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THE UNIVERSITY OF ALBERTA

THE FITNESS PERFORMANCE OF PHYSICALLY AWKWARD CHILDREN

by

JOHN FRANCIS PATON

A THESIS

SUBMITTED TO THE FACULTY OF GRADUATE STUDIES AND RESEARCH

IN PARTIAL FULFILLMENTS OF THE REQUIREMENT FOR THE DEGREE

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FACULTY OF GRADUATE STUDIES AND RESEARCH

The undersigned certify that they have read, and recommend to the Faculty of Graduate Studies and Research, for acceptance, a thesis entitled The Fitness Performance of Physically Awkward Children submitted by John Francis Paton in partial fulfillment of the requirements for the degree of Master of Arts.

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Supervisor

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Date August 12th, 1936.

DEDICATION

To my wonderful and loving parents
Margaret and John whose endless faith
and support has inspired me to fulfil my
own goals and thereby make them proud.
I will love them always

ABSTRACT

The main purpose of this study was to identify a group of physically awkward children, and to determine their level of physical fitness in relation to norms generated from studies of children of the same age and sex.

Using a Motor Behaviour Checklist, teachers in four schools identified 100 children out of 558 as being possibly physically awkward. Of this number, parental permission was obtained to test 55 children. Using the Motor Performance Test Battery (Taylor, 1982) it was determined that 41 of the 55 children were physically awkward. This figure represents 75% of the 55 tested which is 7.3% of the total population in the four schools.

Seven standardized fitness tests were used in this study, the raw scores from these tests being converted to percentiles to facilitate comparisons with normative data for both boys and girls. Except for the skinfold scores, which were within the normal range, the fitness tests showed these physically awkward children, on average, to be below the 30th percentile on the remaining six measures.

The results indicate that these physically awkward children are far below their peers in their level of physical fitness.

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I consider myself lucky not merely to have experienced graduate life at the University of Alberta, but to have had my advisor Dr. A. E. Wall (Ted) as a much valued mentor and friend. Ted's limitless enthusiasm, energy, and very agreeable sense of humour have been an inspiration to me over the past two years. The many hours we spent together revising the final parts of this thesis were greatly appreciated.

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I would also like to thank Jane Taylor and Jacquie Weir without whose help my study would have never been started, let alone completed. My sincere thanks also goes to the many graduate students who helped with the data collection, and to the teachers who took the time to help us identify these physically awkward children. Of course I cannot forget to thank the 55 children who so willingly submitted to our testing. Without

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CHAPTER I

INTRODUCTION

For over 60 years now, a variety of professionals have discussed the problem of the "clumsy" or "physically awkward" child. Until approximately 20 years ago, it was generally believed that the movement difficulties these children experienced were due to organic limitations (Gerstmann, 1940; Doll, 1951; Critchley, 1953; Albitreccia, 1958, 1959; Benton, 1959; Prechtl & Stemmer, 1962; Kong, 1963; Paine, 1968). However, the past 20 years has seen a shift away from this narrow focus to one that is much broader in scope.

R. Tait McKenzie (1926) was one of the first researchers in this century to note that if children do not develop and practice physical skills in childhood it will be difficult for them to learn these skills when they grow older. Orton (1937) supported this observation and suggested that this delay could have grave social consequences for the children involved. Orton was one of the first to stress the need for remedial action including the breaking down of skills into component parts, and learning each of these component parts first before attempting to execute the skill in its entirety. This need for remediation has also been seen by numerous other authors who have published in this area over the past 25 years. For example, Reuben & Bakwin (1968) stressed the need for teaching physically awkward children simple skills in a stable environment.

The relationship between low IQ and physical awkwardness was

brought into question by Annell (1949) who noted that (contrary to popular belief at that time) physically awkward children were, in fact, very often of normal intelligence. Up until the present, it is believed that no direct or causal relationship exists between intelligence and physical proficiency; however, further research on this relationship certainly is needed.

In 1962, the British Medical Association Journal acknowleged the existence of a subgroup of physically awkward children. In fact, they noted that "clumsy children" were not uncommon. This article outlined a number of behavioural characteristics that would later make up part of the syndrome of physical awkwardness; that is, these children displayed behavioural problems in an attempt to cover up their poor performances in physical activity. Gubbay, Ellis, Walton & Court (1965) also reported on these behavioural difficulties.

A much ignored area in the literature on physical awkwardness is that of physical fitness. Ford (1966) first alluded to this problem when he suggested that physically awkward children usually become obese. Illingworth (1968) and Gordon (1969) reiterate this point; however, it was not until 1982 that the level of physical fitness of physically awkward children was first brought into question (Wall, 1982; Taylor, 1983; Wall, McClements, Bouffard, Findlay & Taylor, 1985). These authors contend that the level of physical fitness is lower in physically awkward children because they avoid physical activity as much as possible.

A major problem for physically awkward children is their exclusion (sometimes self-exclusion) from games of a physical

nature with their peers. Brenner, Gillman, Zangwill & Farrell (1967) and Gubbay (1975) highlight this problem, noting that physically awkward children often appear lazy, and lack self-confidence, when in fact such behaviour is merely a ploy to avoid being embarrased in front of their peers when they perform poorly in sport and physical activity. Reuben & Bakwin (1968) report that low self-esteem and feelings of inadequacy were common amongst physically awkward children. They also stress the need for parent education and emphasize the importance of reassuring the parents of physically awkward children that their children are not brain damaged. Wall (1982) further suggests that parents of these children need to be provided with remedial strategies to help physically awkward children adjust to, and try to minimize their lack of skill proficiency.

Illingworth (1968) stresses the need for a comprehensive developmental assessment device. This need was repeatedly stressed by other researchers (Gordon, 1969; Morris & Whiting, 1971; Gubbay, 1975; Keogh, Sugden, Reynard & Calkins, 1979; Wall, 1982). Gubbay (1975) notes that early detection was possible; and in fact, abnormal clumsiness is often first noticed when a child begins to walk. Once in school, he notes that constant illness or truancy on sport or physical education days may also be an indicator that the child is physically awkward.

The syndrome of physical awkwardness, as alluded to by the British Medical Association Journal (1962) is further defined by Henderson and Stott (1977) who claimed that these children experienced rejection by adults, were unpopular with their peers, displayed frequent truancy, depression, anxiety, and were

unhappy. McKinlay (1978) reiterates many of these points and further states that these children lose so much self-confidence that they may often not attempt activities of which they are capable.

When screening for or attempting to identify physically awkward children, Keogh et al., (1979) stress that we should not only look at quantitative data, but also at qualitative data; that is, how the child tries to perform the skill. Wall et al., (1985) lend support to this notion by stating that physically awkward children do not develop adequate knowledge about action, and therefore have fewer automatized skills to handle the task demands of the various situations that they confront. Very often these children lose their self-confidence in movement situations simply because they do not have the necessary physical skills in their repertoire to readily handle the demands of culturally-normative physical activity settings.

Henderson & Hall (1982) prefer to use the term "developmental clumsiness", and they believe that such clumsiness is usually only part of a larger problem in that very few children that were referred for professional assessment have exclusively motor problems. From their research, they believe that the initial identification of physically awkward children is probably best left in the hands of school teachers rather than any other professionals, as they are more likely to observe these children reacting with their peers in the playground.

Wall (1982) extends the discussion of physical awkwardness by stressing that any identification procedures must contain culturally-normative skills, for it makes no sense to test

children on activities that are not normally found in their culture. He describes the social problems that physically awkward children face. As these children are low in skill, they are often ridiculed and labeled "clumsy" by their peers, and are forced to withdraw from group activities. As a result, their enjoyment of physical activity decreases and they encounter considerable rejection by their peers and experience a host of other social difficulties. Therefore, it is not surprising that these children become disinterested in most forms of physical activity and consciously avoid it. Unfortunately their lack of physical activity probably results in reduced physical fitness. Clifford (1985), in support of this latter point, reports that physically awkward children tend to be overweight, and have a history of quitting community-sponsored physical activity programs.

