and to obtain final consent for participation in the program. A permission slip, a copy of which may be found in the Appendix, was given to each parent. This had to be signed and returned before the child could be allowed to participate in the program.

Case Histories

After parental consent had been obtained, background information of each child was procured from Mrs. Inman, Miss Ipsen, and Mrs. Wagoner. This data included: age of the child, classification of cerebral palsy, mentallity in terms of retardation and educability, degree of involvement, personality adjustments and characteristics, emotional traits, sensory impairment, handedness, general health, present therapy and procedures for balance training, and other information which would lead to a better understanding of the physical and mental limitations of each child. Confidential medical reports were not revealed.

Physical Therapy Procedures

So that individual swimming skills, when selected, would be closely related to the type of therapy received by each child, an outline of therapy procedures was made for each child by the physical

therapists. Supine, prone, standing, and mat activities were described in terms of muscles groups and individual muscles which needed lengthening or strengthening, and whether the activities performed were active, active-assistive, or assistive in nature. A special note was also made of the movements which should not be performed. Copies of these therapy procedures may be found in the Appendix. From this information, skills were empirically selected for each child which might best contribute towards balance improvement.

Swimming Program

Objectives

1. To provide an opportunity for the children to experience relaxation.
2. To provide an opportunity for the children to experience freedom of movement.
3. To provide an opportunity for the learning of skills which will aid in the physical, social, and psychological adjustment of these individuals.
4. To provide an opportunity for attaining success which will aid in the understanding which each child has of his own limitations and capabilities.
5. To provide a fun experience in an activity which can be participated in throughout the lifetime of the individual.

A nine-week program, three days per week, was constructed. The skills which were selected for the unit were divided into three parts: skills which would contribute to the general overall adjustment of the

child in the water, the specific skill or skills which would be the balance training portion of the program, and skills for recreation. Adjustment techniques were the same for all individuals regardless of the degree of involvement. All activities were modified to meet the particular needs of each child.

Adjustment Techniques

1. Face in the water
2. Blowing bubbles
3. Identifying objects under water with eyes open.
4. Raising feet from bottom of pool
5. Breath holding
6. Rhythmical breathing
7. Back float and recovery
8. Front float and recovery
9. Pulling self around edge of pool
10. Retrieving objects
11. Body rotation from side to side
12. Bobbing
13. Sit on the bottom
14. Jellyfish float and recovery
15. Walking

Selection of Instructors

Instructors, one for each child, were all graduate and undergraduate students from The Woman's College of the University of North

Carolina. They were selected on the basis of experience which they hadhad with children either in a camp situation or teaching program. This experience did not have to include experience with handicapped children. All instructors were required to have had a course in methods of teaching swimming, Senior Life Saving, or completion of the Water Safety Instructor course. They were also selected on the basis of faculty recommendations and information received during interviews, at which time personal qualifications could be noted.

An orientation class was held for instructors to familiarize them with the nature of cerebral palsy. A color slide series on physical therapy, occupational therapy, and education of the cerebral palsied was shown to give an overall visual image of the characteristics of cerebral palsy, and a glimpse of the rehabilitation program for these individuals.

Cerebral palsy was defined and each of the three most common types was discussed in terms of physical characteristics, personality characteristics, and what to stress in the teaching of activities. The general program was also discussed in regard to the recording of daily case reports, dressing room procedures, and safety factors.

Also, at this time, each instructor was given the case history of the child whom she would be teaching, and some methods which might be helpful in the teaching of the child. Personalities were matched as closely as possible to maintain a favorable relationship between the child and his instructor.

Instructors were then given an opportunity to meet and observe the children at the Cerebral Palsy School. It was felt that through

this meeting, a more rapid adjustment might be made and confidence won before the swimming program began.

COLLECTION AND ORGANIZATION OF DATA

Selection of Tests

Tests were selected and administered by the physical therapists on the basis of progress made by each child in physical therapy up to the time for the beginning of the swimming program. These tests, for the most part, were different for each child. Sitting, standing, and walking tests were included, which ranged from the simple to the more complex skills in each. Tests were given at the beginning and conclusion of the program and a comparison made between scores. Because of the nature of the handicap, results were concerned with individual progress, not comparisons between individuals.

1. Walking - The child was told when to begin walking. The number of steps taken before losing balance were counted and recorded. Three trials were given and an average of the three was also recorded.

2. Knee walk - The child supported himself unassisted on his knees at a designated mark. When told to begin, he started to knee walk maintaining balance as long as possible. The number of steps taken before loss of balance were counted and recorded. Three trials were given for this test and an average taken. Each trial and average were recorded.

3. Standing balance on skiis - The child's feet were strapped to a pair of training skiis . A stopwatch was used to time standing balance

until balance was lost. Three trials were given. Each trial and an average of the three were recorded.

4. Stabilizer standing (knees unlocked) - Feet were strapped to the base of thestabilizer. Braces were unlocked at the knee. A stopwatch was used to time the number of seconds that balance could be maintained. Three trails were given and scores recorded. The average time of the three trials was also recorded.

5. Walking on a board (rod in hand) - Child began at one end of two by four plank. The number of steps taken before balance loss was recorded. Three trials were given and an average also recorded.

6. Sideward walk (to weak side) - The number of steps taken before loss of balance was recorded for each of three trials and an average taken.

7. Backward walk - The steps taken until balance was lost was recorded for each of three trials and an average taken.

8. Standing balance - A stopwatch was used to determine the length of time that balance could be maintained. Three trials were given and times and average time recorded.

9. One leg balance (both legs) - Slight assistance was given on the hand opposite to the leg on which the child was standing. Three trials were given for each leg balance, scores were recorded, and an average of trials for each leg was taken. Trials were timed with a stopwatch.

10. Backward walk on a board (heels down) - Child began at one end of a two by four board, and with alternate steps, walked until balance

was lost. The heels were required to touch the board after each step. Steps in which the heel did not touch the board at the conclusion of the step were not counted. Steps were counted for each of three trials and recorded, and an average taken.

11. Sideward walk on a board (heels down) - Steps were taken to the weak side with the same leg always leading. Heels of both feet were required to be down, or the step was not counted. Steps were counted until balance was lost. Three trials were given, scores recorded, and an average taken.

12. Knee standing - This was a test without support. Feet were allowed to touch the floor. The child maintained balance while being timed with a stopwatch. Three trials were given, scores recorded, and an average taken.

13. Weight distribution - Two balanced bathroom scales were used for this test to determine the distribution of weight to the weak and strong sides of the body. The child placed one foot on each scale. The child maintained standing balance until a reading was made on the face of each scale. If balance was unstable, and the readings fluctuated between several numbers, the middle score was taken. Three trials were given, and an average of the left and right leg was taken. The children who were unable to stand by themselves, were given assistance either on the hands, or under the armpits. However, the weight was allowed to shift naturally.

Movies

A 16 mm movie was made at the beginning and at the conclusion of

the swimming program for the purpose of determining balance compensation in the shoulder, trunk, and hip regions while walking.

Pieces of tape were placed on the middle of the spine of each scapula, on the vertebra prominens, on the spine in the lower lumbar region, and on the crest of each ilium. Each child's gait was filmed from the back as he walked away from the camera. Five to ten steps were allowed to gain balance before filming began. The camera was placed on a tripod and remained in the same position for all of the children. Tri-X reversable film, slowed to 32 frames, was used.

Ten frames, each depicting a different phase in the walking pattern, were selected for analysis. Samples of these gait patterns for each of the children may be found in the Appendix. A photo enlarger was then used to magnify each frame. Graph paper, scaled to ten millimeters per centimeter, was then placed over each frame and the points marked on the back of the child were plotted. An outline of the child's figure was also made to give a clearer picture of body positions in all phases of the walk. A straight line was drawn through the midline of the body, using the marked lumbar vertebra as the midpoint. A straight line was then drawn connecting each hip point with the cervical vertebra forming a triangle. By reading this triangle, it was possible to determine deviations from the normal at the hip level, and also the deviation of the vertebra prominens from the midline of the body. The amount of body rotation may also be determined by this triangle method. Graphically, each of the ten frames was plotted in terms of the following: deviation of vertebra prominens from the midline, vertical

difference between shoulder points, vertical difference between hip points, vertical difference between right shoulder and right hip, vertical difference between left shoulder and left hip and body rotation.

The frames of the first movie were compared with similar phases of the walk in the second movie.

Tape Recorder

Instructors were responsible for the daily lesson plans for their children. Following each lesson, instructors recorded the day's lesson on a tape recorder. A list of questions were constructed to be used as a guide in recording information. A copy of these questions may be found in the Appendix.

Only after the first lesson, were the instructors required to record information by following the questions exactly. Once they were familiar with the type information needed, they were asked to record information in terms of the categories into which the questions were divided. These categories included: skills taught and skills accomplished with and without assistance, motivational procedures, teaching techniques, personality and psychological adjustments, and physical observations in terms of balance, endurance, strength, flexibility, relaxation, and coordination.

The information which was recorded was then transferred to a case folder being kept for each child for use in final analysis of case studies.

Skill progress cards were also kept for each child and were generally used as a motivational devise. Accomplishments were recorded for

each week of the program. Red, gold, and blue stars were used to denote levels of advancement. Red represented the beginner level in which a skill was just being learned. Gold represented the intermediate level in which the skill could be performed with assistance. Blue represented the advanced level in which the skill could be performed with little or no assistance. These progress cards were given to the children at the end of the program.

At the close of the program, having used the various techniques mentioned in the gathering of data, an objective as well as a subjective estimate of individual improvement was made.

CHAPTER V

CASE STUDIES

Introduction

Each case report was divided into five sections so that an overall understanding might be gained of each child - his problems, adjustments and progress.

All background information was compiled and related on the basis of data received from the Executive Director, Chief Physical Therapist, and second Physical Therapist of the Cerebral Palsy School of Greensboro, North Carolina.

The summarizations of the results of the swimming program were reported in four areas of progress. First, the specific skill or skills which were thought to contribute most to individual progress in balance skills were listed. The author had previously made a summary of all swimming skills which were most closely related to the exercise program received by each child in physical therapy. The physical therapists then selected the skills which they thought might benefit each child the most. Secondly, all skills for overcoming fear, adjustment to the water, and swimming skills were listed in the order in which they were presented to each child. Third, all daily lessons were summarized into five categories: Progress made in skills, motivational procedures, special teaching techniques, psychological and personality adjustments, and physical changes which were noted in terms of balance, strength, endurance, flexibility and range of motion, coordination, and relaxation.

Fourth, a summary of preliminary and final test results was included.

Following the summarizations of the swimming program, and listing of test items and scores, changes or improvements, whether physical, psychological, or in skill, were discussed.

CASE #1

Background Data

Subject #1 was the youngest of the twelve subjects, being only five years of age. He came from a middle class family in which there was another child approximately two years older. The father was an ex-serviceman. Both parents were shy and quiet. There seemed to be much love and understanding in the home with a tendency on the part of the mother to be overprotective. The father, at times, had a tendency to be a little harsh.

Subject #1 was sensitive, shy, fearful, and apprehensive particularly when confronted with new situations and people. He had to be approached very gently until an adequate adjustment had been made. Once this adjustment had been made, he was extremely easy to handle.

Thie child was a spastic hemiplegic, with the major involvement on the left side of the body of moderate degree. He wore a low leg brace below the knee. His standing and walking balance were good, and muscular control and coordination were fairly good. Little or no impairment was evidenced in speech. He was left handed.

Subject #1 was small and frail for his age. Although his general health was good, he was susceptible to colds. He was considered educable.

Balance, reciprocal motion, and coordination were stressed in physical therapy treatment. For a more detailed description of physical therapy procedures, a complete description of the program for Case #1 and each other child is included in the Appendix.

Swimming

Recommended Skills for Balance, Strength, Endurance, Flexibility, Coordination, and Relaxation

Legs - frog kick in supine position, flutter kick prone and supine, and walking
Arms - synchronized movement in supine position
Coordinated stroke - elementary back stroke using flutter kick and frog kick

Skills Taught in Order of Presentation

Walking
Flutter kick on stomach from side of pool out of the water
Face in water
Blowing bubbles
Flutter kick on stomach in the water
Flutter kick on back
Submerge head
Sitting on the bottom of the pool
Breath holding
Human stroke
Back float
Alternate arm stroke while walking
Recovering objects

Summary

The first day of swimming for #1 was a day of fear and apprehension. The adjustment of child to instructor was a slow one, and by the end of the period confidence had still not been completely won. The greatest problem with which the instructor was confronted was getting #1 into the water, for he was extremely fearful, shy, and timid. A great portion of the period was spent in sitting at the edge of the pool, until enough confidence had been gained.

Once he did enter the water, he allowed himself to be held around the waist and pulled about in the water while on his back. He walked

about in the water, but did not venture away from the edge of the pool. A large rubber playground ball was used for motivation and was considered to be a successful tool in gaining some self-confidence.

Even though parents were asked not to be in the pool area throughout the course of the program, on the first day an exception was made in the case of #1 because of his age and apprehension. No skills were taught, only moving around in the water so that he might become accustomed to it.

On the second day, #1 was not happy to see his instructor. The rubber ball was again used for motivation, both in and out of the water. Again, a greater portion of the swimming period was spent in sitting and playing at the edge of the pool. A rubber ring was placed in the water, into which #1 threw the rubber ball. A kick board was also used as a target. These three pieces of equipment proved to be excellent motivational devises. This was the first day that #1 took three steps away from the edge of the pool unassisted. This was a thrill to him, for it was his first real accomplishment. His mother did not continue to remain in the pool area.

By the third day, some progress had been made. #1 was still extremely fearful and tense in the water. He seemed more eager to go swimming than previously, but his mother said that he was not as excited about going to the pool as before. Gaining his confidence was still the major problem in adjustment.

He allowed himself to be held in a prone position, so that he could kick his legs. An attempt was made to get his face into the water

and to blow bubbles, but the attempt was unsuccessful. For additional motivation, his instructor said that she would bring a fish for him, to show that maybe he would be able to swim like it. This helped to arouse his interest in learning how to swim, and he became very excited.

On the fourth day, #1 was eager and excited to go swimming. He was happy, friendly, and talkative. He kicked his legs while supported in a supine position. He was successful in getting his face into the water and blowing bubbles. He said that he had practiced blowing bubbles at home while drinking his milk. Once in the period, he lost his balance and slipped under the water. He came up unafraid and continued to play in the shallow area.

Subject #1 was anxious to blow bubbles in the water on the fifth day. He was not afraid of the water or the surroundings, but was still fearful of people. He watched everyone in the pool very carefully.

The metal lion's head which circulated fresh water throughout the pool, and had contributed to his apprehensiveness, became one of his interests. By now, #1 had begun enjoying the splashing of the water as he stood under it.

His instructor felt that #1 had now gained enough confidence in her and in himself to begin introducing specific skills.

Following a two weeks lapse in the swimming due to bad weather, the program was again resumed. By the sixth lesson, #1 had become quite attached to his instructor. He showed no signs of fear in spite of the

fact that he had not been in the water for two weeks. For the first time he was very relaxed, which made it much easier to persuade him to perform.

An attempt was made to get him to understand body buoyancy. This was done simply by pushing one of the rubber balls under the surface of the water and allowing it to jump to the surface. The child tried this, but was not strong enough to push the ball under. After trying, unsuccessfully, to submerge his instructor, he did not understand his own observations.

He ventured for the first time by himself to deeper water by bracing his feet against the wall and pulling himself along the scumgutter.

On the seventh day, it was noticed that #1 had a "feel" for walking in the water. He held his body erect, and his balance was not easily disturbed. His instructor tried to get him to use a flutter board for support, but he was not interested. She also held him around the waist, supporting him on top of the water. Letting the water give most of the support, she held him, with only his head up, until his feet touched bottom once again. This was another attempt to help him to understand body buoyancy.

He submerged three times, sitting on the bottom of the pool. This was not his intention, but happened as a result of loss of balance. He was not startled any time. By now, he had complete confidence in his instructor. In fact, he wouldn't talk to anyone else.

By the eighth day, #1 had no difficulty in blowing bubbles. He

would not place his face into the water of his own free will. However, as he would begin to blow bubbles his instructor would help his head under the surface of the water. This he enjoyed very much.

It was noticed on that day that #1 did not like to be supported on top of the water. When he was motivated to kick, he did well, always bending his knees.

The ninth through the twelfth lessons were similar with not too much progress. He was still shy with regard to people, but made a more rapid adjustment. A technique, resting his head on the instructor's arm, was used to make him feel more comfortable and secure while resting on his back.

He enjoyed holding on to the side of the pool and drawing his legs up to his chest. A contest was held between child and instructor to see who could draw his knees up the highest.

Previously, #1 had only kicked his legs while supported on his stomach. He now also moved his arms alternately as in dog paddle fashion. Because he did not enjoy lifting his feet to the surface, he was first taught to move his arms in crawl fashion while walking. This proved to be a successful progression.

A great portion of the swimming sessions were still spent in playing, with the rubber ball still being his major interest. He would not float alone. He did not mind water being splashed into his face. He would place his face into the water up to his eyebrows and blow bubbles without help.

By the thirteenth lesson, he seemed to enjoy doing things independently. He worked on walking, submerging his head under the water,

and played with a kickboard which now seemed to be a source of motivation for him.

Although his balance was good while he stood or walked in an erect position, while on his back or stomach there was a tendency to roll from side to side. Because he could not control this rolling of his body, balance was disturbed.

The fourteenth, fifteenth, and sixteenth lessons showed little, if any progress in skills. The only new activity was retrieving objects from the water. He used his feet and hands and was thrilled by his new achievement.

Following the completion of his sixteen lessons, #1 had gained a great deal more self-assurance, was less apprehensive, enjoyed being in the water with the other children, and truly had had a fun experience. He always required a great deal of encouragement, but with this was always willing to perform. Relaxation and self confidence were his greatest accomplishments.

Test Results

One Legged Stand

Preliminary Test

right leg

Trial 1 - 20" seconds
2 - 33"
3 - 17"
Average - 23.3

left leg

Trial 1 - 67"
2 - 92"
3 - 52"
Average - 67"

Final Test

right leg

Trial 1 - 18"
2 - 38"
3 - 30"
Average - 28.6

left leg

Trial 1 - 32"
2 - 704"
3 - 47"
Average - 261"

Weight Distribution

Preliminary Test

	left	right
Trial 1	23	15
2	24	12
3	23	15
Average	23.3	14
Difference	9.3	

Final Test

	left	right
Trial 1	20	20
2	25	15
3	24	16
Average	23	17
Difference	6	

Conclusions

Preliminary testing for balance on the one legged stand showed an average of three trials to be 23.3 seconds for the right leg and 67 seconds for the left leg. In the final testing session, a slight improvement was indicated. The average for three trials was 28.6 seconds for the right leg and 261 seconds for the left leg. Trials one and three for the left leg were lower than the same trials on the preliminary test.

Test averages and scores for individual trials in weight distribution showed little, if any, change. Average scores indicated a tendency to support the body weight more on the left side, but distribution was fairly equal.

Although the one legged balance was a new skill to this child, and was not emphasized in the swimming program, there was no reason to believe that swimming did not contribute to the slight improvement which was shown.

The most noticeable changes in this child were in psychological and personality adjustment. He was more outgoing, less fearful, and had more self-confidence.

CASE #2

Background Data

Subject #2 was an eight year old boy with ataxia. His degree of involvement was that of severe. He was the youngest of three children in the family. The oldest child in the family, who also participated in the swimming program, was also an ataxic. The second boy was normal.

Both parents were young, from lower middle class status and each held a full time job, one during the day and the other at night so that one parent would always be at home. They were kind, understanding, and gave much attention to their children. In a case such as this, many parents might have been extremely embittered after having two children with the same affliction; however, these parents had adjusted well to the situation. They accepted the problem and were willing to do anything to help the children.

Subject #2 was educable, as indicated by Mrs. Wagoner, and probably better than his tests showed. His personality was very outgoing. Whenever he had the opportunity, he liked to tease. He was very playful, and it was difficult to tell where this began or ended in terms of retardation. Whenever he became happy or excited, which was most of the time, his entire body shook and wild motions were made with the arms and legs. He had a strange laugh, and rather than talk, made sounds like an infant.

This subject had both a visual problem, or nystagmus, and a speech impairment. When he concentrated on it, his speech was understandable.

He was generally fearless, but it was sometimes difficult to tell because of his teasing nature. His health was good, although he was susceptible to colds.

Subject #2 wore braces below the knee on both legs. In physical therapy, balance and steady motions were stressed. Weights were used on the ankles to help develop the gait pattern.

Swimming

Recommended Skills for Balance, Strength, Endurance, Flexibility, Coordination, and Relaxation.

Legs - frog kick in supine position, flutter kick, standing and walking
Arms - synchronized stroke in supine position and as for human stroke
Coordinated stroke - elementary backstroke, human stroke

Skills Taught in Order of Presentation

Bobbing
Putting face in water
Counting fingers
Blowing bubbles
Back float position
Front float position
Flutter kick on front
Flutter kick on back
Recovering objects from bottom with feet
Standing and walking
Head under water
Retrieving objects with face in water
Frog kick

Summary

Subject #2 was encouraged to play on the first day of the program. He was not very tense, but made wild motions with his arms. He was fearless and independent. There was self-motivation only for what he

wanted to do. He lost interest quickly when confronted with specific skills such as counting fingers. Bobbing up and down in the water, putting his face into the water, the lion's head, and a rubber ball were used for motivation and adjustment. He was enthusiastic about play, and was attentive only when he wanted to be. He became cold and fatigued rapidly. He was very talkative throughout the period, but only about pieces of equipment and the lion.

On the second day, Subject #2 was still a little tense. He had gained more confidence, but was still insecure. His instructor threw a football for him to retrieve. Before he could pick it up, he had to blow bubbles. He was more cooperative than on the previous day. However, he was not too interested in blowing bubbles. This was the only skill attempted on that day. He did not talk as much, was restless, and not excited. Later in the period, he became ill. At the time, he was playing with the life line. The nausea could have been the result of close focusing, or becoming chilled.

His first achievement was that of putting his face into the water and blowing bubbles. It was an experience for Subject #2 to be learning something rather than just playing. He was interested in what his sister was doing, but not interested in performing for her.

The third lesson was a disappointment. He had regressed after his illness. He was only pulled around in the water for a period of re-adjustment.

On the fourth day, the child was eager to get into the water. He kicked his legs while in a prone and supine position, and seemed to have a good feeling about learning this skill. He was still tense and

afraid of becoming ill, so his interests had to be diverted to playing with a kickboard, and retrieving rubber rings from the bottom of the pool with his feet. His head went all the way under the water accidently, but enough of an adjustment had been made so that he did not become frightened. He was more tense from excitement than fright. His major interest was still in playing rather than specific skills. In order to maintain interest, it was necessary to frequently change from one activity to another.

The fifth, sixth, and seventh lessons were a period of rapid adjustment and progress. He was very excited about going swimming. Subject #2 was given an opportunity for independent work, rather than being given complete assistance as previously. He was allowed to hold on to the side of the pool and pull himself along in the water. This was motivation for getting him to perform other skills which were presented to him during the period. He seemed to enjoy kicking his legs. He began this by first drawing his legs up together and then straightening them. He also felt more secure when his instructor stood behind him and gave assistance under the arms. He walked by supporting himself. During these three days, he became much less tense and withdrawn, more outgoing, and enjoyed what he was doing. His attention span became longer and he did not become fatigued as easily. Balance in water was still poor, for his body had a tendency to roll from side to side. His kick was weak, but at least he was willing to try this skill.

By the eighth lesson, there was improvement in balance, kicking,

and relaxation. Just the mentioning of his sister's name proved to be an excellent motivational devise, for they were very close and enjoyed performing for each other. He was happy and willing to try anything that was asked of him. He enjoyed walking, and did not become readily fatigued by activity. Be self-determination alone, after watching his sister retrieve rings from under the water, he finally put his face into the water.

By the ninth lesson, Subject #2 no longer minded getting water into his face. He now was also retrieving rings from under the water. He worked on the frog kick, and enjoyed saying, "Up, out, puuuuuull!" A rubber float was used for support under the head and his interest span was lengthening.

The flutter kick and the child's endurance had improved considerably by the tenth lesson. In order to maintain interest in the kick, a rubber ball was used for motivation. Without this he seemed to lack initiative.

In the eleventh and twelfth lessons, Subject #2 had gained more confidence. Little progress was evident except in his ability to relax and maintain balance. The lion was still an excellent motivational devise.

By the thirteenth lesson, this subject had developed an excellent "feel" for performing the flutter kick. He now worked with a rubber tube around his chest. He was taken to the middle of the pool and told to kick back to the lion. To help him with the kick, his instructor stood behind him and placed her hands on his legs. By feeling

the pressure on his legs, he eventually was able to begin the kick by himself and continue for long periods of time. When he stopped kicking, pressure was again applied, keeping the legs under the surface of the water for resistance, and he would again begin kicking by himself. There was no more difficulty in placing his face into the water. Now that he had developed several skills in which he could experience success, he began enjoying himself even more.

The fourteenth and fifteenth lessons showed definite improvement in attitude and skill. His kick had become strong, endurance had increased, he was more attentive and willing to work on specific skills, and was more cooperative. The first successful attempt was made to completely submerge his head. This was accomplished under the lion's head. He was much happier and more alert, and was learning skills through a play medium.

Test Results

Standing Balance

Preliminary Test

Trial 1 - 2.2 seconds
2 - 1.2
3 - .8
Average - 1.4

Final Test

Trial 1 - 5 seconds
2 - 3
3 - 7
Average - 5

Weight Distribution

Preliminary Test

	left	right
Trial 1	26	21
2	33	18
3	34	15
Average	31	18

Difference - 13

Final Test

	left	right
Trial 1	35	21
	33	33
	36	30
Average	34.6	28

Difference - 6.6

Conclusions

Improvement was shown in all final test scores. An improvement of 3.6 seconds was indicated between averages for standing balance.

In the test for distribution of weight, the difference between the averages for the left and right legs was 13 pounds. In the final test, only a 6.6 pound difference in averages was indicated showing that weight was more equally distributed over each leg.

Swimming may have contributed to the improvement shown in each of these tests.

Improvement was also indicated in swimming skills and attitude. He had begun to develop an awareness of body position, particularly for the flutter kick. His legs were stronger, and there was more definite direction to the kick which he was able to execute by himself. Fear was also diminished.

CASE #3

Background Data

Subject #3 was an eight year old girl with moderate involvement. Her type of cerebral palsy had been diagnosed as spastic quadriplegia with the major involvement on the right side of the body.

The parents were of low socio-economic status. The mother was more interested in the child than the father seemed to be. The child had to be dropped after her first lesson which was almost halfway through the program, because the parents could not be depended upon to transport the child, nor have the child ready when transportation was provided. There was another child in the family who did not live with the parents, but lived with an aunt several miles away. Both parents worked and there were times when the child was left at home alone.

Subject #3 was very out-going, friendly, and enthusiastic. She was a little shy at first, but she made a very rapid adjustment.

Her tests showed a little lower than normal mentality. She enjoyed reading and writing in spite of a poor visual problem. Her speech was fairly good.

She was a little frail and susceptible to colds in the head and chest.

She became more independent after attending a summer session at camp. Up to that time, she had been babied and not allowed to do things for herself.

Emphasis in physical therapy was in gait training.

Swimming

Recommended Skills for Balance, Strength, Endurance, Flexibility, Coordination, and Relaxation

Legs - frog kick
Arms - as for elementary backstroke
Coordinated stroke - elementary backstroke

Skills Taught in Order of Presentation

Walking
Face in water
Flutter kick on back
Back float

Summary

Subject #3 had only one lesson. She had to be dropped from the program because her attendance was too unpredictable.

The author felt that had she continued in the program, she would have made rapid progress. She adjusted well to the surroundings, instructors, and other children. She was not sure of herself upon first entering the water, but wanted to walk around and go into deeper water. She put her face into the water on this first day. With the use of a flotation devise, she was able to float relaxed, and also kick her legs. She wanted to do things by herself, even though she relied on her instructor for assistance. Subject #3 was excited about her swimming lessons, and was anxious to return.

CASE #4

Background Data

Subject #4 was an eleven year old athetoid with all parts involved to a serious degree. Much of his time was spent confined to a wheelchair. He was one of the best adjusted children of the twelve who participated in the program when one takes into consideration his home environment. He came from a family of seven children, of which he was the second oldest. The family was poor, coming from a very low socio-economic class. The mother was the only one who took an interest in the children. She had a tendency to tease her afflicted son a great deal, placing him on the defensive. She tried to make him as independent as possible, sometimes going too far and not realizing that he could not care for himself. He also had to defend himself against his brothers and sisters, who many times took his food from the table when he could not help himself. Often, he had to remind his mother that she had not fed him.

Subject #4 was extremely malnurished. He did not receive the proper food, and many times, received no food whatsoever. At times, he was so weak that he could not perform daily activities at the Cerebral Palsy School. Malnutrition was a major factor in his inability to progress, and the reason for early fatigue.

He was shy and sensitive. However, once he knew that you were his friend and not just pitying him, he lost much of his shyness. He always wore a big smile, and was very affectionate. Subject #4 was a fear case, but once confidence was won and some adjustment made, much

of this fear subsided.

This child had a speech impairment, but when asked to repeat could be understood. His nutritional condition made him easily susceptible to colds particularly in the chest and throat.

He was right handed and used this hand continually to stabilize the left hand which was severely athetotic. He wore long braces which extended from the waist to the feet. Subject #4 had overstrong extensors which he could control if reminded. He was able to walk in braces with assistance and support.

He almost always carried a toy and because of his sensitivity one dare not make fun of him. He could not be forced to respond by speaking to him in a raised or loud tone. This only made him cry and increased his fright.

He was retarded but educable. He understood his limitations and at times became frustrated by them. Otherwise, his adjustment was excellent, considering the many barriers which might have inhibited his progress.

Swimming

Recommended Skills for Balance, Strength, Endurance, Flexibility, Coordination, and Relaxation

Legs - flutter kick prone and supine, standing and walking
Arms - alternate arm stroke under water in prone position
Coordinated stroke - human stroke

Skills Taught in Order of Presentation

Putting face in water
Counting fingers

Semi-float on back
Placing feet on bottom for security
Breath control
Blowing bubbles
Back float
Walking
Flutter kick on back
Face float
Sitting balance
Self support on scumgutter
Flutter kick on front
Pulling self along scumgutter
Placing entire head under water
Back float and recovery
Recovery objects

Summary

On his first day in the water, Subject #4 was periodically tense, then later relaxed. Involuntary actions were reduced in the water. His abilities were challenged, for he had gone swimming previously. There was no response because of his restricted body movements. He had complete confidence in his instructor, however, he was still fearful. He became restless quickly due to his inability to perform. His major accomplishment was in being able to put his face into the water. He was proud of this achievement, and wanted to show the skill to the other children. In order that he might begin to feel and understand body buoyancy, he was placed into a semi-float position on his back. Being able to put his face into the water seemed to give him a little more confidence, but this did not necessarily reduce fear.

In the second lesson, a small amount of time was spent on individual skills at the beginning of the period. Near the close of the period, these skills were returned to once again. This seemed to be a successful procedure for this child, and was used throughout the

remainder of the program.

His breathing was still irregular and uncontrolled when he attempted to blow bubbles. When in the float position, he was tensed at the hip in order to maintain an upright position. Once he was able to relax in this position, there were no visible signs of involuntary movement.

The lion's head was an excellent motivational devise and aid in helping him to relax. After allowing the water to rush over his head and body, he was again placed in the back float position and remained motionless for ten to twelve seconds. All of his activities had to be performed with assistance because of his severe involvement. He kicked his legs when told that he would move more quickly through the water. His interest span was longer than on the previous day.

Subject #4 was tired upon entering the water on the third day, so no progress was made.

By the fourth day he was enthusiastic and eager to discuss future plans. Rubber supports were used to help him feel body buoyancy. This was a successful aid. He was still uncomfortable in the float position and always asked to be pulled about in an upright position. He practiced on sitting balance while supported on his instructor's knees. His balance was poor, not only while performing this skill, but when doing other activities also. He constantly pleaded to walk. This activity became routine out of the water as well as in the water.

By the fifth day, Subject #4 had made definite progress. He was more self-motivated. There was no hesitation about putting his face

into the water and his breathing was more controlled. While working on the back float, he did not complain once. Floats were now used for support rather than personal contact. He floated by supporting himself on the scumgutter.

Two new skills were introduced in the sixth and seventh lessons. Subject #4 was taught how to recover from the back float position. This was not successful with the float supports because he did not like the constant pull to the surface. With support in the small of the back, he was able to float, and when told to sit and raise his head to recover, he responded and was successful. He was usually hesitant about trying something new, but when his instructor said, "please", he was motivated enough to try. The other skill he learned was that of pulling himself along the scumgutter with the instructor assisting. The performances of some of the other children served as a motivational devise, for he had seen several others perform this technique before he asked to be allowed to do it.

No progress was made in the eighth lesson because of cool water and air temperature. He was extremely tense and unable to do anything.

There was improvement in performance in the ninth, tenth, and eleventh lessons. Balance had improved, and recovery from the back float was good because of the tendency he had to bend forward. He was able to extend his body for the back float and maintain a straight line. Control of his breathing had improved and his involuntary movements were greatly reduced. This later was observed as he pulled a rubber ball around in a hula hoop for he had no trouble in controlling

arm direction. When the ball went outside of the hoop, he raised the hoop and placed it over the ball once again. The reason for using this hula hoop and rubber ball was to insure success in grasping objects, for he had difficulty with large objects. These two pieces of equipment were also used as an aid to help develop the kicking pattern. He tried to kick the ball out of the hoop by extending his legs. His legs presented the greatest problem because of their buoyancy.

By the twelfth, thirteenth, and fourteenth lessons, Subject #4 had made excellent progress in spite of limitations in body movement and control in breathing. He had acquired a great deal of self-confidence evidenced by his willingness to perform.

Skills were reviewed in the fifteenth and sixteenth lessons. He no longer had a negative attitude about floating and kicking. Breathing was good. He was able to propel himself from the rope to the end of the pool with his flutter kick. He enjoyed using the goggles to look at the bottom of the pool with his face submerged, and referred to them as "my goggles". All signs of fear had vanished and he now had a good mental attitude towards the water and swimming. His balance was still not good, but had improved. Although he had jerky coordination and movement, he was able to use his arms and legs to move about in the water. He could be left in the middle of the pool where he would get into a float, kick, and recover.

This child had difficulty attaining success on land because of his restricted body movement. In the water, he was able to have a fun

experience and feel free to move with only limited restriction. He was happy, outgoing, and attained a feeling of achievement.

Test Results

Standing (skiis)

Preliminary Test	Final Test
Trial 1 - 5 min. 26 sec.	Trial 1 - 26 min. 29 sec.
2 -12 min. 31 sec.	2 - 9 min. 0 sec.
3 -13 min. 9 sec.	3 - 5 min (Complained of sore feet)
Average -10 min. 22 sec.	Average - 13 min. 10 sec.

Stablizer (knees unlocked)

Preliminary Test	Final Test
Trial 1 - 1 min. 13 sec.	Trial 1 - 1 min.
2 - 55 sec.	2 45 sec.
3 - 55 sec.	3 - 1 min. 15 sec.
Average - 1 min. 2 sec.	Average - 1 min.

Weight Distribution

Preliminary Test

	left	right
Trial 1	41	19
2	41	19
3	39	22
Average	40.3	20
Difference	20.3	

Final Test

	left	right
Trial 1	21	25
2	25	20
3	30	15
Average	25.3	20
Difference	5.3	

Conclusions

An improvement was shown in two of the three test items, standing on skiis and distribution of weight. The average of three trials in standing was 10 minutes in the preliminary test as compared to an average of 13 minutes and 10 seconds in the final test.