By excluding themselves from physical activity at an early age, physically awkward children may rob themselves of the opportunity to fully develop in all aspects of physical growth. While no studies have conclusively shown physical activity to result in increased or decreased stature, there is still considerable support for Steinhaus's (1933) classic contention that pressure effects from physical activity may optimally stimulate epipyseal growth, but excessive and prolonged pressure can retard linear growth.

Though not conclusive, research also supports the notion that inactive children will have a greater percentage of adipose tissue than active children (Von Dobeln & Eriksson, 1972; Parizkova, 1963, 1968, 1970, 1973, 1974). With irregular

participation in physical activity, one may speculate that the muscular strength of physically awkward children is probably below that of their age and sex-matched peers.

Finally, the most important component of physical fitness is that of cardiovascular endurance. Much of the research in this area points to the fact that inactive children will not develop their aerobic power to the same extent as active children (Kobayashi, Kitamura, Miura et al., 1978; Mirwald, Bailey, Cameron, & Rasmussen, 1981). As physically awkward children avoid physical activity, it would be safe to put them in the category of "inactive". It is possible that this lack of activity as a child may lead to sedentary lifestyle patterns, which in turn often accompanies an increased risk of cardiovascular disease.

Problem Statement

The purpose of this study was to identify through the use of qualitative and quantitative instruments, a group of physically awkward children; and to examine the physical fitness characteristics of this group.

As most of the motor test batteries that are available are long and time consuming, it was necessary to develop a more suitable means of identifying these children. Perhaps the most efficient way to identify them is by way of a teacher-administered screening process. This study is just one of a series concerned with the development of just such a screening checklist (Taylor, 1982; Umansky, 1983; Clifford, 1985).

It has already been noted by Wall (1982) that by avoiding

physical activity, physically awkward children may not have sufficient stimulation to develop their fitness. This is a feasible assumption; however, no studies to date have examined the physical fitness of physically awkward children. In order to more fully appreciate the syndrome of physical awkwardness we need to investigate whether physically awkward children are actually lower in their level of fitness than would be expected of their age and sex-matched peers.

One basic question was asked in this study:

Are children who have been identified as physically awkward on the basis of a teacher rating scale and motor performance test results demonstrably less fit than their age and sex-matched peers?

Definition

Physically Awkward Children - Physically awkward children are children without known neuromuscular problems who fail to perform culturally-normative motor skills with acceptable proficiency (Wall, 1982, p. 254). The operational definition for truly physically awkward children used in this study was based on the results of an administration of the Motor Behaviour Checklist and the Motor Performance Test Battery. Children who received three test scores at or below the 10th percentile for their particular age and sex categories were rated as being physically awkward.

CHAPTER II

SELECTIVE REVIEW OF THE LITERATURE

The review of the literature for this study will be divided into two major parts. The first reviews a number of pertinent studies related to the syndrome of physical awkwardness. The second part reviews studies on the relationship of physical activity to physical growth and fitness.

The Concept of Physical Awkwardness

This section provides a brief historical review of the literature on the concept of physical awkwardness. The review has been sectioned according to individual papers written by various authors to facilitate their inclusion and discussion in the summary analysis that follows. The review makes use of rather extensive quotes from original papers in order to highlight the different terms and ideas expressed by the various authors. The summary analysis provided in Tables I to IV highlights some of the major notions related to the concept of physical awkwardness.

A number of studies have referred to children who have had difficulties executing skilled movements, due to organic limitations. However, in terms of the definition of physical awkwardness used in this study these organically-based skill problems are not of direct concern to us. Hence, no discussion will be made of skill difficulties associated with minimal cerebral palsy (Kong, 1963), the neurophrenia syndrome (Doll,

1951), the choreiform syndrome (Prechtl & Stemmer, 1962), developmental Gerstmann's syndrome (Gerstmann, 1940; Critchley, 1953), disorders of body image (Albitreccia, 1958, 1959), right-left discrimination (Benton, 1959), and minimal cerebral dysfunction (Paine, 1968).

McKENZIE, (1926)

In 1926, R. Tait McKenzie made a number of observations on the importance of physical skill which are relevant to our discussion. He emphasized the developmental nature of skill acquisition and the relationship of such development to the increasing task demands which children must face with age:

> The child begins his education by a play system of his own, beginning with simple conditions and work movements. He accustoms himself to his surroundings, learning to judge distance, time and resistance. As his nervous system develops he begins to test himself against his fellows. Movements that at first required his entire attention, like the attainment of the standing position, become relegated to lower levels, leaving his brain free to acquire new and more complicated combinations of movement. He begins to test himself in speed, and to create games of tag, which develop into football, baseball, hockey and lacrosse. Aimless, tugging, and striking develop into the form of contests of track and field. As the nervous system develops still further he passes on to the games involving co-operation as well as greater skill. (p. 630)

He also noticed the problems which less-skilled children face if they do not develop their skills in accordance with their age:

> The true function of athletic sports in education then is, first of all, to train the growing child according to his physiological age, in those activities that are proper to that age. If this training is missed it is very difficult to pick up later on. A child who has learned to swim does not need the elaborate and prolonged instruction necessary to one who takes it when full grown, and if training in running and jumping, throwing and catching is not acquired in youth it is hard to learn the finer co-ordinations in middle life, as every middle aged golf beginner knows. (p. 631)

ORTON, (1937, 1946)

One of the best early descriptions of children with movement difficulties was included in Orton's classic text Reading Writing and Speech Problems in Children (1937). Orton notes that children have been known to be clumsy for a long time. In fact, he notes that Galen referred to such children:

> . . . as being "ambivelous," that is, doubly left-handed. Except for the unjustified implication as to the general unskillfulness of left-handers, this characterization fits the situation well. These children seem to be equipped with a lack of skill on both sides comparable to that of the left hand in a strongly right-handed person. (p. 120)

Orton goes on to describe the syndrome more fully:

> Such children are often somewhat delayed in learning even the simpler movements such as walking and running, and have great difficulty in learning to use their hands and to copy motions shown to them. They are slow in learning to dress themselves and are clumsy in their attempts to button their clothes, tie their shoes, handle a spoon, and in other simple tasks. (p. 121)

He also notes that "At times the motor inaptitude seems to involve movements of the body as a whole including such factors as balance and gait and not merely the more complex movements which underlie manual dexterity" (p. 191).

Orton (1937) places the problem of awkwardness in a socio-cultural context by noting that "a considerable measure of feeling of inferiority seems to be unavoidable in the apraxics, especially as these children grow to the age when they enter active physical competition where their limitations must be rather piteously exposed" (p. 193). Clearly, he appreciated the fact that physical skills are performed in a public environment and that a lack of proficiency in these skills often leads to negative social consequences.

In a subsequent article, Orton (1946) differentiates between two types of developmental apraxia, a sensory and a motor type. He notes that:

> With the sensory type, the child does not apparently understand the motions he wants to make and with the motor type he knows what he wants to do but cannot carry out his idea. Perhaps the best description of this condition in children is "clumsiness". I wonder whether the awkwardness referred to by some observers as "double left-handedness" might not be better explained on this basis. In any case, we have found that by special training methods much can be done to help such children. They are constantly under a tremendous handicap because they cannot compete successfully in any sort of athletics, but often they can be taught to do one thing pretty well. In the case of one boy of this type, the athletic master of his school came to me for instructions. I suggested that he pick out one activity which none of the other boys could do well and try to train the boy so that he could excel in that. He chose quoits and after teaching the boy how to pitch horseshoes successfully, he turned him loose among his schoolmates. His success in this one skill was a great lift to his morale. In such cases, training which we have found most promising is based upon the analysis of the more complex activity into the simplest component units. For example, in baseball, you cannot teach a boy how to pitch until you teach him how to stand properly, how to balance his weight, how to get his arm back for a long swing, etc. By separating the pattern which you wish to teach him into units, working on each one separately and finally putting them together in a given sequence, I feel that much may be accomplished for these youngsters. (pp. 267-268)

Orton's comments on remedial strategies are certainly sensible ones that are congruent with task analysis and direct teaching techniques which have been successfully used with awkward children.

ANNELL, (1949)

In 1949, Annell reported on a study where she noticed motor dysfunctions occurring in children with otherwise good intelligence. Of approximately 600 patients between 6 and 17 years (in Uppsala, Sweden), 78 of them displayed motor dysfunction, and 73% of this identified group had normal or above

average intelligence (using the Terman-Merrill method). She attempted to classify these 78 cases into seven categories, the most common being "motor infantilism." She describes an eight year old boy in this category who:

> . . . learnt to dress himself late and still dresses slowly, finding it difficult to do up buttons, and cannot tie his shoe-laces without their coming undone. He has not wanted to learn to ride a bicycle or to skate. . . . His gait is slightly wide-stepped like that of a small child. He is very uncertain when he makes movements without visual control. His speech corresponds to the development in a 14-15-year-old, with a large vocabulary and excellent contruction of the sentences. (p. 906)

In summary, Annell (1949) notes that this boy:

> . . . had the physical development of an 8 year old, the speech development of a 14 year old and the motor development of a 5 year old. In his class at school he is in some respects far ahead of his classmates, but as regards motor activities, he is far behind them and has no normal contact with them. (pp. 906-907)

Annell ended her article with a plea for an interdisciplinary approach to the problem and a call for remediation of these developmental difficulties; a plea that would be echoed by many researchers who were to follow her.

WALTON, ELLIS & COURT, (1962)

In an insightful article on clumsy children, Walton, Ellis and Court (1962) comment on individual differences in skilled movement:

> No two children are exactly alike in physical or in mental constitution, and whereas some children are lithe and graceful in their movements, in others the co-ordination and control of muscular activity is much less efficient; movements, whether simple or complex, are performed with an excessive expenditure of energy and with inaccurate judgement of the required force, tempo and amplitude. Such individuals are often incapable of achieving even an average standard of performance in athletic activities, or of acquiring those skills which depend upon manual dexterity. They should be regarded as having a disorder of movement

which makes them constitutionally "clumsy." (p. 603)

The authors go on to describe five clumsy children and to synthesize their observations by identifying the main features of the clumsiness syndrome.

First, the five children were sufficiently clumsy that it interfered with their day to day activities. "There was an awkwardness in dressing, feeding and walking and great difficulty in writing and drawing and even in copying. Yet there was no defect in the pyramidal, extrapyramidal or cerebellar pathways which control volitional motor activity" (p. 607).

Second, all five of the children were of normal intelligence; "However, in each child there was a marked discrepancy between an average or above average score on the verbal tests of the Wechsler Scale for Children, and a very low score on the performance tests" (p. 608).

Third, three of the five clumsy children had defective articulation. Fourth, the authors suggest that these children might:

> . . . have a defect of cerebral organization. In them it is the pathways concerned with the organization of skilled movement, or with the recognition of tactile and other sensory stimuli, which are poorly organized, rather than those concerned with the recognition of word symbols necessary for acquisition of the ability to read. It is possible that discrete lesions in one or the other parietal lobe were present, but we have no specific evidence to support this. (p. 610)

Finally, the authors make an extremely important observation about developmental clumsiness:

> It is apparent from a study of these cases that it is never possible to distinguish completely apraxia from agnosia, for defects of recognition almost invariably lead to defects of execution. Although there are grades of severity in these developmental disorders of dexterity and learning there is

> no evidence that in our children the defect is a simple abnormality of maturation which is corrected with the passage of time. Their stubborn apraxic and agnostic disorders have persisted over several years of observation and have not been corrected by normal maturation processes although they have been modified by means of patient, understanding, and individual training. (p. 610)

BRITISH MEDICAL ASSOCIATION JOURNAL, (1962)

The question of clumsy children was addressed in a British Medical Association Journal article in 1962. The author reviews the work of Annell (1949), Prechtl and Stemmer (1962), and Walton, Ellis and Court (1962), and stresses the fact that clumsy children are not uncommon. Furthermore, such children can often be characterized as being awkward in movements, "poor at games, hopeless in dancing and gymnastics; a bad writer, and defective in concentration" (British Medical Association Journal, 1962, p. 1665). Furthermore, the article stresses the importance of the early identification of children with movement difficulties because:

> Failure to recognize that the symptoms are genuine and not due to naughtiness may lead to aggravation of the symptoms and so to a variety of behaviour problems, and it means in addition that the children cannot be given the specialized help and support which they need. (p. 1666)

GUBBAY, ELLIS, WALTON & COURT, (1965)

In their 1965 paper, Gubbay, Ellis, Walton and Court describe a group of 21 children who were referred for problems of severe clumsiness coupled with poor school performance. All of these children had cognitive and performance difficulties which could be viewed as forms of apraxia and agnosia without any concomitant cerebral palsy. They note that:

> Unfortunately the clumsy child with no overt neurological

> signs, because of the nature of his disorder, is less easily recognized and usually receives less sympathy and understanding; hence he becomes more diffident in attempting manual skills and is in turn often accused of laziness or misbehaviour or suspected of being mentally dull. The natural outcome is a feeling of frustration, often leading in turn to a behaviour disorder which aggravates the child's problems of learning and performance. (p. 295)

They go on to note that the aetiology of the syndrome may be due to "inadequate establishment of cerebral dominance, de[illegible] maturation, and structural lesions in one or the other pa[illegible] lobe" (p. 311). They also recommend that the syndrome of clumsiness be more widely discussed and remedial strategies be developed to ameliorate it.

FORD, (1966)

In 1966, Ford used the term "congenital maladroitness" to describe children who are mentally normal, but slow in developing skills, and appear lazy. They avoid games because they cannot compete with their peers:

> They are slow to walk, slow to learn to tie shoe laces and to dress themselves. They cannot ride a bicycle nor play baseball. I have observed this condition more often in boys than in girls. Some of these children are lazy and dislike to exert themselves. They usually become obese. Others are intellectually inclined and spend most of their time reading. In some instances, the child avoids outdoor games because he finds he cannot compete with other boys of his age and gets so discouraged that he stops trying. Some children make persistent efforts to improve their athletic skill despite their handicaps. These children may acquire strong muscles but the other children, who take no exercise, have flabby, poorly developed muscles. (p. 50)

He goes on to describe the problems these children often encounter with skilled activity:

> It is of interest that having spent much time and effort in learning a certain activity, such as riding a bicycle, the child may eventually perform normally. Certain games, such as baseball and basketball, in which highly co-ordinated movements must be made in rapid succession are always beyond

> the capacity of these children. They are usually not handicapped in adult life for they choose a business in which muscular co-ordination is not important.
>
> The real defect seems to be difficulty in learning complex motor reactions. Possibly this is a developmental defect. Lack of proper exercise plays an important role which is probably secondary in most instances, however. (p. 50-51)

Ford was one of the first authors to link physical awkwardness with low physical vigor or fitness. His observation on the task demands of culturally-normative activities is a also an important contribution to the concept of physical awkwardness.