There was only a 2 second difference between averages of the trials for stabilizer standing.

The difference between the averages for three trials in the preliminary test for distribution of weight was 20.3 pounds. The final test indicated that the child was steadier than at first. The difference between the averages for the three trials was 5.3 pounds.

His swimming experience may or may not have contributed to the improvement in scores. His greatest achievements in the swimming program were his more positive attitude towards the water and swimming, and the progress which he made in spite of limitations in body movement.

CASE #5

Background Data

Subject #5 was an eight year old boy who was a spastic paraplegic diplegic with severe involvement. He came from a middle class family in which both the mother and father worked. The father was a policeman in Greensboro, North Carolina. Both parents were extremely over-protective. As a result, the child wanted his own way constantly, and had a tendency to cry when he could not have it. When asked to do something, rather than do it, he responded with a series of unrelated questions which referred to everything but the subject at hand. He was very demanding and domineering and expected to have everything his own way.

He was mechanically minded, and never said anything without its being in question form. He enjoyed taking objects apart and putting them back together again, particularly braces.

At times, he was pushed to perform better than he was capable of performing. As a result, he was sensitive and had to be handled gently, or he began to cry. He had a negative attitude towards "doing" because he was afraid of failure. He was extremely fearful of losing his balance and falling, and, therefore, was unwilling to try things in which he was not sure of immediate success.

Subject #5 was alert, and very conscious of people and immediate surroundings. He always asked, "Who"? "What"? "Where"? "When"? "How"? "Why"? and certainly had no communication problem. However, his thoughts were very unorganized. He had no problem in understanding what

was wanted of him, it was just that he didn't want to "do".

The parents, particularly the father, seemed to have a fairly sound understanding of cerebral palsy. This handicap was hard to accept because the mother had lost another child previously, at birth.

This child had average or better intelligence, and it was believed that someday he might become a mechanic.

His general health was good, but again, as was the case with most of these children, he was susceptible to colds.

He had had surgery performed on the knees for tendon lengthenings. Balance and endurance were stressed in physical therapy. He was able to get about independently by leaning against walls and other objects which were available.

Swimming

Recommended Skills for Balance, Strength, Endurance, Flexibility, Coordination, and Relaxation

Legs - flutter kick in supine and prone position, walking
Arms - alternate arm stroke in prone and supine position
Coordinated stroke - front crawl, back crawl

Skills Taught in Order of Presentation

Putting face in water
Blowing bubbles
Back float
Bobbing and blowing bubbles in deeper water
Walking
Open eyes under water
Retrieving objects held under water
Back float and recovery
Face float
Face float and recovery
Flutter kick on stomach
Arm stroke for back crawl

Hand over hand around the scumgutter
Flutter kick on back
Arms for human stroke
Head under water
Breath holding under water
Human stroke
Retrieving objects from botton
Jellyfish float
Back crawl

Summary

Subject #5 was extremely fearful, tense, and cold on the first day. He remained close to the side of the pool and would not leave. He was very insecure and held on tightly when his instructor moved him away from the side. He was motivated by pretending to be a motorboat while bobbing up and down in the water. He was inquisitive, and wanted to know the mechanics of how everything in the pool operated. After he had been given the opportunity to observe, his attention span increased. His gait was more unstable after the session, which was an indication of fatigue.

Rapid adjustment was made in the second, third, and fourth lessons. He was tense upon entering the water, but was relaxed after several minutes. He walked by placing his hands in his instructor's for support. A game of hide-and-seek was played as motivation for placing the face under water, opening the eyes, and retrieving objects. This was a challenge for him which proved to be successful. He was able to float and recover by holding on to the side of the pool, and with a rubber tube around his waist. He was also able to float motionless in an abdominal float.

He became more independent as evidenced by his desire to get into

the pool without assistance. Because of his strong arms and shoulders, he was able to do this very well. The flutter kick was taught in a prone position because of the success which he experienced in the face float. The arm stroke for the back crawl was also taught since he was constantly trying to propel himself through the water with his arms. Due to immobility of the knee joints, the leg kick was executed with the legs in a straight locked position. He was pleased with himself at being able to retrieve objects from under the water.

He had to be pushed to get maximum results, but could be pushed only so far because he was so sensitive and spoiled. He was uncomfortable in the back float, for the legs, due to their buoyancy, were easily lifted to the surface. The support which was given him was still important in his overall adjustment to the water. Several times, he ducked his head unintentionally. When he found that the water would not harm him if he held his breath, he submerged his head repeatedly. When timed to see how long he could remain under water holding his breath, it was from ten to thirteen seconds. He was playing a game of circus at the time in which he was the circus clown. He was able to walk without assistance, but did not have enough self-confidence to try. In order to keep his attention, it was necessary to keep him moving and to provide situations which were interesting and fascinating to him.

By the fifth lesson, Subject #5 had gained full confidence in his instructor. For the first time, he had raised himself into a face float position by supporting himself at the corner of the pool. He would not

have done this had he not felt reasonably secure in the water. He was now more enthusiastic and eager to work. He had been so used to getting his way that it was difficult to get him to perform what his instructor wanted him to do, but when he found that he was being unsuccessful in getting his own way, his attitude changed.

By the sixth and seventh lessons, he was able to execute the flutter kick with a bent knee while in a back lying position and the kick had become much stronger in this position. While in a prone position, the knees were still straight and the kick was weak. He had coordinated the human stroke, but his flutter kick was too weak to propel him through the water. The arms for the back crawl were not well coordinated. Subject #5 continued to be frightened of losing his balance. An unsuccessful attempt was made to get him to retrieve an object from the bottom of the pool. A new technique was tried to get Subject #5 to open his eyes under water. His instructor sank below the surface. He had to submerge, open his eyes, and reach for her. This was successful. He was able to raise himself into the back float and recover without assistance so long as he was able to feel the side of the pool.

Subject #5 became more relaxed by the eighth lesson. He was unsuccessful in performing the jellyfish float because of his fear of losing his balance and falling forward. His arms, legs, and breathing were good. He still tried, periodically, to get his own way, but his instructor was determined that he would not have it.

By the ninth lesson, he was still fearful and reluctant to perform skills which he was capable of doing. He still would not walk

away from the side towards the center of the pool without assistance. He did once, but did not realize that he had been tricked into it.

The tenth and eleventh lessons showed improvement in skills which had already been performed, but no new skills were introduced.

By the twelfth lesson he was able to submerge his head without difficulty. He was able to swim the width of the pool on his stomach without assistance, although his instructor's hands had to be within view and reaching distance.

This child had the ability to swim, but did not have the self-confidence. Much of his fear had been overcome, but his progress was predominately inhibited by this factor.

The thirteenth and fourteenth lessons showed improvement in the back crawl and float. He was more relaxed which aided his ability to perform.

The greatest inhibiting factor in his progress continued to be the psychological barrier. This was penetrated, but it still placed limitations on what the child could do.

Test Results

Steps

Preliminary Test	Final Test
Trial 1 - 62	Trial 1 - 74
2 - 57	2 - 69
3 - 72	3 - 82
Average - 63.3	Average - 75

Knee Standing

Preliminary Test	Final Test
Trial 1 - 75 seconds	Trial 1 - 32 seconds
2 - 55	2 - 27
3 - 97	3 - 78
Average - 75.6	Average - 45.6

Weight Distribution

Preliminary Test

	left	right
Trial 1	24	28
2	30	20
3	30	20
Average	28	22.6
Difference	5.4	

Final Test

	left	right
Trial 1	20	35
2	30	30
3	25	35
Average	25	33.3
Difference	8.3	

Conclusions

The only improvement indicated was in the number of steps taken while walking. An average of 63.3 steps were taken in the preliminary test as compared to an average of 75 steps for the final testing.

The difference between the averages of trials for the preliminary and final test in knee standing was 30 seconds, with the final test being considerably lower.

In the preliminary test for distribution of weight, the difference between the averages of trials for the left and right side was 5.4 pounds, with the weight supported over the left leg. The final test scores showed a difference of 8.3 pounds between the averages with the weight supported over the opposite leg.

Although the only improvement which was shown in balance was in the number of steps taken, his greatest achievement was in gaining a

little more self-confidence as a result of his swimming experience.

CASE #6

Background Data

Subject #6 was an eight year old out-patient who was a spastic paraplegic with moderate involvement. His disability was not apparent unless he was walking. He was well developed for his age, rather than being small, as were many of these children. He came to the Cerebral Palsy School for physical therapy treatment once a week.

The parents were upper middle class and educated. There was also a younger child, a girl, in the family. Subject #6 had normal intelligence, and because his handicap did not inhibit him, he attended a regular elementary school.

He was very precise in everything which he attempted to do, including his speech. He gave the appearance of being a child prodigy. The only sensory impairment was in vision, for which he wore glasses. When asked if he would like to participate in the swimming program, he replied, "I think that would be very nice!"

His health was excellent with a tendency to be susceptible to colds.

He wore braces which came below the knee. Gait training stressing toeing the left foot straight ahead, dorsi-flexion and full knee extension, was the major activity in physical therapy treatment.

Swimming

Recommended Skills for Balance, Strength, Endurance, Flexibility, Coordination, and Relaxation

Legs - scissor kick on left and right side
Arms - as for side stroke on left and right side
Coordinated stroke - side stroke on left and right side

Skills Taught in Order of Presentation

Putting face in water
Blowing bubbles
Back float and recovery
Front float and recovery
Counting fingers with eyes open under water
Scissor kick
Sitting on bottom of pool and recovery
Breath holding
Retrieving objects
Flutter kick on stomach
Arms as for human stroke
Coordinated human stroke with breathing
Dive into deep end and swim to rope
Distance swim without breathing
Arms for sidestroke
Distance swim - length of pool and back with flippers
Coordinated sidestroke
Rhythmical breathing
Sommersaults
Distance swim - length of pool without flippers
Turning over - back to front, front to back
Flutter kick on back with flippers, no arms
Flutter kick on front with flippers, no arms
Foot first plunge from diving board
Standing front dive from board
Front crawl

Summary

Subject #6 was able to perform many of the beginning skills with some efficiency upon entering the swimming program. He was enthusiastic about learning the side stroke because this was something completely

new to him. On the first day he required no assistance except when working on the scissor kick. He understood all directions given and needed no demonstration of skills. He was eager to learn the side stroke on both sides immediately, so that he would not become one sided. He was never fearful or tense in the water.

The first three lessons were devoted to work on submerging, blowing bubbles, breathing, diving for objects in the shallow area, coordinated human stroke, and scissor kick. He had a great deal of self-confidence and was not hesitant about performing.

On the fourth day, Subject #6 dived into the deep water and swam to the rope. Flippers were used for distance swimming without breathing. The side stroke was coordinated. Although he had difficulty in maintaining balance while on his side.

On the fifth and sixth days there was improvement in breathing, which had become more natural. He had powerful legs and could swim for considerable distances without becoming fatigued. This child was very serious and exacting about everything that he did. He enjoyed working on the sidestroke, although the coordination was difficult. His arm stroke had improved. He had a little difficulty with rhythmical breathing, but showed improvement. He had a tendency to want to show off his skill to others who were in the pool.

There was a two weeks lapse in the program because of bad weather. Subject #6 enjoyed being back in the pool after his long absence. He had not forgotten the sidestroke, but still had difficulty with the coordination. A flutter board was used to practice the scissor kick

and the flutter kick.

By the eighth lesson, he was more physically active and even more mentally alert. Coordination of the sidestroke had improved. He had a good flutter kick when using the flippers. He was anxious to turn sommersaults and perform some tricks for his instructor.

By the ninth lesson, he had improved in strength and endurance. He was able to swim the full length of the pool with the flippers without becoming tired. He worked independently on turning over, from back to front and from front to back.

The tenth, eleventh, twelfth, and thirteenth lessons showed some improvement in the sidestroke coordination. His knees were flexing well, and a rubber tube was placed around his feet so that he could work on the arm coordination. This proved to be very effective. Coordination in arm and leg strokes, and stamina were much improved from the first day of the program. The problem in the scissor kick was the separation of the legs from front to back, but he was showing improvement.

In the fourteenth lesson, his abilities were challenged. Before he could leave the pool, he had to swim three widths of the pool. All of these widths did not have to be done at the same time. He succeeded easily. While working on the sidestroke, his coordination was better when he was told to slow down.

By the fifteenth and sixteenth lesson, he was able to float on his back completely relaxed, and was also able to flutter kick the length of the pool while on his back. He swam his three widths of the pool

immediately to get them over with. He was now beginning to get a little tired of the sidestroke because of the difficulty that he was having with the coordination. The amount of time spent on the stroke was reduced so that he would not become bored.

The seventeenth, eighteenth, nineteenth, and twentieth lessons showed definite improvements in all strokes. He had more endurance when performing the front crawl, in which he had an excellent arm stroke. The sidestroke had improved in spite of difficulty in coordination. He was able to swim long distances without the use of flippers, which was an indication that his flutter kick had become stronger. He began diving from the diving board, feet first, then head first.

The greatest improvements were shown in coordination of body parts, more strength in the legs, greater lung capacity as evidenced by his ability to remain under water for long periods of time, and improvement in balance while performing various skills. He had an excellent mental attitude towards the water and swimming, and worked hard to make his skills perfect.

Test Results

Weight Distribution

Preliminary Test

	left	right
Trial 1	36	30
2	38	28
3	33	31
Average	35.6	29.6
Difference	6	

Final Test

	left	right
Trial 1	37	31
2	34	34
3	41	29
Average	37.3	31.3
Difference	6	

Conclusions

The final test for distribution of weight indicated no change in the distribution. The difference between the averages of the trials for both the preliminary and final tests was 6 pounds, with the weight to the left in each case. This indicated that the child was fairly steady.

The ability to coordinate the limbs in performing specific swimming strokes was his major achievement as a result of his swimming experience.

CASE #7

Background Data

Subject #7 was an eleven year old rotary extension athetoid with moderate involvement. Her body was twisted to the left side and bent over. This body position had a definite influence on her difficulty to maintain balance. She had no natural arm swing because of tightened extensors in the elbow and this also influenced balance.

This subject was an only child from a middle class family in which both of the parents worked. The mother maintained a beauty shop in the back of the home and through this helped to support the family. The father made no decisions in the home, but left this up to his wife. He did not appear to be interested in the welfare of his child, nor the progress which she was making. He seemed almost to resent the fact that his child was a cripple.

The mother was more interested in herself than the child. She rarely spoke of her daughter, but instead, spoke of herself and the beauty shop which she owned.

Subject #7 was shy and withdrawn, probably due to the fact that she had not been given the opportunity to express herself at home. She spent a great deal of time at her grandmother's home which was next door to her own.

She was afraid to be disappointed, so approached everything negatively. When asked if she would like to go swimming, she answered no. This was not because she did not really want to take part in the program, but because she felt that her parents would not allow her to participate.

It was much easier to say no rather than to be disappointed by the parents.

This child had average intelligence, and was a hard worker. Her speech was impaired, but understandable when she took her time. If she could not be understood, she was asked to repeat what she had said in a lower pitch and putting all endings on her words.

She was fearless, but displayed little self-confidence. Her physical performance was good when she moved slowly and deliberately. When she was rushed, tension increased and bodily control decreased.

Swimming

Recommended Skills for Balance, Strength, Endurance, Flexibility, Coordination, and Relaxation

Legs - frog kick in supine position, flutter kick in prone and supine position, walking
Arms - synchronized stroke in supine position
Coordinated stroke - elementary back stroke

Skills Taught in Order of Presentation

Face in water
Walking - foreward, sideward to the right
Back float
Flutter kick on back
Blowing bubbles
Hand over hand around scumgutter
Frog kick
Flutter kick on stomach
Back float and recovery
Arm movements for back crawl, human stroke
Head under water
Recovery to back float position when balance is lost while walking
Coordinated elementary backstroke
Coordinated human stroke
Swimming in deep water
Turning over from back to front, front to back

Summary

Subject #7 was neither enthusiastic, nor happy about going swimming. On the first day, she was extremely tense as evidenced by rigid body movements. She gripped her instructor tightly around the neck, and would not release her hold unless she was standing in the water with support. Uncontrollable movements in the muscles of the face were very noticeable. Breathing was labored, and there were no signs of relaxation in the body. Her body became rigid whenever water came near her face.

The only skills which were performed with any degree of success were the flutter kick while in a back float position, and walking. She was supported from behind under the armpits by her instructor, and by a rubber tube around her waist. A football was used to motivate her to kick her legs. The kick was weak and executed with very little directional control. While walking, she had to be given assistance the entire time. Muscular tension contributed to the imbalance which she had while walking. Walking served as an excellent aid in building self-assurance and reducing fear. By the end of the first lesson, Subject #7 was happier as a result of her swimming experience as compared to the lack of enthusiasm which she displayed upon entering. After leaving the water, she had to be reminded to slow down, for her balance while she walked was extremely unsteady. The greatest difficulties encountered were fear and severe muscular tension.

On the second day, she was more enthusiastic about going swimming. Once in the water and moving about, muscular tension was reduced and

fear diminished. She immediately wanted to put her face into the water. She was able to get her mouth under the surface of the water and blow some bubbles, but poor control over breathing was not conducive to success. She walked with self support at the side of the pool. When she released her hold on the scumgutter, she was able to take several steps without losing her balance. Slow movement had to be stressed, for muscular tension increased when she rushed or became excited. Floating was completely unsuccessful because of the tension produced when her feet were raised to the surface. Walking was still the best aid in relieving tension and fear. She was more self-motivated and interested in the skills which she was attempting to learn and she was happy the entire period instead of being withdrawn as previously. She became fatigued early, more from excitement and tension than from actual performance.

By the third lesson, the child's attitude had completely changed. She wanted to be independent, and repeatedly said, "don't hold me, don't hold me!" She walked the width of the pool four times during the period without the help of her instructor who stood on the other side and waited for her to cross. Balance was much improved except when walking past the lion's head. The water coming from its mouth upset the gait pattern forcing her to hold to the side. She also walked from the more shallow end out towards deeper water where her instructor stood. She was successful until the water reached chest level. The buoyancy of the body in this depth of water disturbed her balance. Subject #7 pulled herself along the scumgutter for half the length of

the pool. This eventually became one of her favorite skills. She had lost her shyness, talked constantly, and was overjoyed by her accomplishments. She had also gained confidence in her abilities to perform.