BRENNER, GILLMAN, ZANGWILL & FARRELL, (1967)

Brenner, Gillman, Zangwill and Farrell (1967) found similar findings to those of Walton et al., (1962) and Gubbay et al., (1965). They believe that the developmental apraxic-agnostic syndromes are more common than generally supposed. The authors note that only one of the 810 schoolchildren in their study had been previously referred for specialized help:

> Yet most of these children had for years been regarded by their parents as abnormally awkward or clumsy, and by their teachers as untidy, difficult and irritating. In spite of mounting problems at school, none had been referred to the educational psychologist or the child-guidance services. (p. 261)

The authors found children with visuo-motor handicaps to experience more problems than children without these handicaps:

> Handwriting was always poor, and two children were backward in reading. . . . As might be expected, the children in the two groups differed greatly with regard to interests and hobbies. In the control group 11 children enjoyed model making, carpentry, jigsaws, or, in the case of girls, knitting or sewing; in the experimental group, on the other hand, not a single child enjoyed any of these activities. Only one child in the experimental group, as compared with eight children in the control group, was reported to be proficient at games.
>
> Ratings by teachers of a number of personality traits revealed marked differences between the two groups. Whereas

> [redacted]e was little difference in the case of traits such as concentration or persistence, most children in the experimental group were regarded as clumsy, awkward, untidy, and inept on the sports field. Two were rated as overactive. Most of these children tended to be described by teachers as particularly irritating, difficult, lacking in self confidence, and unpopular with their peers. (p. 261)

Brenner et al., (1967) stress the necessity for early detection and management of apraxic and agnostic children. Furthermore, they believe "it should be added that research into the degree to which the disability may be overcome, or compensated, by appropriate training is urgently needed" (p. 261).

REUBEN & BAKWIN, (1968)

In 1968, Reuben and Bakwin described a syndrome of behaviour that they called developmental clumsiness or developmental apraxia. Again, they based their syndrome on their own clinical observations and on a review of the literature on the subject. The striking feature of the clinical syndrome was clumsiness which was "severe enough to interfere with everyday activities such as dressing, feeding, playing games requiring motor skills and the like" (p. 606). Dysgraphia (poor handwriting) was usually part of the syndrome along with fine motor performance difficulties on the Goodenough Draw-a-Person Test and the copying of simple geometric forms. Furthermore, the children often had articulatory speech defects and a much lower score on the performance portion of the Wechsler Intelligence Scale for Children (WISC) than they had on the verbal one. Reuben and Bakwin also note that more boys are usually affected than girls and the syndrome usually has:

> A fairly severe emotional overlay frequently (acc[redacted]panying) the clumsiness. Feelings of inadequacy and loss of self-

> esteem are prominent. Schoolwork suffers because the child is unable to write his assignments satisfactorily or complete examinations on time. Exclusion from games requiring motor skill is another source of unhappiness. Furthermore, the awkward child is a frequent butt for teasing. (p. 607)

The authors include a number of case histories, one of which describes a 10 year old boy with poorly lateralized dominance who was referred for a neurologic examination because of poor coordination, speech defect and scholastic difficulties, particularly in reading and spelling:

> In spite of his clumsiness, speech problem and insecure manner he had a number of friends with whom he played regularly. He was not adept at sports and managed to keep up with group activities. For example, in summer camp he regularly "struck out" and missed ground balls and flies in the field. As a result, he was usually made the umpire. He did better in swimming and running, although he did not appear agile. He was never able to tie his shoelaces adequately and had trouble using a knife at the table. (p. 608)

It is interesting to note that Reuben and Bakwin recommend that the management of this developmental syndrome should include reassurance to the parents that it is not caused by minimal cerebral damage. They stress the value of decreasing demands for perfection in handwriting and motor skills and recognize that these children will be able to learn simple motor skills that require one to organize one's own kinematic pattern without having to respond to fast changes in the environment as is needed in ball games. They note that the "syndrome is distinguished from the cerebral damage syndrome, with which it is often confused, by the absence of a history of cerebral trauma or disease and by lack of abnormal neurologic findings" (p. 610).

Like Brenner et al., (1967) Reuben and Bakwin stress the emotional and social difficulties associated with developmental

clumsiness.

ILLINGWORTH, (1968)

R.S. Illingworth, a distinguished British paediatrician, also contributed to an understanding of physical awkwardness. In a classic article on delayed motor development, he, like others before him, reports on the clinical manifestations of clumsy children:

> These children present with the complaint that they are always falling; they walk into objects; they knock objects over; misjudge the width of the doorway; can't jump like a 3-year-old or hop like a five-year-old; they write badly, holding the pencil in an odd way, with the paper at an unusual angle, often with the tongue protruding and unwanted movements in the other hand; they throw a ball badly; have trouble with buttons, shoe laces and needle threading; there may be difficulty in right-left appreciation; and there is often associated over-activity, impulsiveness and defective concentration. The problem causes considerable difficulty at school, particularly if the child is thought by the teacher to be just naughty. (1968, p. 577)

Illingworth deals with the myriad of reasons why a child might exhibit skill difficulties. He notes that clumsiness:

> . . . is commonly an indication of really minimal cerebral palsy of the spastic, athetoid or ataxic type. The symptom may be an emotional problem, and emotional problems may aggravate some degree of clumsiness of organic origin. The child is expected to be clumsy and awkward, and therefore he is clumsy. Clumsiness may be due to a persistence of mirror movements and, rarely, to the Klipple-Feil syndrome or part of familial dysautonomia. (p. 578)

Illingworth stresses the importance of a "careful developmental and neurological examination, including tests of manipulative ability, timed performance tests (such as bead-threading, placing pellets into a cup), walking along a straight line or ledge, or standing on one foot" (p. 578). He also notes that delayed motor development may be due to emotional deprivation, lack of opportunity, personality, obesity, and

muscular dystrophy. In conclusion, he notes that "delayed motor development in infants and children is a frequent source of anxiety to parents" (p. 579). He stresses that such delays may be due to normal variation or be a familial feature; however, he recognizes the need for comprehensive developmental assessment which may require a prolonged examination in order to reach an accurate diagnosis.

BAKWIN, (1968)

Reuben and Bakwin's (1968) article on developmental clumsiness appeared in an important issue of The Pediatrics Clinics of North America. Harry Bakwin was the editor of that issue and made a number of important points about developmental syndromes in his Foreward to it. Bakwin (1968) stresses that:

> The developmental behavioural syndromes differ in two ways from those due to cerebral damage: first, in the developmental syndromes there is no history of a damaging injury to the brain; and secondly, no neurologic signs are demonstrable. Suggestive evidence in favour of a diagnosis of a developmental disorder is a history of developmental deviations in the near relatives, but this must be carefully evaluated, since developmental deviations are widespread.
>
> The developmental disorders are unrelated to general intelligence. They are seen in children with high, average and low intelligence. Boys are affected several times more often than girls.
>
> In some of the developmental disorders a marked emotional overlay dominates the clinical picture. Children with developmental dyslexia are usually brought to the physician because of behavioural symptoms rather than for their difficulty with reading. Children with developmental clumsiness are unhappy because their school grades suffer, owing to poor handwriting, and because of ineptness in sports. (p. 566)

Bakwin's points on developmental syndromes are important in our consideration of the syndrome of physical awkwardness. First, he recognizes that such syndromes have no history of brain damage or no neurological signs associated with them. Often they may be

associated with a familial history of developmental delay. Furthermore, they are generally not related to the level of intelligence of the person. However, usually there is a marked emotional overlay due to the social consequences of the syndrome.