The fourth, fifth, and sixth lessons showed an improvement in all skills. She was more relaxed and performed with less effort. She pulled herself hand over hand the full length of the pool, and wanted to be sure that everyone saw her. Soon after this, she traveled all the way around the pool. She became more comfortable and relaxed in the back float, although she was not secure. When water touched her face, she no longer became as tense, and she was now able to get her face almost entirely in the water. A great deal of praising and encouragement eventually led to her performance of more advanced skills.

By the seventh lesson she was ready to begin work on the frog kick. She now had gained enough self-confidence and was able to relax enough to move about with two rubber floats attached to her body, one on the chest and the other on the back so that she could have a solid support for the head. In this way, it was possible for her instructor to move the child's feet and manipulate them for developing a "feel" for the kick. Only one explanation and one manipulation of the legs was necessary in order for Subject #7 to perform the skill. Although there was tenseness in the legs, and not a very wide separation to the side, the coordination was excellent. When reminded to slow down and glide at the end of the kick, she was able to propel herself for a short distance through the water. The flutter kick was always used at the beginning of the swimming sessions for adjustment to the water.

Her kick became stronger and more relaxed. Involuntary movements in muscles of the face were reduced. There was more a look of relaxation and satisfaction.

By the eighth day, Subject #7 was able to propel herself across the width of the pool with the flutter kick and frog kick. The frog kick was still weak, but coordination was good. She was still uncomfortable in the back float position when she was not moving, but when the water was warm enough she showed a definite improvement in this skill. She was also able to recover from the float position without assistance. Balance was poor both in the float and the recovery due to the tenseness in the body.

By the ninth and tenth lessons, balance, strength, endurance, coordination and flexibility had improved in leg strokes. The flutter kick was performed with a more definite rhythm and direction. She was able to kick from one side of the pool to the other without stopping. In the frog kick there was greater adduction at the hip and more powerful abduction. She no longer lost her balance in the forward walk, and work was begun on the sideward walk to the right, or weak side. Balance was lost readily while moving in this direction. Once while moving in this direction, she lost her balance and her head completely submerged. Instead of becoming frightened, she only said, "I put my head under!" Except for this one time, she was able to recover with very little assistance. Work was also begun on an arm stroke, first with an alternate pull and then with a synchronized pull of the arms. She could not pull her arms to her sides, particularly the left arm which was usually

in a straight, locked position. Her instructor moved her arms to help develop relaxation and, again to develop a "feel" for the movement.

In the eleventh lesson, the child's greatest achievement was that of submerging her head under the water coming from the lion's head. She did so fourteen times of her own free will without becoming choked or disturbed by the water rushing over her face. One of the other children had done it twenty times, and Subject #7 was determined that she would do better than this saying, "I'll duck my head a hundred times!" And with a slight competitive air and determination, she succeeded in bettering the score, although in the beginning of the program she would not go near the lion.

By the twelfth and thirteenth lessons, the leg strokes had become even stronger. The child could alternate between leg strokes without any difficulty in obtaining good results with the coordination. She was taken to deep water (nine feet) and allowed to move about independently. Her instructor remained nearby, but gave no assistance. Subject #7 was able to execute the flutter kick while in a prone position and with full support from her instructor although she was extremely tense in this position. Balance was improved in the float and recovery, which she was now able to perform without any assistance.

By the fourteenth lesson, there was no fear. She was able to put her entire face directly into the pool. In fact, the first time that she was successful in doing this, she submerged seventy four times. The lion was an excellent motivational devise towards her eventual success in this skill. She swam the full length of the pool alternating

between the flutter kick and frog kick, stopping only a few times to rest.

There was no progress in the fifteenth lesson because of cold water conditions.

Balance, coordination, and relaxation were particularly stressed in the last five lessons. Subject #7 was able to swim with a well coordinated elementary backstroke. She was able to turn herself about and swim in another direction. Balance had improved to the point that her instructor was able to sit at the edge of the pool and observe the progress being made. By now, Subject #7 swam solely in deep water, and was able to maintain her own balance when she began to sway to one side or the other. Breathing was much more natural. She was able to pull her arms to her side if she performed slowly and thoughtfully. Balance was improved in walking. When she did lose her balance, she immediately raised herself into a back float position without assistance. Muscular tension was greatly reduced, which elevated performance. She was able to turn over from back to front and flutter kick for short distances. She had to be assisted to get into a supine position again. She had an excellent mental attitude towards the water and swimming, and had begun to recognize her own abilities. Her body was more erect, and she performed with much greater ease. She was more independent, more self-confident, and less withdrawn.

Test Results

Sideward Walk - to right

Preliminary Test

Trial 1 38 steps
2 8
3 - 25
Average - 23.3

Final Test

Trial 1 - 1184 steps
2 - 1504
3 - 1033
Average- 1240.3

Backward Walk

Preliminary Test

Trial 1 - 128 steps
2 - 147
3 - 210
Average - 161.6

Final Test

Trial 1 - 508 steps
2 - 814
3 -1313
Average - 878.3

Weight Distribution

Preliminary Test

	left	right
Trial 1	39	32
2	40	20
3	40	21
Average	39.6	24.3
Difference	15.3	

Final Test

	left	right
Trial 1	32	37
2	29	41
3	30	39
Average	30.3	39
Difference	8.7	

Conclusions

The final test scores for Subject #7 showed remarkable improvement in two of the three test items, and an improvement in the third item. The average number of steps of three trials in the preliminary test was 23.3 before losing balance. The average for the three trials in the final test was 1240.3 steps.

The average number of steps for three trials in the backward walk was 878.3 steps in the final test, as compared to only 161.6 in the preliminary test.

Final test scores for weight distribution indicated a more equal distribution of weight over both the legs. However, in the preliminary test the weight was carried more to the left, and in the final test, the weight was shifted to the right in all three trials.

The improvement indicated by test scores paralleled the progress made in swimming skills. As a result, there was reason to believe that swimming may have contributed to improvement in balance.

CASE #8

Background Data

Subject #8 was the oldest of three children, and the second of the three children to be afflicted with cerebral palsy. She and her brother were ataxics, and the brother also participated in the swimming program.

Subject #8 had severe involvement. There was also a visual and speech impairment and the visual problem, or nystagmus, had a tendency to cause nausea. Periodically, she had to be asked to focus a long distance to help prevent nausea from occurring.

She was able to get about independently with the help of crutches. Without these, she lost her balance readily. Weights were used on the ankles to help develop the gait pattern.

This subject was a little shy until she had adjusted to new surroundings and new people. However, she was usually in an extremely good mood. She giggled constantly and sometimes this was responsible for her inability to perform.

Her mentality was below average, but not much. It was difficult to tell exactly, for her tests fluxuated.

She was fearless and willing to try any new skills regardless of the consequences. Poor balance did not make her reluctant to perform.

For background on the family, refer to CASE #2.

Swimming

Recommended Skills for Balance, Strength, Endurance, Flexibility, Coordination, and Relaxation

Legs - frog kick in supine position, flutter kick, walking
Arms - synchronized stroke in supine position
Coordinated stroke - elementary backstroke

Skills Taught in Order of Presentation

Face in water
Blowing bubbles
Back float
Head under water
Breath control
Breath holding
Face float
Opening eyes under water
Walking
Hand over hand around scumgutter
Retrieving objects
Flutter kick on stomach
Flutter kick on back
Frog kick
Arm strokes - alternately and simultaneously
Jellyfish float
Coordination of arms and legs on back
Rhythmical breathing
Coordination of arms and legs on stomach
Back float and recovery
Changing direction
Deep water swimming

Summary

Subject #8 was fearful and tense on her first day in the water. She was particularly ill at ease when the water came near her face. She was most secure while standing with the help of her instructor. She became extremely excited while watching her brother, who also participated in the program. The first session was devoted to play to develop an interest in the water, and to help in her adjustment. By the end of the

period, she was able to put her face into the water without assistance. Her fears subsided by the end of the session, and she giggled her approval of the entire situation.

By the second day, she had made an excellent adjustment. The only tenseness present was when she felt herself going down in the water, or was on her back. Otherwise there was no insecurity. She was able to put her face into the water, but had difficulty with controlling breathing.

By the fourth lesson, Subject #8 was submerging instead of placing her face under water. She was still tense while on her back, and drew up her arms when in this position. Her interests seemed to be more diverted to what other children in the pool were doing rather than on her own accomplishments. By allowing her to do as others were doing, she was motivated to learn.

Her balance was poor in the water, particularly when she walked, or floated on her back. While walking, she moved too hurriedly and the water resistance caused her to fall. In the back float position, she constantly leaned to one side and could not erect herself. She was most comfortable when walking or floating on her stomach.

By the seventh lesson, she was more cooperative, more attentive, and eager to learn. She was able to float in a face float position for several seconds without support. She was able to recover rings from the bottom of the pool so long as they were not lying flat. She now used a rubber support for assistance and appeared to be much more at ease.

By the eighth and ninth lesson, her instructor felt that she was

ready for more concentrated work on specific skills and that earlier skills could be used as diversions. Her balance was still poor while floating and walking . When the flutter kick was introduced, she had difficulty kicking without leaning to one side. Because she could not erect herself, she reached for objects to grasp. The kick was weak and very unrhythmical. An attempt was made, as much as possible, to keep the legs under the surface of the water so that she could feel the resistance of the water. A hula hoop was used for a partial support as the child walked. This was a fairly successful devise. Her favorite activity now was that of submerging.

She had difficulty with her arm stroke when the arms had to be moved alternately. There was very little difficulty with a simultaneous pull, for she had a tendency to do this anyway. A technique was used to try to correct her leaning to one side. By having her lean to the other side, it was hoped that she would be able to maintain balance. This was unsuccessful. There was a great deal of self-motivation for learning, and she was much more attentive.

By the eleventh lesson, balance had improved in the walk. The frog kick was introduced for the first time, and the flutter kick was improved. Arms and legs were not well coordinated. Her greatest problem was in maintaining balance.

By the thirteenth lesson, two new skills were added. She was able to sit on the bottom of the pool, and was able to do the jellyfish float. Her interests changed from day to day. One day she wanted to do nothing except walk around the pool. In the next lesson she would not even

mention walking. The wrong approach in teaching was to ask her if she could do something. Response was better when she was asked to do something.

By the fourteenth lesson, rhythmical breathing was introduced. She was able to place her face alternately in and out of the water without much difficulty. She enjoyed the flutter kick while in a prone position. While she worked on walking, her instructor told her to be a soldier. This made her stand more erect rather than lean forward and her balance was improved as a result. Her instructor felt that if the child's walking improved, her flutter kick might also improve, or visa versa, for she leaned to the same side in each. She still liked to perform for anyone who would watch.

In the fifteenth lesson, the arms and legs were coordinated for the front crawl. She still had difficulty with the alternate arm stroke. Breath control was much improved as evidenced by the fact that she was able to leave her face in the water for at least five strokes without raising up. Her balance had improved.

By the eighteenth lesson, there was improvement in all skills. She had more endurance, and kicks were becoming stronger. Walking balance was improved, although still unsteady, as was the back float position. When she began to lose her balance, she was asked to look in the opposite direction. This was a successful technique in aiding to maintain balance.

By the nineteenth lesson, Subject #8 was able to perform a coordinated elementary backstroke without assistance from her instructor,

only a rubber support behind the head and around her waist. She was taken to deep water, and allowed to move about independently. However, her instructor always remained nearby. She was able to float and recover with considerable improvement in balance.

In the twentieth and twenty-first lessons, Subject #8 was a deep water swimmer. She was independent, and able to control her direction. She was able to turn herself around in the water, was able to use arms and legs well, had balance control, and had no difficulty with the float and recovery. She had more self-confidence, and was excited over her accomplishments. She still needed work on bodily direction, or placement of arms and legs, but there was definite improvement over the first days of the swimming program. She was always happy and giggled constantly. She continued to be interested in what the other children were doing, and was always anxious to display her own skills. Balance, strength, coordination, and endurance, were improved.

Test Results

Steps

Preliminary Test

Trial 1 - 12 steps
2 - 12
3 - 16
Average - 13.3

Final Test

Trial 1 - 42 steps
2 - 52
3 - 39
Average - 44.4

Knee Walk

Preliminary Test

Trial 1 - 6 steps
2 - 14
3 - 9
Average - 9.6

Final Test

Trial 1 - 12 steps
2 - 15
3 - 18
Average - 15

Weight Distribution

Preliminary Test

	left	right
Trial 1	22	40
2	30	42
3	30	42
Average	27.3	41.3
Difference	14	

Final Test

	left	right
Trial 1	27	40
2	22	45
3	20	47
Average	23	44
Difference	21	

Conclusions

Final test scores showed an improvement in two of the three items. The difference between the averages of three trials for the preliminary test and final test was 31.1 steps, with the final test average being the highest.

The average number of steps in the knee walk was raised from 9.6 to 15 steps in the final test. Both tests indicated balance improvement.

In the test for distribution of weight, the difference between the averages for right and left side was 14 pounds. The final scores showed no improvement. The difference between the averages of trials in the final test was 21 pounds. The weight was shifted to the right in both testing sessions.

In test items in which there was improvement, swimming may have contributed to the progress made.

CASE #9

Background Data

Subject #9 was a ten year old girl, spastic triplegic, severe involvement. The left arm was the only good limb of the four extremities.

The parents were on the upper socio-economic level. There was an older brother who was in the seventh grade. The father was connected with the educational system of the city. The parents were strict, but they were interested in the progress of the child, and were willing to do anything which might be of benefit to her. The handicap was a severe strain on the mother, physically and psychologically. There was much love, sincerity, and understanding among members of the family.

Subject #9 was shy and self-conscious, but made a rapid adjustment. She was very affectionate once trust had been placed in an individual, or individuals.

She was extremely fearful. Sudden sounds, loud sounds, or any sudden disturbances of any kind caused her entire body to jerk violently. All movement had to be within her range of vision, or she became easily startled.

Her intelligence was normal or better. She spoke distinctly, with thought, and with excellent grammar usage. There was a visual impairment for which she wore glasses.

Control braces from the hip down were worn for gait training. Short leg braces were worn the remainder of the time.

Her health was excellent.

Swimming

Recommended Skills for Balance, Strength, Endurance, Flexibility, Coordination, and Relaxation

Legs - flutter kick in prone and supine position
Arms - synchronized and alternate arm stroke in supine position, alternate arm stroke in prone position
Coordinated stroke - back crawl with synchronized arm stroke, human stroke with alternate arm stroke
Trunk - sitting balance

Skills Taught in Order of Presentation

Flutter kick on back
Flutter kick on stomach
Face in water
Breath control
Sitting balance
Back float
Arms for back crawl
Hand over hand along scumgutter
Flutter kick in vertical position
Body rotation while holding on to side of pool
Maintaining balance while in a back float position
Back float and recovery
Blowing bubbles
Arms for human stroke
Coordinated human stroke
Turning in a circle while in a back float position
Coordinated back crawl
Counting fingers with face in water
Retrieving objects with face in water
Swimming in deep water
Head under water
Submerging the body

Summary

Subject #9 had an excellent attitude on her first day in the water. She was tense at first, but relaxed after she became accustomed to the water and surroundings. She was extremely conscious of sudden sounds

and movements made by others in the pool, and had violent flexor contractions when these occurred. This was also the result when water was splashed into her face unintentionally. Movement was very limited because of her severe involvement. An attempt was made to do the flutter kick in a supine position. This was almost completely unsuccessful because the legs crossed and locked after every two or three kicks. The kick was weak and very labored, and in order to move the legs, it was necessary for the child to throw her head back, bracing it against her instructor's body, and to arch her back. She was able to float with support under the head and hips, but she was not relaxed in this position. Subject #9 understood her own limitations, and seemed a little self-conscious of her disability. She always tried to do more than was expected of her.

By the second lesson, she was less mindful of other sounds in the pool. She was still sensitive, but did not jerk as violently. An arm stroke was introduced so that success in movement could be experienced. The right arm remained flexed almost the entire time, but with the left arm was able to move slowly in a circle. Work on the arms and legs was alternated, for each required maximum effort on the part of the child. She was talkative, and wanted to know what she would be doing next. She had to be encouraged so that she would not lose interest.

By the third day, Subject #9 was performing with two rubber floats attached to her body, one on the chest and the other behind the head. With these floats, she required less assistance from her instructor.

She was able to float motionless, although not completely relaxed. She could hardly believe that she had one this without any support from her instructor. The flutter kick was slightly improved, but still labored and with the legs crossing. She put her mouth into the water for the first time, However, she still disliked the water coming this close to her face. She was able to pull herself slowly along the scumgutter. Her balance in the float was poor.

By the fourth and fifth lessons, she was becoming more relaxed and stronger. Rather than erect her when she lost her balance to the side in the float position, her instructor told her that she would have to do this by herself. There was success on the first day. She was able to put her face into the water up to her nose at least ten times although she was still very insecure when performing this. The flutter kick continued to be weak, but she was able to kick more consistantly without the legs crossing. Subject #9 knew when she had improved in a skill and always commented by saying, "It was a lot better today", or "It was a lot easier today." The flutter kick was much stronger when she kicked in a prone position than when she was on her back. This may have been due to the resistance and the assistance which the water gave her legs, for she was in more of an upright position with the legs further under the surface of the water. The legs were buoyant and raised to the surface when she was in the back float position.

Three major accomplishments were evidenced on the sixth day. The child was less sensitive to splashing water, she allowed the water from

the lion's head to rush over her body, and was able to float and recover without losing her balance to the side. She was much more relaxed in the float position, and when asked if she was comfortable, she replied "There's nothing to it!" The flutter kick in supine position was still a hard task for her.

By the eighth lesson, she was almost completely relaxed in the back float, except when kicking or moving the arms. By holding on to the side of the pool, and with assistance to keep her legs down, she was able to turn her body from side to side. This was difficult for her because of the poor right arm.