GORDON, (1969)

Neil Gordon, a consulting neurologist began his article (1969) as follows:

> The clumsy child has always been a figure of fun and is likely to be unhappy at school. He is always falling down and is constantly dropping things. Performance at most games is poor and this is not compensated for in the classroom, because writing is illegible and behaviour difficult. (p. 19)

He goes on to note that such children often have had a high incidence of complications before, during, and after birth; however, routine medical examinations usually reveal few abnormalities; in fact, cerebral palsy and other neuromuscular disorders can often be quite easily ruled out leaving developmental rather than organic causes at the heart of the problem. Gordon notes that clumsiness is often associated with mental retardation; however, there is still a considerable percentage of children of normal intelligence who exhibit movement difficulties. Children with speech difficulties, especially articulatory ones, are often clumsy; and children who are clumsy often have difficulties with handwriting. Furthermore, he stresses the need for a screening test to identify these children as early as possible in order to minimize the social and emotional consequences that usually emerge from such a developmental problem.

Gordon (1969) suggests that:

> . . . clumsiness of movement may be mainly the result of a sensory or a motor disability or, more likely, a mixture of both. In acquiring new motor skills anyone is likely to be clumsy to begin with and only repeated practice will overcome this and develop the physiological mechanisms that underlie the ability to execute a particular movement. If clumsy children suffer from a faulty development of those mechanisms which build up the patterns and memories of movements essential for performance of any motor function, surely "repetition" must be a guiding light in the management of these children. Whatever movement is particularly difficult for a child, whether it is running, tying up shoe-laces, writing neatly or recognizing and copying shapes, must be attempted again and again. To begin with it may be necessary to break down a particular skill into simpler parts so that they can be taught separately and then recombined into the whole. Making this sufficiently interesting to the child and suitably rewarding success may be the major contribution of the remedial teacher. Showing the child ways in which he can circumvent his disability can also be of particular importance. (p. 20)

Many of the above recommendations were made by professionals working with clumsy children; however, Gordon was the first to appreciate the importance of how professionals might be able to help a clumsy or physically awkward child avoid the behavioural and social consequences of his or her developmental disability. His recognition of the importance of targeting specific skills for instruction and practice, echoes the earlier recommendations of Orton (1937) and underscores the importance of prescribing skills for instruction for awkward children that will be of the most benefit to them.

DARE & GORDON, (1970)

In a subsequent article, Dare and Gordon (1970) note that children with movement difficulties may be thought to be of low intelligence; however, it is only when a child's:

> . . . clumsiness is out of context with his chronological age and overall level of intelligence will a specific type of developmental disorder be considered. In clumsy children motor development is delayed and the child does not learn

> tasks such as doing up buttons or tying shoe-laces at the appropriate age, is always dropping things and is falling, and has difficulties in taking part in games, in writing, even in copying. (p. 178)

They go on to note that such movement difficulties:

> . . . almost inevitably lead to the child's failure and consequent disappointment and frustration at school. It is not therefore surprising that many of these children have emotional and behavioural problems such as inability to concentrate, rapid swings of mood and unrestrained behaviour generally. (p. 178)

They stress that children with visuo-motor disabilities need special help as early as possible if secondary emotional and behavioural disorders are to be minimized.

Like others, they stress that developmental clumsiness in some cases may be due to some form of cerebral insult:

> However, in other cases the clumsiness may be unassociated with brain damage, and there is some danger of classifying children under a particular term when their disability may be due to various causes or when one category may overlap others and occur at different levels of intelligence. (p. 178-179)

They report a number of case histories that they have dealt with at Children's Hospitals in Manchester, England. Most of the children were referred due to complaints by parents. However, the performance-verbal discrepancy on the Wechsler Intelligence Scale for Children often was found to be a useful diagnostic indicator. Nineteen of the 35 children (16 boys and only 3 girls) were within the normal range of intelligence "and their clumsiness was considered to be due to a specific developmental disorder" as illustrated in the case histories they reported (Dare & Gordon, 1970, p. 179).

Dare and Gordon (1970) report that a 10 year old boy was fairly typical of these children, in that:

> His balance has always been poor, he had often fallen and was a bad runner. Throwing or catching a ball was still obviously difficult for him and his parents spontaneously commented on his poor hand-eye co-ordination. He was very slow in learning to tie his shoe-laces and in showing a preference for one hand, though he is now right-handed and right-footed. Speech had never been any trouble but his writing was very untidy and slow. On examination there were no abnormalities apart from the clumsiness of movement. He could hop quite well on both feet and the electroencephalogram was normal. His overall IQ on the Wechsler Intelligence scale for children was 113 with a verbal IQ of 116 and a performance IQ of 107; on the Stanford-Binet Form L his IQ was 101. This boy was under considerable pressure at school to obtain a place in a grammar school and this may have accentuated his difficulties. (p. 180)

The authors go on to describe two other groups of clumsy children; namely, those who were also found to be mentally handicapped and those who showed evidence of cerebral palsy.

Dare and Gordon (1970) again stress the need for school based tests to identify such children. They note that standard neurological examinations "may miss the fairly subtle derangements of these clumsy children" (p. 181). Furthermore, they note that:

> . . . there are some children whose clumsiness appears to result from a failure of sensory organization and others who are clumsy in spite of few or no perceptual difficulties. The latter seem to lack the ability to build up the patterns of movement essential for the smooth performance of any motor function. (p. 182)

They stress that remedial strategies for these children must "take into account the many component functions of perceptual motor performance" including those of sensory organization and perception as well as the more expressive functions (p. 182).

In a section on advice to parents, Dare and Gordon (1970) reiterate Gordon's (1969) earlier point on the importance of considering which skill should be prescribed for instruction.

They recommend that professionals "explain that constant practice will probably improve his performance, but there may be some activities which are worse than others and which will need to be circumvented. Progress may be slow at first but can be expected to get quicker" (p. 183).

GUBBAY, (1975)

In 1975, Gubbay published an excellent monograph on developmental clumsiness. He included an extensive review of the literature on the subject and provided the following definition:

> . . . the "clumsy child" is to be regarded as one who is mentally normal, without bodily deformity, and whose physical strength, sensation and co-ordination are virtually normal by standards of routine conventional neurological assessment, but whose ability to perform skilled purposive movement is impaired. This type of clumsiness is designated by the neurological term apraxia. (p. 39)

Gubbay notes that using the adjective "developmental" denotes the fact that the condition is congenital or one that is acquired early in life.

Furthermore, he notes that:

> The word "clumsy" does not have sufficient precision to be acceptable as a scientific neurological term, because clumsiness may be the end result of a large number of differing neurological defects. However, it can be a most useful expression in conveying the message to parents and teachers alike, provided its lack of specificity is fully appreciated. (p. 40)

Gubbay goes on to note that the terms "apraxic" and/or "agnosic ataxia" may also be used to describe the condition. He notes that "it is difficult to determine the arbitrary point in the scale below which a child might be regarded as clumsy" (p. 40); hence, a profile analysis of each child's performance will be needed. However, he stresses that:

> Ultimately it can only be a matter of opinion as to whether a particular child's clumsiness is a problem, for it depends upon the relative standards of his environment as well as its competitiveness. A particular child's indexterity only becomes a problem when it results in failure to satisfy his particular environmental requirements. Nevertheless, arbitrary standards of motor performance are necessary for the broad assessment of individual children or for screening large groups of children such as entire school populations. (p. 40)

Gubbay makes a number of other observations on the plight of clumsy children. He notes that many of them have a family history of clumsiness and the more severely affected ones usually have a history of perinatal abnormalities. They have often been slow to acquire developmental motor milestones even though the delay is usually not too great. A degree of clumsiness is noted when the child first learns to walk; however, once the child enters kindergarten or pre-school programs, their lack of proficiency is more noticeable. The problem is the most difficult during the elementary school years when "the child is increasingly expected to look after his own personal needs at home as well as to cope with the demands of motor skills both within the classroom and on the playground" (p. 43). He also notes that difficulties with eating properly, dressing quickly, and of handling self-care skills like brushing one's hair and teeth may also be a source of frustration to both the child and his or her parents.

Gubbay notes that developmental clumsiness may also result in social difficulties:

> A sense of failure and frustration besets the clumsy child who may have to content himself with television despite parental pleas to interest himself more in physical activities. If intellectually inclined he may sublimate these problems by retiring to his bedroom with a book, perhaps to the exclusion of playing ball games with his

> friends at the park. With the consequent prejudice of his popularity he may be forced to withdraw even further from desirable contact. (p. 44)

Gubbay makes a number of important observations on the problems that sport and physical education bring to these children:

> Compulsory sporting and gymnasium periods are anticipated with increasing apprehension and a child may repeatedly invent ingenious excuses such as illness and other indispositions to avoid being the butt of ridicule by his peers. When involved especially in team ball games, his sense of self-depreciation may be heightened by the failure of his team caused by his fumbling and innacurate throwing. Perhaps his only recourse might be to act the fool as a cover in order that others may think he is not really trying his best; consequently as he gets older he may undersell himself in other spheres of endeavour which may not require physical skills. The truancy record of these children tends to be worse on days when sport is played at school. (p. 44)

Gubbay completed an extensive survey of clumsy children aged 8 to 12 years in British schools. A total of 992 children were screened. A teacher's questionnaire, a screening examination questionnaire, a questionnaire for parents, a neurological and general medical examination, and an electroencephalogram formed the basis for data collection on the clumsy and control children. Details of the results are provided in Gubbay's (1975) monograph; however, the results strongly support the observations that Gubbay made on the characteristics of clumsy children outlined above.

HENDERSON & STOTT, (1977)

In a very important article, Henderson and Stott (1977) report on the development of a test of motor impairment. They note that many clumsy children experience "rejection by adults, unpopularity with peers, frequent truancy, failure in other school subjects, and feelings of depression, inadequacy,

aggression and unhappiness" (p. 38).

They note that no acceptable test of motor impairment had been developed and no suitable school programs to handle this serious developmental problem had been established. In their article, they report on the development of a test of motor impairment that they feel can be of use to parents and teachers who wish to help children with movement difficulties.

The authors report that Stott (1966) based the original edition of the test on the earlier work of Oseretzky (1948). However, only 35% of the items on the Stott, Moyes, and Henderson (1972) revision of the test were from Oseretzky's original test items. They also note that a number of factors had to be considered in the development of this test of motor impairment. These included practical requirements designed to facilitate the use of the test by professionals in the field such as: a limited time for administration, usually less than 15 minutes; simple, clear instructions; and, minimal equipment and facility space.

The authors discuss a number of factors that affected the items which they included in the test. First, inasmuch as the test was designed to primarily assess one's motor impairment, the authors tried to minimize "perceptual, cognitive and emotional factors which might affect performance" (p. 39). They also attempted to make the test items "simple enough to be understood by children of IQ 50 and over" (p. 39). In doing so, they also recommended that "the tester should make sure, by such explanation and demonstration as are necessary, that the child understands the requirements of each task and is willing to cope

with it" (p. 40). Furthermore:

> In order to further reduce the influence of perceptual and cognitive factors, test items were framed in such a way that they made no great demands on the child's ability to solve spatially complex problems or to remember complex directions. (p. 40)

The authors also attempted to minimize the cultural and experiential differences in their test. Cultural differences were "minimized by providing a wide range of different tasks within each area of function" (p. 40), while experiential differences were more difficult to deal with. On their attempt to minimize experiential differences, the authors note that:

> Judging space and distance is largely a matter of experience yet cannot be taken out of the test tasks because it is as much an integral part of motor behaviour as the cognitive and emotional factors mentioned earlier. To discount this factor we have had to rely upon all children having had the experiences necessary for making the space and distance judgements required in the test. The only activities which may not fully meet this criterion are those of catching and throwing a ball. These tasks seemed so revealing of motor dysfunction that they have been retained despite our qualms. We have tried to counteract the effect of previous experience in this activity by a generous practice allowance, which has the effect of permitting the child to become familiar with and practice the activity within the particular distance or space used in the test. (p. 40)

Henderson and Stott also report that they attempted to minimize sex differences in motor performance; however, "this necessitated the choice of items which give neither sex an evident experiential advantage or an advantage based on differences in size or weight" (p. 41). The authors go on to note that the factor analytic studies of the Oseretzky Test usually resulted in rather diffuse factors that did not conform to Oseretzky's original six areas of function (Thams, 1955; Vandenberg, 1964). They report "that individuals can be neurologically impaired in specific areas; indeed a

characteristic of neural dysfunction, as observed clinically, is its heterogeneity and relative uniqueness. Motorically one finds children who have fine and not gross impairment and conversely" (p. 42).

The authors also report on the criteria they used for passing and failing the test. They decided to set the failure point at:

> . . . a level of impairment which would begin to be a handicap to a child in his everyday life, whether it be his ability to play the games of his age-group, avoid accidents to himself or the objects he comes in contact with, or develop manual skills such as writing or using tools. (p. 43)

The authors conclude by noting that their test could be used as a screening instrument, a test of individual assessment, a measure of motor dysfunction which correlated with different behavioural disturbances, and as a technique to increase our understanding of motor function and dysfunction.

Clearly, Stott and his collegues by developing their test of motor impairment made a major contribution to the identification and evaluation of clumsy children. However, as a more complete understanding of physical awkwardness emerges, especially in relation to its socio-cultural context, we may wish to examine some of the premises upon which the Stott, Henderson and Moyes Tests (1972) are based.

McKINLAY, (1978)

Ian McKinlay, a Manchester neurologist, described clumsy children as those:

> . . . children without frank neurological disorder whose postural, balancing or manipulative faculties fall outside the normal range for their age. It may be used better to

> describe those whose motor co-ordination lags, at least in some respects, by two years or more behind their general developmental level at that time. Thus there is a full range from clumsy gifted children to clumsy mentally handicapped children. Their predicament, which often includes gauche behaviour and ineptness at games, with consequent difficulty in making friends, can lead to loss of self-confidence to such an extent that such children will not attempt activities of which they are capable. (1978, p. 494)

McKinlay calls for remedial strategies to deal with the plight of these children. He notes that:

> "Cerebral dysfunction", "neurodevelopmental delay" or "perceptuo-motor disorder" are theological terms of remote interest to the agnostic, who would nonetheless be quite happy to teach a clumsy child to swim or dance or make bread. Brain damage may be dismissed as a forlorn medical matter, yet the prescription would be a bicycle, cassette recorder, hill-walking or a typewriter. One wonders how much the Olympic athletes and their coaches know of dendritic spines, yet improving performance by technique and encouragement is an accepted and measurable everyday event. (p. 494)

He goes on to stress the importance of remedial physical education classes, sensorimotor training programs, and the careful selection of leisure time activities for these children.

GUBBAY, (1978)

Gubbay (1978) reports that 39 children were referred to the Princess Margaret Hospital in Perth, Australia, for neurological assessments due to clumsiness of the limbs or gait from 1966 to 1978. They report that "there were varying degrees of awkwardness of handwriting (25 children), sporting activity (20) or schoolwork (18); and 13 of the children had speech difficulties and five were dyslexic. There were associated behaviour problems in 25 of the 39 children" (p. 643). The children ranged in age from five to 12 years, and there was a 2:1 male-female ratio.

The authors report that 36 of the 39 children were definitely apraxic (defects of motor planning) and 12 of them were agnostic (defects of visuospatial recognition). The clumsy children also exhibited poor performance on the following battery of four motor ability tests: clap-then-catching a tennis ball, rolling a tennis ball underfoot, threading 10 beads, and inserting differently shaped objects into slots.