By the tenth lesson, she was showing excellent progress in strength, stamina, and coordination. The legs were stronger and no longer crossed in the flutter kick. She was able to coordinate the arms and legs, but only when she began the leg kick first. A great deal of emphasis had been placed on slow, controlled movement to prevent sudden reflex action. This finally brought excellent results. For the first time since the beginning of the swimming program Subject #9 was able to straighten her right arm slowly and pull it to her side without a resulting stretch reflex. From this point on, she was able to use this arm with the other in a coordinated stroke. She was so thrilled by this that she cried out, "Look at my arm!" Of course, the excitement caused her to tense, and lose control of the arm. Floats were removed to practice the back float. She was supported under the head until there was sufficient relaxation. Then, her instructor moved her hand. The child was able to maintain the float position for several

seconds. She went under water several times while unassisted, but always came up smiling. She very seldom choked on the water that entered her mouth. While floating, the child's instructor stood behind her and kept reminding her to look back so that she would not raise her head. This served as an excellent reminder.

Subject #9, by the thirteenth lesson, was making steady progress. She had good control over the right arm. The flutter kick was stronger. The only problem here was in getting the legs started. Once this was accomplished, she was able to execute a continuous kick for the width of the pool. She no longer jumped with every little sound. With only one support on the chest, and her head resting in the water, she was able to float motionless for approximately five minutes. She was able to move both arms simultaneously and at will.

By the fourteenth lesson, she was able to extend the right arm and keep it extended for more than fourty seconds. She put her head and face under the lion's head thirty-five times, and allowed the water to rush over her face and body. Breathing was more relaxed and controlled. With two floats strapped to her body, she was allowed to work independently. The child moved her arms and kicked her legs, propelling herself through the water with only occasional directional guidance from her instructor. She was much more self-confident, and enjoyed this independence. Her movements were much more limited on land than they were in water, and she was given every opportunity to experience this physical freedom which thrilled her so much. She had now reached a plateau in terms of the number of skills which could be

presented, but improvement was steady in the skills she was already able to perform.

By the seventeenth lesson, Subject #9 was swimming in deep water with only the aid of two rubber floats. She was given a brief survival lesson. When asked what she would do should she ever fall out of a boat in the middle of a lake she replied, "Float!"

By the twentieth lesson, she was able to kick her legs over fifty times without stopping. She was able to perform a modified human stroke while supported by her instructor. There was improvement in strength, coordination, and endurance. Practice in sitting balance had been given since the beginning of the program while floats were being strapped to her body, and had improved.

Subject #9 had improved in all skills by the twenty-fourth lesson. In the twenty-first lesson she kicked her legs sixty-two times without stopping. In the twenty-third lesson, she kicked them one hundred times without stopping. In the final lesson, she kicked them one hundred and seven times without stopping. She moving with greater ease. There was increased range of motion of the limbs. Her back and legs had become stronger. She was able to consciously control the movement of the right arm. She had improved in strength and endurance. Coordination was improved. She was more self-confident, and enjoyed moving independently. She had a much more relaxed facial expression while performing skills. She spoke freely and enthusiastically of her accomplishments. She had experienced success and gained satisfaction in unrestricted movement.

Test Results

Sitting Balance

Preliminary Test	Final Test
Trial 1 - 35 minutes	Trial 1 - 126 minutes
2 - 28	2 - 130 minutes
3 - 40	3 - 104 minutes 21 sec.
Average - 34.3	Average - 2 hours 7 seconds

Weight Distribution

Preliminary Test

	left	right
Trial 1	42	18
2	40	20
3	40	20
Average	40.6	19.3
Difference	21.3	

Final Test

	left	right
Trial 1	31	35
2	34	27
3	30	30
Average	31.6	30.6
Difference	1.0	

Conclusion

A definite improvement in balance was indicated by final scores on the two test items.

The average for three trials in the preliminary test for sitting balance was 34.3 minutes. The average for three trials in the final test was 2 hours and 21 seconds.

There was a more equal distribution of weight as shown by test scores. The difference between the averages of trials in the preliminary test was 21.3 pounds with the weight supported over the left leg. The difference between the averages in the final test was 1 pound with the weight still to the left.

The improvement in balance paralleled the progress made in performance of skills in swimming. There was no reason to believe that

swimming did not contribute to the progress made in balance as indicated by test scores, and many reasons to believe that it did. Her greatest achievement as a result of the swimming program was threefold. There was greater flexibility in the joints, particularly of the hip and knee, improved muscle balance and coordination between flexors and extensors in hip and knee.

CASE #10

Background Data

Subject #10 was thirteen years of age and the oldest of the children who participated in the swimming program. She was a spastic athetoid with moderate involvement.

She came from a family of upper socio-economic status. There were two other children in the family, a boy who was a freshman in high school, and an older girl who was about to graduate from high school and enter college. The handicap was difficult for the mother to accept. Both parents were shy and quiet.

This subject was also shy. She realized her limitations, saying that no matter how hard she tried, her performance would never be like that of a normal individual. She was willing to work, but needed prodding and a great deal of guidance. She liked to be around older people rather than those of her own age. She attended a regular elementary school and was used to being under normal children. Her standards were high, probably because of her association with the normal. She could be spoken to as any other fifteen or sixteen year old teen-ager, and expected to be treated as a grown-up.

She was easy to handle, but did not want to be treated like a handicapped individual. Her attention span was good, but when she lost interest in a project, would not continue to work on it.

She was fearless and quiet. There was a visual and speech impairment. General health was excellent.

Coordination was stressed in physical therapy and occupational therapy. She was an out-patient who came for treatment once per week.

Swimming

Recommended Skills for Balance, Strength, Endurance, Flexibility, Coordination, and Relaxation.

Legs - frog kick supine and prone
Arms - as for elementary backstroke and breast stroke
Coordinated stroke - elementary backstroke, breast stroke

Skills Taught in Order of Presentation

Surface dive and underwater swimming
Frog kick
Human stroke
Float on face and recovery
Retrieving objects
Back float and recovery
Elementary backstroke
Breast stroke
Front crawl
Flutter kick on back, no arms
Surface dive and recover under rubber tube
Swim on stomach, turn over, swim on back
Swimming width of pool
Rhythmical breathing
Back float in deep water
Sitting on bottom of pool
Swimming width of pool on back using frog kick, no arms
Swimming width of pool on stomach with arms only as for elementary backstroke
Dive from side of pool
Endurance swimming - rope to wall in deep end
Deep water swimming
Swimming length of pool
Dive from board
Dive and swim length of pool

Summary

Subject #10 had had swimming before and was fairly skilled in several strokes. Her coordination was poor, but she had no difficulty in relaxing. She was independent, shy, self-conscious, and hard to know.

She was enthusiastic and ready to be challenged. The first day was one of adjustment of subject to instructor, and of instructor to subject. The frog kick was taught immediately to insure interest in a new skill which had never before been performed. She would not ask for help, but inwardly wanted it. Her instructor manipulated her legs to help develop a feel for the kick.

By the second day, she was familiar with the elementary backstroke, breast stroke, crawl, underwater swimming, and had learned how to float. She was only able to float for a short time by herself, but improved with each attempt. Since Subject #10 was already able to perform many of the skills to a beginner degree, coordination was given the most emphasis. The frog kick was not too successful, for when she drew her legs up, she submerged. There was also a problem of relaxation when she performed on her back. She was able to push off from the side of the pool and flutter kick to the other side, stopping once to catch her breath. When unsuccessful in a skill, she wanted to change to another rather than practice.

She was most successful and comfortable while swimming on her stomach. By the third lesson, she was attempting to turn over from front to back, but was unsuccessful.

By the fourth lesson, she was more relaxed in the float position. She was able to swim twenty-five to thirty feet on her back using just the arms as in the elementary backstroke. Breast stroke practice was provided in a game situation. She enjoyed working on skills when it was done through the medium of play. She swam the width of the pool in

deeper water without stopping to rest. There was no difficulty in sitting on the bottom of the pool to retrieve objects. She still wanted to be completely independent, and would not ask for help.

By the seventh lesson, instructor and student had become friends. The adjustment process was a long one until enough trust had been placed in the instructor. Racing was used as motivation to use arms and legs. She responded well. She first had to swim across the pool using arms alone, then legs alone, then using a coordinated stroke. This was done in prone and supine position. Water polo was also played in a similar way using various swimming strokes. She progressed from a sitting dive to a standing dive with the knees bent. Flippers were used to help develop more confidence. Subject #10 was now more happy and good natured, rather than being so serious. A better relationship between subject and instructor was apparent.

Now that her leg strokes had improved, Subject #10 was more willing to practice on her skills. By the eighth lesson, her legs were stronger and better coordinated.

By the tenth lesson, endurance was much improved. She swam from the rope to the end of the pool seven times. Emphasis was now on distance swimming while working on coordination, relaxation, rhythmical breathing, and endurance. She was still uncomfortable in the back float and had difficulty with balance but continued to be enthusiastic and feel achievement.

In the eleventh lesson, relaxation was given the greatest emphasis and her response was excellent. She was now swimming more in deep

water than in shallow water. This also motivated her to learn and improve her skills.

By the thirteenth lesson, the frog kick was much improved. When she was asked to move slowly and to relax she became less tired and coordination was better as a result. She was able to swim under water in the deep end of the pool.

By the fifteenth lesson her desire to learn was still strong, but when her instructor told her that she could do anything that she wanted to do she replied, "I can't do everything that I want to do, well." She knew her limitations, but at times had a complete defeatist attitude. Her legs and arms had now become stronger. Once in a while she made movements in directions that were not intended.

By the seventeenth lesson, she was able to execute a well coordinated elementary backstroke. Although she was still not as comfortable while working on her back, this was her best stroke. The breast stroke was improving, but the coordination of arms and legs was much more difficult for her. She had a great deal more power in her elementary backstroke, and when asked if she felt any difference in her kick, she replied, "I guess so!" This was a typical response.

By the twenty-first lesson, Subject #10 had improved in strength, endurance, coordination, relaxation, and balance. She was able to swim the length of the pool without stopping, and could hold her breath for long periods of time while under water. She was able to do a standing front dive from the diving board. The elementary backstroke was well coordinated. Now that she was more comfortable in the supine position, she no longer had as great a desire to practice the breast stroke

which was now also coordinated, but not as well as the other stroke. She was more talkative and outgoing, and more willing to receive help. At no time did she require the use of flotation devises, and very seldom did she need support from her instructor. Her work was completely independent. Her motivation was determination to do well.

Test Results

Steps on a Board (rod in hand)

Preliminary Test

Trial 1 - 48 steps
2 - 4
3 - 10
Average - 21

Final Test

Trial 1 - 88 steps
2 - 8
3 - 17
Average - 38

Weight Distribution

Preliminary Test

	left	right
Trial 1	30	55
2	35	70
3	40	55
Average	35	60
Difference	25	

Final Test

	left	right
Trial 1	40	50
2	42	52
3	42	58
Average	38	53.3
Difference	15.3	

Conclusions

There was an improvement in both test items. An average of 17 more steps was taken in the final test for steps on a board, the preliminary test showing an average of three trials to be 21 and the average of the final test trials 38.

Distribution of weight had improved. However, the weight was still shifted to the right side. The difference between the averages for the left and right side in the preliminary test was 25 pounds. The

difference between the averages in the final test was 15.3 pounds.

The improvement indicated by the test scores paralleled the progress made in swimming, and there was no reason to believe that the swimming did not contribute to balance improvement.

CASE #11

Background Data

The handicap of this child was the result of an auto accident when he was five years of age. At the time of the swimming program, he was nine years old. The classification of cerebral palsy was diagnosed as mixed spastic quadriplegia with tremor with the major involvement on the entire right side of the body. His degree of involvement was that of moderate to severe.

He came from a middle class family in which there was one other younger child. The parents both worked to support the family. As was usually the case when both parents worked, one did so during the day and the other at night, so that someone would always be at home to care for the children. The handicap was a hardship for both parents, particularly because he was a normal child up to the time of the accident.

His mentality was below average as indicated by low test scores and his memory was impaired. Only one direction could be remembered at one time. He had no speech control, and therefore could not communicate, although it was believed that he could understand more than he could communicate. How much he did understand, was difficult to say because of his inability to communicate.

He was extremely sensitive and headstrong. When forced to do something that he did not want to do, he began to cry and sometimes went into temper tantrums. When disappointed, he also began to cry. He was shy and lovable and it was fairly easy to win his confidence.

He required careful handling, for if he was determined to do some task other than what he was asked to do, he was very difficult to handle.

This child was right handed before the accident, but then became left handed.

He wore braces on both legs below the knee. Balance and coordination were stressed in physical therapy.

He was a big, well developed child for his age, and was in excellent health.

Swimming

Recommended Skills for Balance, Strength, Endurance, Flexibility, Coordination, and Relaxation

Legs - flutter kick in prone and supine position, walking
Arms - alternate arm stroke in prone position
Coordinated stroke - human stroke

Skills Taught in Order of Presentation

Walking
Face in water
Flutter kick on back
Blowing bubbles
Head under water
Retrieving objects
Back float
Face float
Flutter kick on stomach
Arm and leg movements on back and front

Summary

Subject #11 had a total of fifteen lessons which for him were periods of fun and play. At no time did he display any fear. He was able to perform only one skill independently, and this was the ability

to walk the width of the pool without the help of his instructor. His only other interests lay in playing with various pieces of equipment in and around the pool area.

He was able to comprehend very little of what was asked of him. He responded to demonstration and extreme coaxing, but because of his short interest span, only cooperated for very short periods of time. His memory was unpredictable. At times, he remembered a prior lesson, but he never was able to remember what he had done several lessons previously.

His interest span was longest when he worked on the flutter kick on his back using a rubber ball for motivation to kick. He also enjoyed walking inside a hula hoop, and playing under the water which flowed from the lion's head. No other motivational devises were successful. Walking and playing were his major activities.

Subject #11 never became cold or fatigued. He had no special interests other than play. His greatest achievements were the confidence he displayed in his ability to walk across the pool independently, and the cooperation which he gave considering his very short interest span.

This child was always very warm and affectionate. He was interested in watching the other children in the pool, and tried to get their attention.

In the thirteenth, fourteenth, and fifteenth lessons progress was finally made in getting Subject #11 to use his arms and legs in some kind of a pattern for a stroke, both in the prone and supine positions.

However, when he lost interest, he resisted the efforts of his instructor. He was able to put his head under water, but because of poor breath control, he choked easily. The fact that he choked did not frighten him.

His inability to comprehend and follow directions well, and his short interest span, were the greatest barriers to his progress.

Test Results

Steps

Preliminary Test

Trial 1 - 400 steps
2 - 392
3 - 162
Average - 318

Final Test

Trial 1 - 381
2 - 289
3 - 391
Average - 353.3

Standing and Sitting

Preliminary Test

Trial 1 - 36
2 - 41
3 - 50
Average - 42.3

Final Test

Trial 1 - 41
2 - 45
3 - 53
Average - 46.3

Weight Distribution

Preliminary Test

	left	right
Trial 1	18	70
2	26	50
3	45	35
Average	29.6	51.6
Difference	22	

Final Test

	left	right
Trial 1	38	50
2	61	27
3	45	47
Average	48.	41.3
Difference	6.7	

Conclusions

There was an improvement in all test scores. An average of 353.3 steps were taken in the final test as compared to 318 steps in the final test.

Standing and sitting balance were slightly improved. The average for the first test trials were 42.3, and the average for the three trials in the final test was 46.3.

Weight was more evenly distributed, as indicated by an average score of 48 for three trials in the first testing for the left side, and 41.3 for the right side.

Although it was difficult to ascertain the effect of the swimming program on Subject #11, it was felt that it was not detrimental to his progress and it undoubtedly afforded certain psychological satisfactions.

CASE #12

Background Data

Subject #12 was an eight year old out-patient who came to the Cerebral Palsy School once per week for physical therapy treatment. He was a rotary athetoid with moderate involvement.

He had lived with his grandparents since birth. The parents and a ten month old sister lived in Baltimore where the father was stationed in the service. He called the parents by their first names, and referred to the grandparents as mother and father. They were of middle class status and raised the boy as their own son.

The child had an outgoing personality. He talked constantly. He accepted his handicap well. He thought faster than he could speak. His speech was impaired by the fact that his tongue rolled whenever he wanted to say something. At times, he became quite frustrated by this. He was of normal or better intelligence, and was much more alert than many of his normal classmates.

Subject #12 was easy to get along with, and got along well in a normal situation. He was always happy and willing to try new things.

He had a severe lordosis problem, making it necessary to avoid any activities which would aggravate the condition.

He was susceptible to colds, particularly in the chest. After seven swimming lessons, he was forced to drop from the program because of a severe bronchial infection which almost resulted in pneumonia.

Posture activities were stressed in physical therapy. This child had flat feet, which also contributed to imbalance as much as the palsy.

His favorite hobbies were drawing, typing, and reading. The grandmother believed that someday he would make a good draftsman.

Swimming

Recommended Skills for Balance, Strength, Endurance, Flexibility, Coordination, and Relaxation

Legs - scissor kick, walking
Arms - as for side stroke
Coordinated stroke - side stroke

Skills Taught in Order of Presentation

Walking
Back float
Face in water
Frog kick
Finning
Jellyfish float
Hand over hand along scumgutter
Head under water
Surface dive
Frog kick and scull on back
Sitting on bottom of pool
Retrieving objects
Blowing bubbles
Scissor kick
Swimming under water

Summary

Subject #12 remained in the program for only seven lessons, but in that short time, made excellent progress. On the first day, he was cold and tense upon entering the water. He was secure with his instructor, but had a "don't let me go" attitude. He was very friendly and always smiling. He was able to walk in the water. The back float was introduced. It was necessary to use a special technique to prevent increased curvature in the lumbar spine. The instructor bent her

elbow, so that the child could rest his head in the bend. She also gave support in the small of the back. This raised his head causing his back to be rounded. He would do no skills without assistance. He responded well to directions, and tried hard to please. He had a short interest span when he saw the other children working on other skills. He wanted to show his instructor that he could do things for himself, but was apprehensive.