The authors call for an interdisciplinary approach to the diagnosis and management of such children and stress the need for early identification of the problem.

KEOGH, SUGDEN, REYNARD & CALKINS, (1979)

Keogh, Sugden, Reynard and Calkins (1979) in an article on the identification of clumsy children define clumsiness as a problem of inadequate movement performance. Following Morris and Whiting (1971), they view clumsiness "as maladaptive behaviour in relation to expected or required movement performance" (p. 32). Keogh and his collegues suggest that:

> Performance inadequacies or movement tests will provide an initial indication of movement skill problems, but detailed and systematic observations of clumsy children also are needed to identify the nature of a child's problems. Inability to perform a movement adequately is the general indication of clumsiness; how a child attempts a movement can provide clues about the problems a child is having. (p. 33)

Thus, they stressed the need for both quantitative performance measures and qualitative observation if we wish to accurately identify, evaluate, and prescribe remediation for, clumsy children. In an attempt to improve assessment and identification procedures, they conducted a study of kindergarten children in which clumsiness was measured by the following three procedures:

a movement performance test, a classroom teacher checklist, and an observation scale administered by trained physical educators. The authors report that the three procedures identified different sets of boys as being potentially clumsy. Furthermore, the procedures did not identify 20% to 30% of boys who had been characterized as having movement problems.

The authors note that the:

> . . . identification of individuals as extreme on a particular characteristic should be a multiple measurement process. Also, group statements of relationships or correlations between measures are not sufficient to determine agreement in identifying individuals at extreme ends of the distribution. Only a direct comparison of individuals identified by each measure will indicate the extent of agreement. (p. 38)

Commenting on the nature of clumsiness, the authors note that the children were better able to control movements relating to movements-for-self than movements involving other persons and objects. They also point out that some clumsy children conceal their movement difficulties by deliberately engaging in disruptive behaviours while other children are inappropriately identified as clumsy because of their disruptive behaviour.

HULME, SMART & MORAN, (1982)

In a more recent study of clumsy children Hulme, Smart, and Moran (1982) examined visual perceptual deficits in clumsy children. Basing their definition of clumsy children on the earlier work of Gubbay (1975) and McKinlay (1978), they defined clumsy children as "a small group who experience severe difficulties in developing adequate skills of movement which cannot be explained in terms of gross sensory defects or general intellectual impairments" (p. 475).

In an earlier study, these authors had found clumsy children to have had significant deficits in visual, kinaesthetic and cross-modal judgements of length, as well as low scores on the spatial subtests of the WISC. Inasmuch as "variations in motor skill correlated with performance on the visual perceptual measures but not the kinaesthetic or cross-modal tasks" (p. 475), the authors hypothesized that clumsiness may be caused by an impairment of visual perception.

Using a set of four motor performance tasks developed by Gubbay (1975) and a skipping task, the authors found that the 12 clumsy children were significantly poorer on these tests than their 11 year old age-matched controls. Furthermore, the clumsy children had considerably more difficulty visually perceiving the length of straight lines than did their age-matched peers. They also showed this discrepancy when the stimuli were presented sufficiently fast enough to rule out eye-movement difficulties as the source of their visual-perceptual deficits.

HENDERSON & HALL, (1982)

Henderson and Hall (1982) in an article on the concomitants of clumsiness note that the concept of developmental clumsiness had been used for approximately 50 years. They contend that the term clumsiness, at least in the medical literature, has been used to identify a specific group of children whose dominant characteristic is "exceptionally poor motor co-ordination" (p. 448). However, the authors go on to state that:

> . . . there is little evidence to support this notion. Although some children labeled as "clumsy" do appear to have an exclusively motor problem, such cases are relatively rare. More often, detailed analysis reveals a wide range of

> disorders and dysfunctions, with poor motor co-ordination being but one component. (p. 448)

In order to examine the above hypothesis, the authors conducted a study of 400 infant school children in four schools. The 20 teachers participating in the study were asked to identify any child in their classroom:

> . . . whom she considered (a) had poor motor co-ordination for his or her age and (b) whose lack of co-ordination was significantly affecting school progress. It was emphasised that academic or behavioural difficulties were not to be a reason for inclusion if there was no evidence of motor impairment. (p. 449)

The teachers identified 20 such children; however, only 16 of the children were able to participate in the subsequent testing.

The authors administered the following to the children: a neurodevelopmental examination and medical history, a children's drawing test, and a test of motor impairment (Stott, Moyes, & Henderson, 1972). Henderson and Hall report that the 16 clumsy children were a heterogeneous group with a wide range of scores on each of the measures. However, careful analysis of the test results indicated that three groups emerged: A group of five children with above average intelligence who were competent in both reading and arithmetic and who seemed to have an isolated motor impairment problem, a second group of 5 children whose motor difficulties were associated with numerous other problems along with fairly low IQ scores, and a remaining group of six children with mixed difficulties.

The authors report considerable agreement among the children identified by the teachers and the subjective assessment of the paediatrician. Furthermore, unlike other studies (Gubbay, 1975;

Keogh, et al., 1979), there was remarkably high agreement on the scores received by the clumsy children on the various objective measures used in the study. The authors conclude by suggesting that "the primary recognition of motor impairment might be safely left in the hands of the teachers" (p. 458); however, the authors do note that "the final proof of the teachers' competence would require an assessment of the number of 'false negative' results, i.e., the number of significantly motor-impaired children not detected by the teachers, but this was not feasible in our study design" (pp. 458-459).

WALL, (1982)

In 1982, Wall used the term "physically awkward" to describe those children who have, for many years, been described as clumsy. In his definition, he excludes neurological insult or defect as a possible cause of physical awkwardness. He stresses that when the motor performance of these children is judged, the skills observed must be ones that would be found commonly in the culture that the child belongs to:

> Physically awkward children are children without known neuromuscular problems who fail to perform culturally normative motor skills with acceptable proficiency. As with all definitions of extremely complex phenomena, we need to clarify a number of ideas that are included in this definition. Culturally-normative physical skills are skills that are generally used within a specific culture by a large majority of people. Skills such as running, jumping, and climbing are culturally-normative in many environments, whereas skills like hitting a cricket ball, and high-kicking a stuffed seal skin are identified with other cultural environments. In North America, the skills of catching, throwing, kicking and hitting a ball, swimming, and in some instances skating and skipping are physical skills that are widely used in play, games, and sports.
>
> . . . Proficiency in skill is characterized by purposeful, planned, accurate, and precise behaviour. Unfortunately, acceptable proficiency is not so readily

> defined. To a large extent, the band-width of acceptable proficiency varies with the age, sex and socio-cultural environment of the person. Even more so, the performance expectations of significant others such as siblings, parents, teachers, and peers certainly influence the standards of acceptable performance. (p. 254)

In discussing the work of Whiting, Clarke and Morris (1969), Wall also notes some of the social difficulties physically awkward children experience. He discusses how reading disabled children can attempt to hide their disability in the classroom situation in a number of ways; however, he goes on to note that:

> . . . if a child fumbles a ball thrown by a playmate, it is obvious to everyone involved. The negative reactions that the child receives may force him or her to withdraw from other group experiences and discourage involvement in play and game situations. In time, the child's peers label him or her as clumsy and exclude him or her from group play situations. Ultimately, the child's lack of motor skill, minimal enjoyment in physical activity and social difficulties within play situations combine to create a disinterest in physical activity and a corresponding low level of physical fitness. (p. 255)

Wall (1982) also stresses the seriousness of the syndrome of physical awkwardness, the importance of accurate identification processes through professional evaluation, and finally, suggests a number of remedial strategies that might help physically awkward children.