By the second day, he was more alert and less afraid of doing things by himself. He practiced walking and balancing himself on the black line on the bottom of the pool. In his first attempt to put his face into the water, he was not too successful for he breathed in-stead of out. After a while, he understood the principle of breathing out under water and was no longer afraid. He was able to move his arms and legs in a very modified frog kick.

By the third lesson, he rarely showed lack of confidence except when attempting a new skill.

By the fourth lesson, he was able to perform all of the skills which were introduced. The jellyfish float was presented and he almost floated by himself. He pulled himself, hand over hand, along the scumgutter beyond the rope. He was now also able to put his whole head under water. He wanted to learn skills which would enable him to move about in the water independently.

The fifth, sixth, and seventh lessons helped to develop a sense of achievement. He floated on his back independently for five seconds. He was working on the jellyfish float, but was afraid. He became more

relaxed. Subject #12 was able to put his head in the water, blow bubbles, sit on the bottom of the pool with some assistance, and could pull himself all the way around the pool. He retrieved rings from the bottom of the pool with assistance and then without. He was interested in knowing how the water supported him. Although he was afraid of the jellyfish float, he eventually succeeded in this skill. The sidestroke was introduced, and he grasped this quickly. All skills had improved, and he had an excellent attitude and will to learn. Although he had only seven lessons, he was capable of performing a number of skills, had gained more self-confidence, and enjoyed his swimming experience.

CHAPTER VI

PRESENTATION AND ANALYSIS OF DATA

The primary purpose of this study was to determine the effects of various individually prescribed swimming skills upon the balance of cerebral palsied children with problems of imbalance.

Procedure

One method employed to determine if there had been any improvement in balance while walking was a 16 mm movie slowed to 32 frames per second. One movie was taken at the onset of the swimming program, and another made following the conclusion of the program. Gait patterns could be analyzed. Body compensation for maintaining balance could be determined in terms of body sway and amount of rotation.

Pieces of black tape were placed on five areas of the posterior view of each child where compensation for imbalance would be most clearly indicated. These areas were: the vertebra prominens, the center of the spine of each scapula, the crest of the ilium of each pelvis, and the lumbar curve of the spine which represented the midline of the body.

Each child was then placed at a designated starting line and given several steps to establish the gait pattern. The children walked away from the camera for approximately thirty feet.

Ten frames depicting different phases of the gait pattern were selected at random for analysis. Each frame was placed under a photo

enlarger, and a piece of graph paper calibrated to ten millimeters per centimeter placed over each of the ten projections. The marks on the backs of the children were then traced onto the graph paper. Using the lumbar point as a guide, a straight line was drawn through the midline of the body. In addition, straight lines were drawn connecting each hip point with the vertebra prominens to form a triangle. By reading this triangle, body sway and body rotation in balance compensation could be determined.

Graphic Representation of Gaits

Graphs were constructed depicting five different aspects of the postural alignment while walking.

Deviation of Vertebra Prominens from Midline

Using the same type of graph paper used to chart the movie frames, a horizontal line was drawn to represent the midline of the body. The number of deviations to the right and to the left of the midline, each millimeter representing one deviation, was charted with any point to the right falling above the horizontal line, and any point to the left falling below the horizontal line. For graphing purposes, five millimeters represented a score of one deviation to the right or to the left of the line. These points were then connected to illustrate one phase of the gait pattern.

Vertical Difference between the Shoulders

The number of deviations which the right shoulder mark fell above and below the left shoulder mark was graphed for each of the ten movie

frames. All points higher than the left shoulder mark were plotted above a horizontal line, and all points below the left shoulder mark, below the horizontal line. When these points were connected, the relationship of the shoulders to compensation in the walking pattern was indicated.

Vertical Difference between the Hips

The same procedure as for the shoulders was followed to show movement patterns of the hips while walking.

Difference between Right Shoulder and Right Hip, Left Shoulder and Left Hip

A horizontal line was drawn on graph paper. All points plotted above this line represented the right side of the body, and all marks plotted below the line represented the left side of the body. The vertical height, or distance between the shoulder and hip points was graphed to indicate body lean and trunk sway in maintaining balance.

A second movie was made at the conclusion of the swimming program to compare gait patterns. To select the proper movie frames for analysis, a frame which most closely resembled the first frame analyzed from the preliminary filming was first selected. The number of frames between each subsequent frame was counted so that similar frames as those in the preliminary filming were used for analysis. The same procedure was followed for plotting the second group of deviations, with these being superimposed upon those of the first graphs. The graphic representations for each subject's gait, with the exception of cases #4 and #9 who could not walk, and #3 and #12 who were dropped from the program,

may be found in Figures 11 through 18. In this way, changes in the gait pattern were easily observed.

Analysis of Results

To determine if any change had occurred, an arbitrary number was chosen by adding together the sum total of deviations for each of the five items for analysis including the deviation of the seventh cervical vertebra from the midline of the body, vertical difference between the shoulders, vertical difference between the hips, vertical difference between right should and right hip, and vertical difference between left shoulder and left hip. This procedure was followed for both films. This arbitrary number represented the balance score for each child. If the sum of the scores for the deviations in the second filming was lower than the first balance score, walking balance was said to have improved. Of the eight gait patterns filmed, seven improved as indicated by a lower balance score on the second filming, and one received the same score, indicating no improvement in gait.

Analysis of Balance Scores

Subject #1 produced a balance score of 112 in the first filming as compared to 101 in the final results. There was a slightly greater deviation of the seventh cervical vertebra to the left of the midline. The hips and shoulders were more level. There was slight rotation of the trunk, probably due to a more natural arm swing which the child had developed since the first filming.

Subject #2 showed balance scores of 237 for the first results, and 217 for the final results. There was more trunk lean to the right,

as compared to a left lean in the first films. The hips were more level. The right shoulder was lower due to the sideward lean of the trunk.

The balance score for Subject #5 dropped from 355 in the first film results, to 317 in the final film results. There was a slightly greater deviation of the vertebra prominens to the left of the midline. The hips and shoulders were more level. There was less body lean, and more body rotation.

The balance scores for Subject #6 were 261 on the first results and 239 for the second films. There was a greater deviation of the vertebra prominens to the right of the midline of the body. The shoulders remained fairly level, with the right still lower than the left. The hips were more level. There was less shoulder rotation, and less trunk lean.

Subject #7 produced balance scores of 352 on the first films, and 298 in the final film results, indicating considerable improvement. The body was more erect. The seventh cervical vertebra was closer to the midline. The shoulders and hips were more level. Body rotation was still to the left, but to a lesser degree.

Although the balance scores for Subject #8 were the same for both film analyses, improvement was indicated in three items. The shoulders and hips were more level. There was less deviation of the vertebra prominens to the left and right of the midline. Both balance scores were 200.

The balance scores for Subject #10 dropped from 342 on the first films, to 317 in the second films. The hips and shoulders were more level. The vertebra promines was closer to the midline, however, there

was greater lean to the left as compared to the lean to the right in the previous analysis.

Subject #11 showed improvement in the balance score, dropping from 300 to 268. The shoulders and hips were more level. There was greater deviation of the vertebra prominens to the left of the midline due to body lean to the left.

Statistical Analysis of Balance Scores

The "t" test for significance of difference was used to determine if there was a significant improvement in balance within the group. The means for the sums of the balance scores of the eight children filmed were 269.875 for the first film, and 244.625 for the second film. The mean difference was 25.250. A difference in group balance, "t" value of 4.3196 was found to be statistically significant at the 1% level of confidence, indicating that swimming may have contributed to improvement in walking balance.

CHAPTER VII

SUMMARY AND CONCLUSIONS

This study was to determine the effects of various swimming skills on balance of cerebral palsied children who had problems of imbalance. A secondary purpose was to determine what specific skills could be performed, to what degree relaxation and unrestricted movement could be obtained, and psychological changes which might result from the swimming experience.

The twelve subjects selected for the study were all children with varying degrees of imbalance in either kneeling, sitting, standing, or walking. Parents were asked to give written consent for their children to participate in the program.

Background information was obtained on each child to give an overall view of their physical and psychological status at the onset of the swimming program.

Outlines of the physical therapy procedures for each child were secured from the physical therapists so that swimming skills selected would be in accordance with the therapy program.

Instructors, one for each child, were selected on the basis of past experience in swimming, enthusiasm, and interest in working with the handicapped. They were oriented on the nature of cerebral palsy and swimming procedures before the program begin. Each instructor was responsible for the skills and daily lessons to be presented to her child as he progressed within his own capabilities.

A series of tests were selected for each child on the basis of balance status, and were administered at the onset of the program.

The same tests were administered at the conclusion of the program to note any changes which had taken place.

A 16 mm movie of gait patterns in walking was made prior to the beginning of the program and following its conclusion. Using a photo enlarger, a triangular representation was made of ten different phases of the gait pattern. Numerical values were assigned to the deviations shown in the various items for analysis. The balance scores obtained were subjected to statistical analysis to determine if there was a significant change within the group between the first and second filming.

Daily procedures for each child were recorded on a tape recorder following each session so that individual progress could be interpreted in case history summarizations.

Summary of Results

The results described were based upon the author's findings as indicated by individual balance test scores, gait patterns as analyzed from slow motion moving picture frames, and summarization of case study reports.

All of the children improved in balance test scores at the conclusion of the swimming program. Although the improvement was present in varying degrees, and all of the children did not improve in all test items, the improvement which was indicated was consistant among the subjects. This may be an indication that swimming contributed to balance improvement.

Progress was also shown in strength, coordination, endurance, relaxation, and the ability to maintain body balance in water. The

children in which this was particularly evident were Subjects #6, #7, #8, #9, and #10. Subjects #1 and #5 only showed improvement in their ability to relax. The relaxation which these children were able to experience made possible the performance of skills and movements which ordinarily were not possible. Subject #9, who was extremely restricted on land in terms of movement, was able to reciprocate her legs and use her arms with much greater ease in the water.

Once fears were diminished, the progress made in skills was rapid. Most of the children, with the exception of Subjects #2 and #11, were allowed to move about independently either without support and assistance, with float supports attached to the body, or with assistance from the instructor. Subjects #6 and #10 required no assistance and were completely independent in deep water. Subjects #7, #8, and #9 were independent in deep water when supported by flotation devises.

All of the children, with the exception of Subject #11, acquired a number of skills which gave them a feeling of accomplishment. Because they were able to experience success, they became less conscious of their restrictions. They became more outgoing and at ease among people.

The gaits of the children, with the exception of Subjects #4 and #9 who could not walk, had improved. In general, the shoulders were more level, the hips were more level, there was less deviation of the body to the left and right of the midline, and there was less body sway. When subjected to statistical analysis, the balance scores made in the film analysis, showed a significant improvement within the group. With this in mind, there is a possibility that swimming contributed to the

improvement in balance.

In addition to the findings of the author, an interview was held with Mrs. Wagoner and Miss Ipsen, the two physical therapists who were closely associated with the program. Each was asked to give a summary of the contributions which they felt swimming may have made to the physical and psychological progress of each child.

Case #1

His hip and back muscles were stronger. He was capable of giving more physical resistance to strain than before. He was more sociable and at ease with his playmates. He was no longer shy about telling them what and how to do something. He always had a sense of humor, but never displayed it until now because of his withdrawal tendencies. He runs, which he did not do before. This was not the result of a physical change, but the result of feeling more secure in performing.

Case #2

Little or no change was evident. He had better balance in coming to the upright position.

Case #4

The joints of the Subject were loosened. His hip thrust was increased. He was more secure among people, and he was proud that he was selected to participate in the program. He had developed a feeling of importance as a result of his participation in the program which meant that he had a feeling of being able to do something, and of being someone.

Case #5

He had stronger flexors, stronger abductors, adductors, and rotators in the hip, and was able to move the abductors and adductors voluntarily. As a result of increased muscle power, the hip joint had loosened. Previously, he had to lock the hip in order to maintain balance. His fear was greatly diminished. He was much easier to handle and his greater feeling of security contributed to his overall improvement. Coordination of the trunk and hip was improved due to a stronger latissimus dorsi. His knees weakened as a result of improved strength in the hip muscles.

Case #6

The Subjects arm and leg coordination were improved. He appeared to be better balanced, and there was better extension in the hip. He moved more freely and it was felt that improvement in gait was the result of loosening. He responded better to directions.

Case #7

The Subject's trunk rotation was decreased and there was less tension in walking. There was greater equality in length of step, and she toed straight ahead rather than to the right as previously. She had greater tolerance to walking to the right as well as backwards and had increased her strength, in general. Her response to slight rises in her pathway was less extreme. She was more upright when walking.

Case #8

There was excellent progress in physical therapy. Her concentration was improved and she responded to directions more quickly.

She had stronger leg and hip muscles. Her trunk and hip, and shoulder girdle coordination were improved. Her arms were no longer out to the side. Although she had more of a tendency to fall backwards, she was able to maintain a straighter line while walking, rather than falling to the side with each step.

Case #9

Subject #9 was overbalanced backwards. She had greater endurance in walking. The knees were unlocked. The shoulders were better centered over the hips until she tired. There was better functioning of the arms without forward flexion of the trunk. She was better able to maintain an upright position while sitting, and at the same time, use the left arm. There was more equal strength rather than one-sidedness. There was more extension in the right arm.

Case #10

She had stronger neck muscles, shoulder girdle, and external rotators of the hip. Her balance was more forward. There was limited loosening of back and hamstring muscles. Her coordination was improved, although not too noticeable. She was a little more outgoing, but was already well-adjusted.

Case #11

There was difficulty in determining improvement because of illness which intervened at the close of the program. It was felt that his final test scores were not valid because the child was weakened by his illness.

Conclusions

Swimming provided a medium through which a less restricted type movement could be experienced. The physical excercise itself, and the fact that the swimming provided a satisfying recreational experience, produced relaxation and joint movement which may have contributed to the physical progress of the children, not only in the performance of swimming skills, but progress in their daily physical therapy programs as well.

With the freedom of movement, came a feeling of satisfaction and security in reduced fears which helped to remove psychological barriers prohibiting success in performance. Swimming contributed to physical progress in the attainment of increased strength, endurance, flexibility, coordination, balance, and relaxation, and to psychological freedom as evidenced by more outgoing tendencies.

Mrs. Carmen Wagoner, Chief Physical Therapist of the Cerebral Palsy School, had this to say about the results of the program:

> "Swimming was useful to the treatment program. It stepped up interest in physical activities. The children felt that they were better than before, and tried harder to improve. They were no longer afraid of failure in competition. The children were able to experience ease in a new medium. Fears, which are one of the major inhibiting factors to progress, were greatly reduced. And in general, tolerance and balance were improved."

Miss Ute Ipsen, second Physical Therapist, concluded the following as a result of her observations and experiences with the children:

> "Swimming provided a recreational experience which produced relaxation, which contributed to progress made in physical therapy. The greatest contribution made by the swimming was the psychic freedom produced, and security in believing that they could do. The program provided a break in the

daily routine, which in itself contributed to relaxation. The children, generally, were more outgoing than withdrawn. They were more easy in their association with people. The program was one more link which helped to make their circle of life greater."

With the results ascertained in this study, the author would like to recommend that further study be conducted in the area of swimming for the cerebral palsied. It was believed that swimming may open new doors to the rehabilitation of these individuals, for the physical exercise experienced in a medium which gives assistance as well as resistance to body movement, and relaxation produced as a result of the recreational experience, will relieve physical restrictions and produce a certain degree of psychic freedom, which will enhance progress.

BIBLIOGRAPHY

BIBLIOGRAPHY

A. BOOKS

1. American National Red Cross. Swimming for the Handicapped, Instructor's Manual. Washington, D. C.: The American National Red Cross, 1955. 59 pp.

2. Bolton, Elizabeth and Dianna Goodwin. An Introduction to Pool Exercises. Edinburgh and London: E and S Livingston, 1956. 48 pp.

3. Cardwell, Viola E. Cerebral Palsy. New York: Association for the Aid of Crippled Children, 1956. 625 pp.

4. Clemens, Benda E. Developmental Disorders of Mentation and Cerebral Palsies. New York: Grune and Stratton, 1952. 565 pp.

5. Crothers, Bronson and Richmond S. Paine. The Natural History of Cerebral Palsy. Cambridge Massachusetts: Harvard University Press, 1959. 299 pp.

6. Cruickshank, William M. and George M. Raus. Cerebral Palsy. Syracuse University Press, 1955. 560 pp.

7. Daniels, Arthur S. Adapted Physical Education. New York: Harper and Brothers, Publishers, 1954. 538 pp.

8. Deaver, George Gilbert. Cerebral Palsy - Methods of Evaluation and Treatment. Institute of Physical Medicine and Rehabilitation, New York University - Bellevue Medical Center, 1955. 57 pp.

9. Egel, Paula F. Technique of Treatment for the Cerebral Palsied Child. St. Louis: The C. V. Mosby Company, 1948. 203 pp.

10. Gray, Henry. Anatomy of the Human Body. Philadelphis: Lea and Febiger, 1954. 1480 pp.

11. Hutchinson, Esther and Elizabeth H. Lanctot. Handbook on Physical Therapy for Cerebral Palsy. Columbus, Ohio: The Ohio Society for Crippled Children, Inc., 1945. 48 pp.

12. Lowman, Charles L. and Susan G. Raen. Therapeutic Use of Pools and Tanks. Philadelphia and London: W. B. Saunders Company, 1952. 90 pp.

13. Pohl, John F. Cerebral Palsy. Saint Paul, Minnesota: Bruce Publishing Company, 1950. 224 pp.

14. Russ, Joseph D. and Hyman R. Soboloff. A Primer of Cerebral Palsy. Springfield, Illinois: Charles C. Thomas, Publisher, 1958. 77 pp.

15. Stafford, George T. and Ellen Davis Kelly. Preventive and Corrective Physical Education. New York: The Ronald Press Company, 1958. 395 pp.

16. Taylor, Edith Meyer. Psychological Appraisal of Children with Cerebral Defects. Published for the Commonwealth Fund, Cambridge, Massachusetts: Harvard University Press, 1959. 499 pp.

17. Willard, Helen S. and Clare S. Spackman. Occupational Therapy. Philadelphia, London, Montreal: J. B. Lippincott Company, 1947. 416 pp.

B. PERIODICALS

18. Bailey, Louise A. "Physical Therapy in the Treatment of Cerebral Palsy," Physical Therapy Review, 30:230-231, June, 1950.

19. Bobath, K. "Spastic Paralysis: Treatment by Use of Reflex Inhibition," British Journal of Physical Medicine, 13:121-127, June, 1950.

20. Brown, Richard L. "Swimming - Activity for the Handicapped," Journal of American Association for Health, Physical Education and Recreation, 24:14-15, April, 1953.

21. Burton-Bradley, Claudia. "The Spastic Child," Medical Journal of Australia, 1:821-824, June 15, 1957.

22. Cruickshank, W. M. "The Multiply Handicapped Cerebral Palsied Child," Exceptional Children, 20:16-22, October, 1953.

23. Cunningham, W. D. "Cerebral Palsy," Medical Journal of Australia, 1:824-826, June, 1957.

24. Denhoff, E. and R. H. Holden. "Family Influences on Successful Adjustment of Cerebral Palsied Children," Exceptional Children, 21:5-7, October, 1954.

25. Denhoff, E. and M. L. Silver. "Prognostic Studies in Children with Cerebral Palsy," Journal of the American Medical Association, 161:781-784, June, 1956.

26. Derham, R. J. "The Causes and Management of Cerebral Palsy in Childhood," British Journal of Clinical Practice, 13:15-22, January, 1959.

27. Epstein, B. "Cerebral Palsy: Causes and Early Diagnosis," South African Medical Journal, 30:25-28, January 14, 1956.

28. Hill, A. S. "Cerebral Palsy, Mental Deficiency and Terminology," American Journal of Mental Deficiency, 59:587-594, April, 1955.

29. Houtz, Sara Jane and others. "Fundamental Approach to the Study of Stance Stability and Locomotion in the Cerebral Palsied," The Physical Therapy Review, 32:51-55, February, 1952.

30. Miles, Walter R. "Static Equilibrium as a Useful Test of Motor Control," Journal of Industrial Hygiene, 3:316-336, February, 1922.

31. Minear, W. L. "Cerebral Palsy; Spasticity," Rocky Mountain Medical Journal, 48:757-767, October, 1951.

32. Minear, W. L. "Classification of Cerebral Palsy," Pediatrics, 18:841-852, November, 1956.

33. Phelps, Winthrop M. "Characteristic Psychological Variations in Cerebral Palsy," Nervous Child, 7:10-13, January, 1948.

34. Phelps, Winthrop M. "The Differential Characteristics of Spasticity and Athetosis in Relation to Therapeutic Measures," New York State Medical Journal, 41:1827-1832, September 15, 1941.

35. Phelps, Winthrop M. "Description and Differentiation of Types of Cerebral Palsy," The Nervous Child, 8:107-127, April, 1949.

36. Phelps, Winthrop M. "The Spastic Child," Occupational Therapy, 17:207-215, August, 1938.

37. Plum, P. "The Prognosis in Cerebral Palsy," Danish Medical Bulletin, 5:58-65, February, 1958.

38. Rood, Margaret S. "Project for Treatment of Cerebral Palsy," Occupational Therapy and Rehabilitation, 17:93-96, April, 1938.

39. Schlesinger, E. R. and N. C. Allaway, "Survivorship in Cerebral Palsy," American Journal of Public Health, 49: 343-349, March, 1959.

40. Spears, Catherine E. and Winthrop Morgan Phelps, "Preliminary Trial of a New Muscle Relaxant in Outpatient Children with Cerebral Palsy," Archives of Pediatrics, 76:287-292, July, 1959.

41. Travis, Roland C. "A New Stabilometer for Measuring Dynamic Equilibrium in the Standing Position," Journal of Experimental Psychology, 34:418-424, October, 1944.

42. Travis, Roland C. "An Experimental Analysis of Dynamic and Static Equilibrium," Journal of Experimental Psychology, 35:216-234, June, 1945.

43. Whipple, Marguerite E. "Balance and Walking in the Treatment of Cerebral Palsy," Physical Therapy Review, 32:65-72, February, 1952.

44. Wolf, A. "Features of Pathology of Cerebral Palsy; Possible Factors in its Etiology," Quarterly Review of Pediatrics, 6:104-112, May, 1951

45. Yannet, Herman. "Multiple Handicaps in the Cerebral Palsied," Journal of Pediatrics, 53:639-644, November, 1958.

C. PAMPHLETS

46. Taylor, Eugene. "Help At Last for Cerebral Palsy," Public Affairs Pamphlets, No. 158, Public Affairs Committee Incorporated, 1950. 31pp.

APPENDIX

Greensboro Cerebral Palsy School
1601 Gatewood Avenue

CASE #1 Left-handed. Good speech.

Stress balance, reciprocal motion and coordination.

Supine: Stretching of right TA and hamstrings
hip internal rotators, hip flexors and adductors
Diagonal exercises for coordination

Prone: (Avoid hyperextension and plantar flexion position)
Stretching of hip flexors, and lateral trunk, right.
Strengthening of external rotators, right; hip extensors and abductors bilaterally.
Shoulder girdle strengthening

Sitting: Reciprocal: Ankle, knee and hip flexion and extension.

Mat: crawling on hands and knees
squatting
sitting: a. long-legged position
b. tailor sitting.

Carmen Wagoner, R.P.T.

Swimming Skills

CASE #1

Supine

Stretch right TA	Hamstrings	Hip flexors
Frog kick	Wading Flutter kick Kick and Finn Scissor kick	Flutter kick

Adductors	Hip internal rotators
Frog kick	Frog kick

Prone (avoid hyperextension and plantar flexion)

Stretch lateral trunk (right)	Hip flexors
Side stroke	Flutter kick Human stroke

Strengthen external rotators (right)	Hip extensors
Flutter and finn	Flutter kick

Abductors	Strengthen shoulder girdle
Frog kick	Overhand stroke

Greensboro Cerebral Palsy School
1601 Gatewood Avenue

CASE #2 Right(?) handed. Poor to fair speech.

Stress balance and steady motions.

Supine:

Strengthening of hip and knee flexors and extensors hip adductors and rotators, internal and external, all bilaterally.

Prone:

Repeat same exercises listed under prone position
Strengthening of back

Mat: Hand-knee crawling
Knee standing
Repeat supine exercises in crawling position
Stabilizer standing

Strengthening and reciprocation of ankle and knee joints by propelling special rolling chair with feet.

Carmen Wagoner, R.P.T.

Swimming Skills

CASE #2

Supine

Strengthen hip flexors	Extensors	Adductors
Wading	Flutter kick	Frog kick
Flutter kick		
Scissor kick		

Rotators (internal and external)	Knee flexors
Frog kick	Flutter kick

Extensors

Wading

Prone

Strengthen back

Flutter kick
Human stroke
Backcrawl

Greensboro Cerebral Palsy School
1601 Gatewood Avenue

CASE # 3 Left(?)handed* Fair to good speech.

Tends to walk with extended right knee; should be encouraged to bend it.

Supine: Stretching of left heel cord.

Neck and abdominal strengthening
Strengthening of hip and knee flexors and extensors in reciprocal pattern, hip abductors.

Prone: Stretching of hip flexors, bilaterally
Neck and back strengthening

Mat: Crawling on hands and knees
Sitting for gravitational stretch of hamstrings, bilaterally and internal rotations, left.

Stair Climbing to strengthen ankle, hip and knee flexors and extensors. (This is also a means by which she is encouraged to flex the right knee at the peoper time.)

*This little girl has a way of doing some activities, right hand leading, and others left hand leading.

Carmen Wagoner, R. P.T.

Swimming Skills

CASE # 3

Supine

Strengthen neck and abdominals

Flutter kick
Flutter and finn
Back crawl

Strengthen hip, knee flexors and extensors

Flutter kick
Scissor kick

Hip abductors

Frog kick

Prone

Stretch hip flexors	Strengthen neck and back
Flutter kick	Flutter kick
Human stroke	Human stroke

Greensboro Cerebral Palsy School
1601 Gatewood Avenue

CASE #4 Right-handed. Fair Speech

Moderate extensor thrust in hips and lower extremities, feet included. Wears control braces.

Plynth exercises:

A. Supine: stretching of left and right hamstrings, left and right hip adductors, right internal rotators and hip flexors both right and left.

anterior neck and abdominal strengthening
guided active-assistive or active exercises to joints of upper extremities.

B. Prone:

stretching of quads
back and neck strengthening
active-assistive and active exercises to lower extremities.

C. Mat: a:rolling from side to side. b. crawling using arms only

D. Sitting: 1. Unbraced - tailor fashion on mat

E. Stabilizer standing, one knee locked

F. Assisted walking on skis.

G. Sitting position: reach-grasp, return-release

H. Standing table about one hour a day, avoid tendency of upper trunk to shift to the left.

Carmen Wagoner, R.P.T.

Swimming Skills

CASE #4

Supine

Stretch hamstrings	Hip adductors	Hip flexors
Flutter kick Wading	Frog kick	Flutter kick

Internal rotators (right)	Strengthen neck
Frog kick	Flutter kick

Abdominals	Upper extremities (active-assistive)
Flutter kick	Overarm stroke

Prone

Stretch quads	Strengthen neck and back
Flutter kick Human stroke	Human stroke

Lower extremities (active and active-assistive)

Flutter kick
Frog kick

Greensboro Cerebral Palsy School
1601 Gatewood Avenue

CASE #5

Right-handed, Good speech. Gets about independently leaning on walls, furniture, etc.

Supine: Stretching of adductors and hip flexors
active - assistive hip and knee flexion and extension
active hip abduction
active-assistive reciprocal dorsi - and plantar flexion
active external rotation, left
neck and abdominal strengthening
active hip external rotation, left

Prone: stretching of quads
active hip extension
active knee flexion done separately, then reciprocally
neck and back strengthening

Standing: Deep knee bending to lengthen tight structures and strengthen weak ones.

Mat: Hand-knee crawling
Knee standing

Tricycle riding to strengthen hip and knee extensors. Propels himself on special rolling chair to strengthen quads and hamstrings. Gait training to build up endurance.

Carmen Wagoner, R.P.T.

Swimming Skills

CASE #5

Supine

Stretch hip adductors	Flexors
Frog kick	Flutter kick

Hip flexion	Hip extension	Knee flexion
Wading	Flutter kick and finn	Flutter kick
Flutter kick	Flutter kick	Scissor tread
Frog kick	Frog kick	Frog kick

Knee extension	Hip abduction	Reciprocal dorsi
Flutter kick	Frog kick	Flutter kick
Frog kick		

Plantar flexion	External rotation
Flutter kick	Frog kick
Frog kick	

Neck and Abdominal strengthening

Flutter kick
Back crawl

Prone

Stretch quads	Hip extension,	Strengthen neck and back
Scissor kick	Flutter kick	Flutter kick
Frog kick	Frog kick	Arms-human stroke
	Scissor kick	

Greensboro Cerebral Palsy School
1601 Gatewood Avenue

CASE #6 Right-handed. Good Speech

Supine: stretching of hamstrings, hip flexors
neck and abdominal stregthening
quad and dorsiflexor strengthening

Prone: stretching of quads
strengthening of neck, back and hip extensors bilaterally

Gait training stressing (1) active effort to toe left foot straight ahead (2) dorsi-flexion and full knee extension.

At home, sandbag stretching for hip flexor shortness for one hour a day, 6 days a week. A break is allowed at 15 min. intervals.

Carmen Wagener, R.P.T.

Swimming Skills

CASE #6

Supine

Stretch hamstrings	Hip flexors
Flutter kick	Flutter kick
Wading	

Strengthen neck and abdominals

Flutter kick
Back crawl

Strengthen quads

Flutter kick
Kick and finn
Wading

Prone

Stretch quads	Strengthen neck
Scissor kick	Flutter kick
Flutter kick	Human stroke

Greensboro Cerebral Palsy School
1601 Gatewood Avenue

CASE #7

Right handed Fair Speech

Supine: Stretching hamstrings, hip internal rotators both on left only.
Strengthening of neck and abdominals

Long-legged sitting:
Stretching of gastrocnemius, more on left

Prone: Stretching quads, more on left, internal rotators of hip, left.
Also hip flexors more on left and TFL bilaterally
Strengthening of neck and back
Strengthening of hamstrings and hip extensors, both bilaterally.

Sitting: Strengthening of toe flexors and invertors all bilaterally.

Standing:
Plantar flexor quad and gluteus maximus strengthening all bilaterally.

Mat: Hand-knee crawling
Sitting for gravitational stretch of hamstrings bilaterally and internal rotators, left.

Gait: Pushing weighted pushcart to strengthen plantar flexors, hip extensors, quads, shoulder girdles and elbow extensors.

Carmen Wagoner, R.P.T.

Swimming Skills

CASE #7

Supine

Stretch hamstrings	Hip internal rotators (left)
Wading	Frog kick
Flutter kick	
Frog kick	

Prone

Stretch quads	Internal rotators
Flutter kick	Frog kick
Human stroke	

Stretch hip flexors	Strengthen neck and back
Flutter kick	Flutter kick
Human stroke	Human storke

Strengthen hamstrings	Hip extensors
Flutter kick	Flutter kick
Human stroke	
Kick and finn	

Greensboro Cerebral Palsy School
1601 Gatewood Avenue

CASE #8 Right handed Fair Speech

Supine: Strengthening of neck and abdominals, hip abductors bilaterally.

Prone: Strengthening of neck and back, hip extensors bilaterally.

Mat: Hand-knee crawling
Knee standing
Knee walking

Standing balance practice unsupported, 11 oz. weights on each ankle.

Gait training with sawhorse crutch used as a walker.

Posture training in standing position.

Carmen Wagoner, R.P.T.

Swimming Skills

CASE #8

Supine

Strengthen neck and abdominals	Hip abductors
Flutter kick	Frog kick
Back crawl	

Prone

Strengthen neck and back	Hip extensors
Flutter kick	Flutter kick
Human stroke	Frog kick

Greensboro Cerebral Palsy School
1601 Gatewood Avenue

CASE #9 Left handed Good speech
Wears control braces for gait training. Remainder of time she uses short leg single-bar upright type.

Plynth exercises:

A. Supine: Abdominal strengthening

Legs: resistive plantar flexion, hip and knee extension
gluteus medius strengthening
Arms: active-assistive and active motion to shoulders, arms, wrists and hands.

B. Prone: gluteus maximum medius strengthening
neck and back strengthening

C. Sitting position: Bilateral exercises for shoulder flexion, elbow and wrist extension, reach and grasp, return and release.

D. Sitting balance practice without support using various chairs so she will learn to depend on her muscles instead of props.

E. Stabilizer standing with knees locked.

F. Assisted walking pushing pushcart.

G. Standing table, 30-60 minutes daily.

H. Long-legged sitting position: remove own control braces.

Carmen Wagner, R.P.T.

Dr. Winthrop Phelps writes of Case #9: "I have suggested to her family that if she could have an under-water couch so that she could lie on that and reciprocate her legs and also twist and turn her back, it would be good."

Swimming Skills

CASE #9

Supine

Strengthen abdominals

Flutter kick
Back crawl

Plantar flexion

Wading
Flutter kick

Hip and knee extension

Flutter kick

Shoulders, arms, wrists, hands

Arm stroke - back crawl, human stroke

Prone

Maximus, medius strengthening

Flutter kick

Neck and back strengthening

Flutter kick
Human stroke

Greensboro Cerebral Palsy School
1601 Gatewood Avenue

CASE #10

Stretch

Posterior neck
Back, moderate
Hamstrings, severe
TA, moderate

Strengthen

Anterior and posterior neck
Shoulder girdle, bilaterally
Hip external rotators
Forefoot evertors, bilaterally

Balance centered too far back. Should be brought foreward.

Carmen Wagoner, R.PT.

Swimming Skills

CASE #10

Frog kick
Elementary backstroke
Breast stroke
Flutter kick
Human stroke
Front crawl

Greensboro Cerebral Palsy School
1601 Gatewood Avenue

CASE #11 Left-handed No speech

Should not walk barefooted. Is limited to 15 mins. at a stretch on his feet.

Supine:
Stretching of TA bilaterally, left shoulder extensors and elbow flexors.
Strengthening of abdominals
Strengthening of upper extremities, especially right.
Strengthening of hip abductors and dorsiflexors, both bilaterally.

Prone:
Stretching of hip flexors
Strengthening of back, hip extensors and abductors bilaterally.
Strengthening of right knee flexors.

Sitting with hamstrings released.
Strengthening of dorsiflexors and quads both bilaterally.

Stress coordination and balance.

Carmen Wagoner, R.P.T.

Swimming Skills

CASE #11

Supine

Abdominals	Extremities, right side
Flutter kick	Human stroke
Hip abduction	**Stretch extensors and elbow flexors**
Frog kick	Overarm stroke

Prone

Knee flexion

Flutter kick
Human stroke

Greensboro Cerebral Palsy School
1601 Gatewood Avenue

CASE #12 Fair Speech

Avoid position of lordosis

Supine: Stretching of TA and hamstrings
Neck and abdominal strengthening

Prone (In this position care is taken to avoid position of plantar flexion of feet)
Stretching of hip flexors

Strengthening of shoulder girdle and hip extensors

Sitting with feet on floor. Strengthening of dorsi-flexors and toe flexors.

Mat Work: (No knee standing at present)
Training in coordination and balance
1) stand on hands and knees
2) sitting back on heels
3) squat
4) long-legged sitting position. Movement of arms and trunk while still maintaining balance.

Standing with feet parallel. Avoid knee hyper-tension and lordosis; see that back is straight, shoulders back.

Gait training soon as braces arrive.

Carmen Wagoner, R.P.T.

Swimming Skills

CASE #12

Supine

Stretch hamstrings and TA

Wading

Strengthen neck and abdominals

Flutter kick
Back crawl

Prone (no plantar flexion)

Stretch hip flexors — Strengthen shoulder girdle

Flutter kick — Arm stroke

Strengthen hip extensors

Flutter kick

PARENT OR GUARDIAN APPROVAL

_____ has my permission to participate in the nine week swimming program to be held at the Woman's College of the University of North Carolina between February 12 and April 10, 1960. I understand that every possible precaution will be taken for my child's safety, and I understand that the college is not responsible for any accidents.

Parent or Guardian_____

Date _____

GUIDE QUESTIONS FOR SUMMARIZING

DAILY LESSONS

Each lesson should be summarized into the following categories: skills taught, motivation, teaching techniques, personality and psychological adjustments, and observations of physical improvement in terms of balance, strength, coordination, endurance, flexibility, and relaxation.

Guide questions

1. Is the child fearful and tense in the water, or fearless and relaxed? How do you know?
2. Does he seem to have confidence in you, or is he insecure?
3. Did you have to use any special techniques to win his confidence? What?
4. Does he cooperate with you, or is he independent and uncooperative? If uncooperative, what were his reactions?
5. What skills did you attempt to teach during the period? What were the child's reactions to their presentation? (fear, comprehension, enthusiasm, withdrawal, willing, no response).
6. Was he able to perform the skills without your assistance? If not, what assistance was given? (personal contact, flotation devises, other)
7. Was the child able to comprehend directions?
8. Was he attentive?
9. Did the child have any confidence in his own abilities to perform, or was there a negative response? (confidence with or without support)
10. Were you able to hold his interest for long periods of time, or was his interest span relatively short.
11. Did he fatique readily? If so, was it due to too cold or too warm water? What were the signs of fatigue?

12. Was it necessary to use any special motivational devises, or was there sufficient self-motivation to insure effort in performance? Did the child respond to motivational procedures?

13. Do you feel that he experienced success in the period? Did the child have a feeling of achievement? In each question, if the answer is yes, how do you know? If the answer is no, why not?

14. What was the worst problem that you encountered today, if any? If this was a psychological problem, how did you handle the situation?

15. What was your most satisfying experience?

16. Did the child ever become frustrated, angry, or restless with his inability to perform a skill, or skills?

17. What special teaching techniques did you utilize? Were these successful or unsuccessful? Which techniques obtained the best results, and which techniques the poorest response?

18. What other observations were you able to make?

TYPICAL CEREBRAL

PALSY GAITS

Figure 2. Subject #1 Spastic

Figure 3. Subject #2 Ataxia

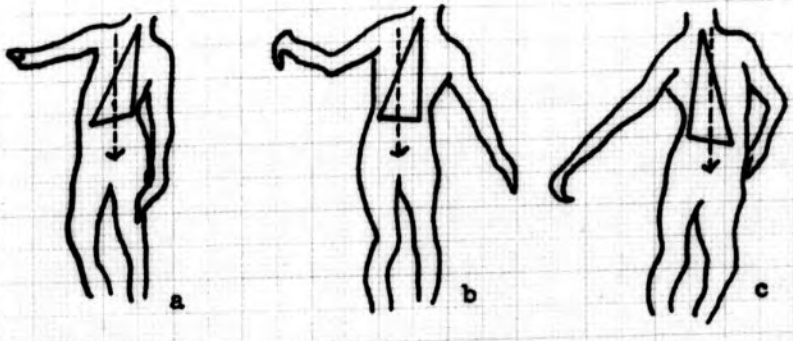


Figure 4. Subject #5 Spastic

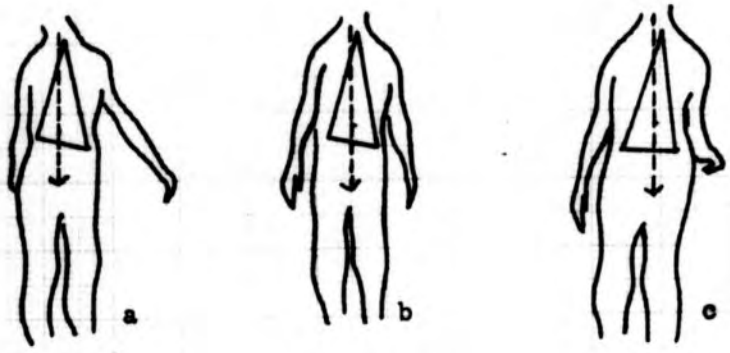


Figure 5. Subject #6 Spastic

Figure 6. Subject #7 Rotary Athetoid

Figure 7. Subject #8 Ataxia

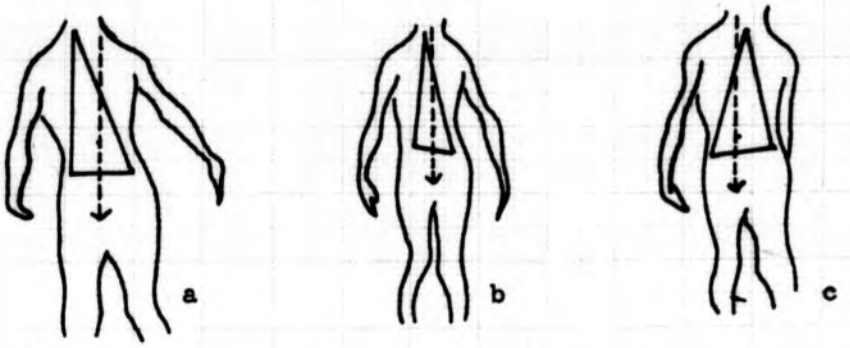


Figure 8. Subject #10 Spastic Athetoid

Figure 9. Subject #11 Spastic

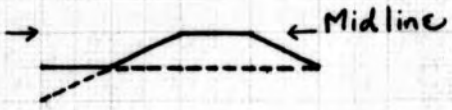
Figure 10. Subject #12 Rotary Athetoid

GRAPHIC REPRESENTATION

OF

CEREBRAL PALSY GAITS

Figure 11. Case #1



A. Deviation of Vertebrae Prominens from Midline

B. Vertical Deviation of Shoulders

C. Vertical Deviation of Hips

D. Deviation of Right Shoulder and Right Hip

Key

_____ = Film #I

_ _ _ _ _ = Film #II

E. Deviation of Left Shoulder and Left Hip

Figure 12. Case #2

A. Deviation of Vertebrae Prominens from Midline

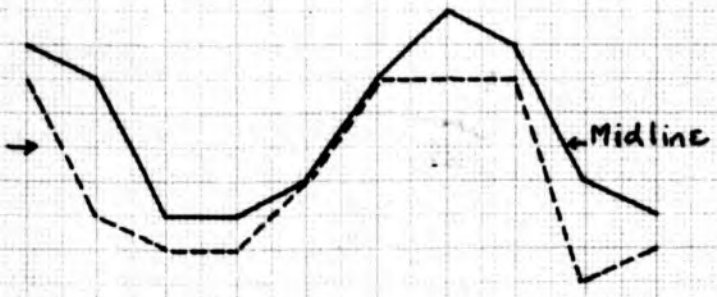
B. Vertical Deviation of Shoulders

C. Vertical Deviation of Hips

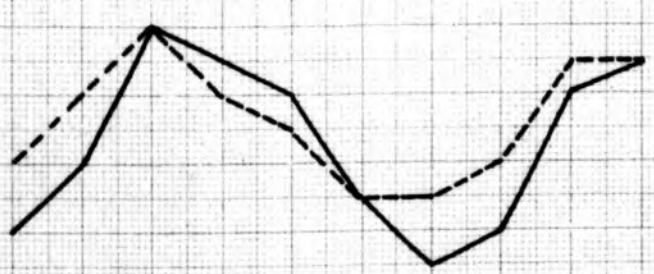
D. Deviation of Right Shoulder and Right Hip

E. Deviation of Left Shoulder and Left Hip

Figure 13. Case #5



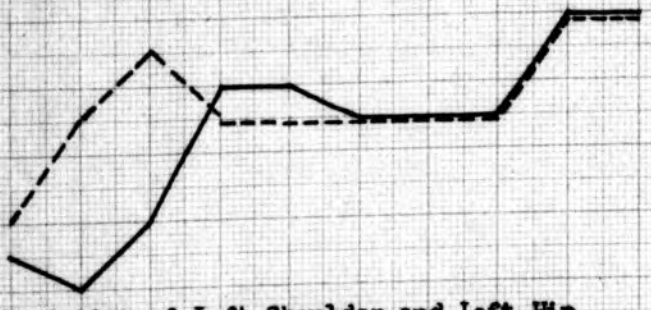
A. Deviation of Vertebrae Prominens from Midline



B. Vertical Deviation of Shoulders

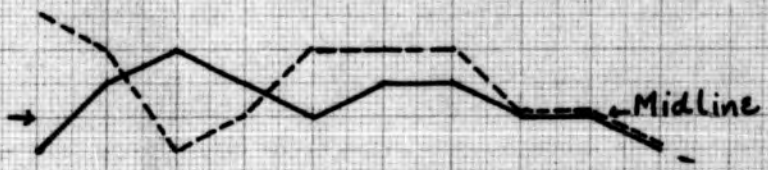
C. Vertical Deviation of Hips

D. Deviation of Right Shoulder and Right Hip



E. Deviation of Left Shoulder and Left Hip

Figure 14. Case #6

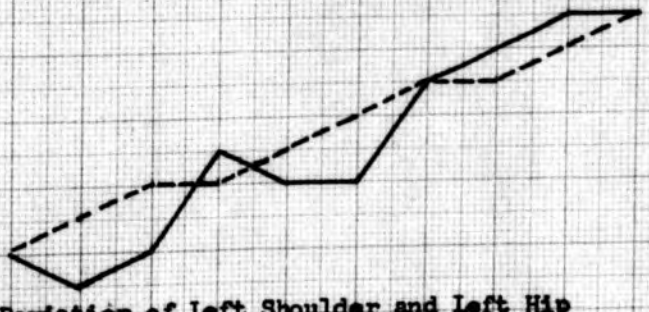


A. Deviation of Vertebrae Prominens from Midline

B. Vertical Deviation of Shoulders

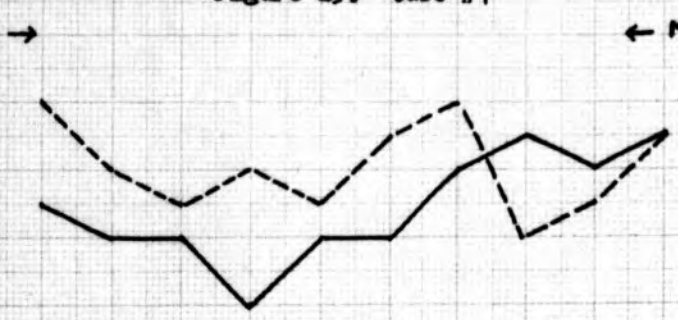
C. Vertical Deviation of Hips

D. Deviation of Right Shoulder and Right Hip

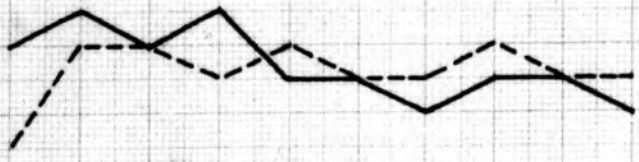


E. Deviation of Left Shoulder and Left Hip

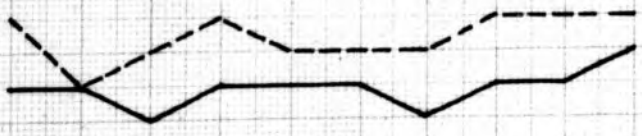
Figure 15. Case #7



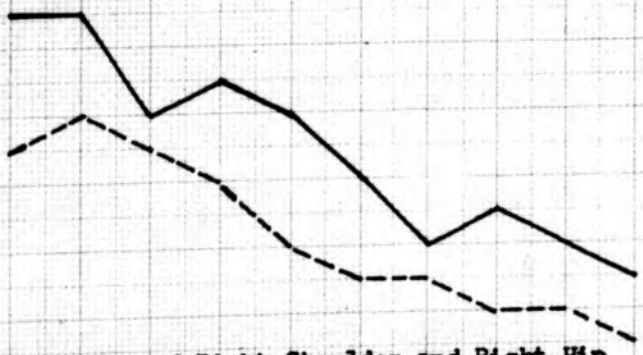
A. Deviation of Vertebrae Prominens from Midline



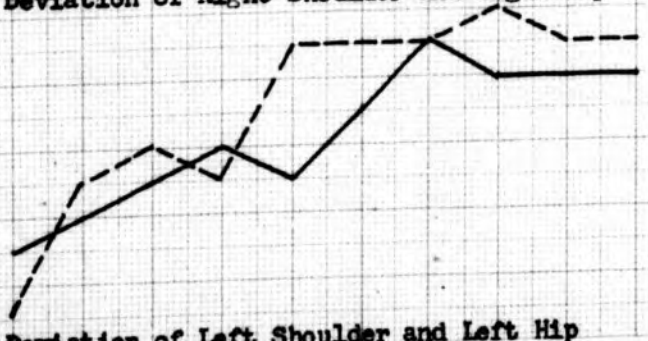
B. Vertical Deviation of Shoulders



C. Vertical Deviation of Hips

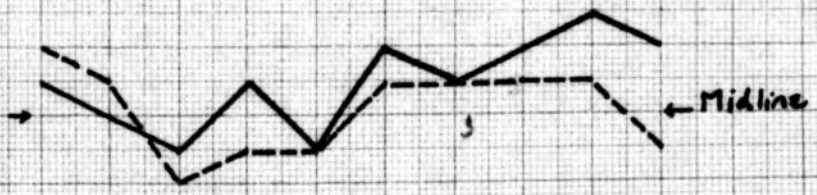


D. Deviation of Right Shoulder and Right Hip



E. Deviation of Left Shoulder and Left Hip

Figure 16. Case #8



A. Deviation of Vertebrae Prominens from Midline

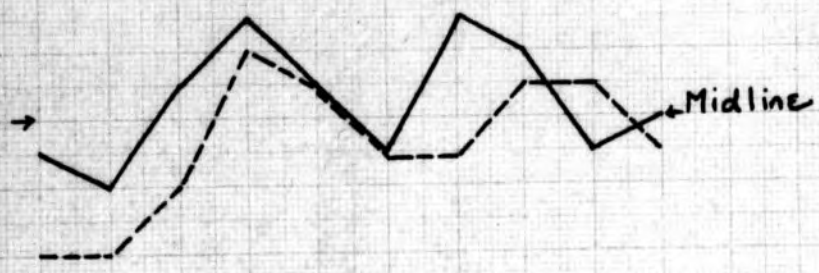
B. Vertical Deviation of Shoulders

C. Vertical Deviation of Hips

D. Deviation of Right Shoulder and Right Hip

E. Deviation of Left Shoulder and Left Hip

Figure 17. Case #10

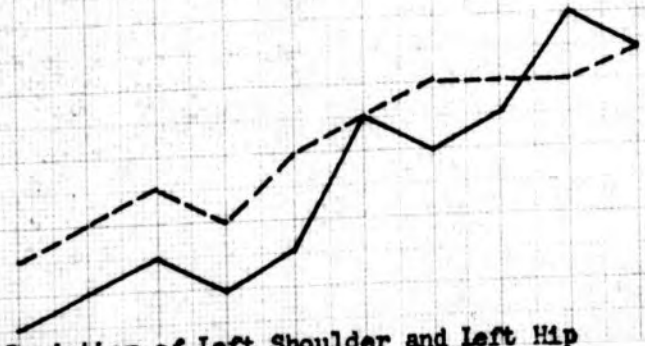


A. Deviation of Vertebrae Prominens from Midline

B. Vertical Deviation of Shoulders

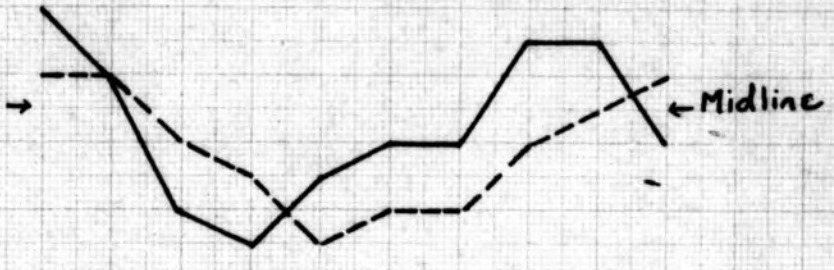
C. Vertical Deviation of Hips

D. Deviation of Right Shoulder and Right Hip

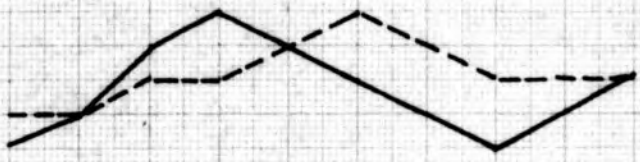


E. Deviation of Left Shoulder and Left Hip

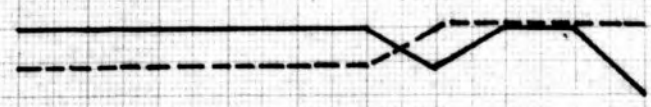
Figure 18. Case #11



A. Deviation of Vertebrae Prominens from Midline

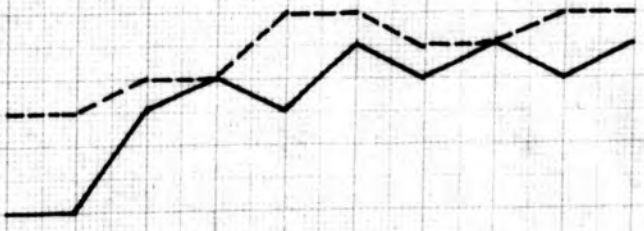


B. Vertical Deviation of Shoulders



C. Vertical Deviation of Hips

D. Deviation of Right Shoulder and Right Hip



E. Deviation of Left Shoulder and Left Hip

Typed by

Marie K. Lane