TAYLOR, (1982)

Using the same theoretical definition of physical awkwardness as Wall (1982), and using an arbitrary operational definition of physical awkwardness, Taylor (1982) examined the incidence of physical awkwardness in both reading disabled and normal elementary school children. The research sample was made up of one hundred and twenty-eight control children and one hundred and twelve reading disabled children. She used a

modified form of the Stott Test of Motor Impairment and found 48 of the 240 children that were tested, or 20 percent to be physically awkward. However, closer examination showed that 27.7 percent of the reading disabled children were physically awkward, whereas only 13 percent of the normal children fell into this category. The three areas where the reading disabled children performed more poorly than the control students were catching, balance, and jumping tasks.

Taylor notes that the reading disabled children had more difficulty than the control group of children in structuring a response to a problem that was presented to them. For example, often, members of the reading disabled group could not differentiate right from left, and therefore had difficulty with ball skills and balance tasks where they were required to use only one or the other. The reading disabled group also demonstrated a considerable lack of skill proficiency The following examples highlight this problem:

> In the throw, clap and catch task, there was a noticeable number of reading disabled children children who did not relate the speed with which they clapped to the increased probability of catching the ball. Frequently they got trapped by a rhythm and stuck with it, even when it was obvious that the ball would hit the floor before they finished clapping. It was also apparent, especially in the board balance tasks, that the method of using arms outstretched and alternating the position of the limbs to maintain balance was not a familiar strategy to these children. (pp. 96-97)

In her conclusion, Taylor notes that the major differences between the two groups of children were in the gross motor area, and were most evident at age eight.

KNUCKEY & GUBBAY, (1983)

Knuckey and Gubbay (1983) completed a follow-up study of 52 clumsy children and their 51 controls eight years after their original assessment in order to assess the difficulties that the children had experienced due to their clumsiness. They defined the "clumsy child" as:

> one who is mentally normal, without bodily deformity and whose physical strength, sensation and co-ordination are virtually normal by the standards of routine, conventional neurological assessment, but whose ability to perform skilled purposive movement is impaired. This type of clumsiness can be considered to be due to developmental apraxia and agnosia and is part of the spectrum of Minimal Cerebral Dysfunction. (p. 9)

Gubbay reported that the clumsy children in his original study (1979) were ". . . significantly inferior to their controls in handwriting, sporting ability, popularity and academic performance, and had a much higher incidence of EEG abnormality" (p. 9). He reports that the children did not receive any educational or remedial intervention between their original assessment and their reassessment. The young adults, 16 to 20 years, were reassessed on five of the original tests that Gubbay had used.

The clumsy children were divided into three groups according to the degree of their clumsiness: mild, moderate, and severe: those with no score below the fifth percentile, one score below the fifth percentile, and two or more scores below the fifth percentile were placed into the above three categories respectively.

The results indicate that whereas the control children were significantly better than the clumsy children on all five tests

when they were originally assessed, they were better on only two tests when reassessed, namely, the clapping and catching a tennis ball and piercing 20 pinhole tests. The authors contend that with time the "controls and clumsy children merged together functionally as they matured" (p. 11). Furthermore, the severely clumsy children were significantly less proficient than the controls on four of the five tests whereas the mild and moderate groups had improved to the level of the controls. The authors conclude by noting that:

> Despite earlier studies suggesting that about six percent of children are troubled by clumsiness in school years, only a small proportion of the clumsy children are likely to be affected by their disability after leaving school. However, it is important to attempt to circumvent the secondary emotional disturbances which may occur in our schoolchildren as the result of clumsiness. (p. 12)

CLIFFORD, (1985)

Working with the same group of children as Taylor (1982), Clifford (1985) attempted to determine the free time leisure pursuits regularly participated in by a group of seven physically awkward children.

Individual and group profiles of the seven physically awkward children were presented. These profiles included information in the following areas: subject characteristic data, motor performance data, psychometric data, neighbourhood recreational activity data, and community-sponsored activity data.

The group was comprised of three males and four females aged 9 to 11. Clifford notes that few of the other marker variables which have been reported by other researchers were displayed by these children:

> No trends were apparent with respect to birth rank, incidence of ambidexterity, discrepancies in intelligence test scores, or feelings of incompetence as measured by the Harter Perceived Competence Scale. A tendency towards being overweight and exceedingly low scores on both the Motor Performance Test Battery and the Motor Performance Rating Scale were noted, however. (p. v)

Furthermore, she notes that:

> The results of the Free[illegible]isure Pursuits Questionnaire indicated that this grou[illegible]ildren participated in a limited number of activities. They preferred individual as opposed to group activities and activities which were low in spatial and temporal task demands. Their few after school playmates tended to be younger than themselves. Although they had all been enrolled in at least one community-sponsored activity, they had a history of quitting these types of activities. (p. v)

In sum, these physically awkward children participated in activities that require minimal skill proficiency. Furthermore, they very rarely participated in team or competitive sport activities.

WALL, McCLEMENTS, BOUFFARD, FINDLAY & TAYLOR, (1985)

In an attempt to develop a more comprehensive understanding of the syndrome of physical awkwardness Wall, McClements, Bouffard, Findlay, & Taylor (1985) present a Knowledge-Based Approach to motor development with direct implications for the physically awkward.

Wall et al., (1985) stressed the different types of knowledge about action that children acquire as they develop, and provided a comprehensive overview of the consequences of inadequate skill development.

The authors stress that possibly the most significant feature of skilled action is its consistency and stability over time. They note that "skilled action is characterized by the

performer's ability to predict, plan, and execute movements in response to changes in the performance environment" (p. 22).

Wall and his colleagues believe that children develop four major types of knowledge about action, and that this knowledge will largely be determined by the structural capacity and past experience of a person. The four types of knowledge are: procedural, declarative, affective, and metacognitive.

"Procedural knowledge about action refers to the storage of action schemas that control the cognitive and motor processes that are responsible for the execution of skilled actions" (Wall & Taylor, 1984, p. 162). Through mental and physical practice, the procedural knowledge associated with a skill becomes automatized so that it frees the learner to deal with changing aspects of the performance environment.

"Declarative knowledge about action refers to the factual information stored in memory that will influence the development and execution of skilled action" (p. 30). The authors suggest that this declarative knowledge about action is "continually modified and restructured into coherent packets of knowledge that can influence conceptually-driven thinking about action. During infancy, declarative knowledge about action is non-verbal, but as children develop knowledge about action, they start to use language to describe their actions. Through the process of play, their level of declarative knowledge about action increases and becomes an important base through which to classify, categorize and eventually consciously control movement.

Affective knowledge about action refers to the subjective feelings which children attach to their performance of motor

skills. Wall et al., stress the importance of success in physical activity and the resulting movement confidence and positive self-concept that this success can create. Conversely, they contend that "learned helplessness" is a common feature amongst children who continually fail in activities requiring physical proficiency (Gibson, 1982). The authors describe this learned helplessness as being characterized by "a lack of motivation, minimal persistence in the face of difficulties, and a general apathy to involvement in challenging situations. Negative feelings of competence and confidence can have major effects on the motivational state of a learner" (p. 30). They also note that affective knowledge about action can greatly influence the acquisition of procedural and declarative knowledge about action.

Metacognitive knowledge about action refers to our overall understanding of declarative, procedural, and affective knowledge; that is, the knowledge we use to determine whether or not we are capable of performing a skill. "In a sense, it is a higher type of declarative knowledge about action that develops as children become consciously aware of what they can or cannot do in thousands of action situations (p. 31-32). Furthermore, "as children grow older, they use such metacognitive knowledge about action to improve their ability to learn in problem-solving situations" (p. 32).

The authors discuss the syndrome of physical awkwardness and note the implications that an "inability to proficiently execute culturally-normative motor skills" can have for physically awkward children. They contend that physically awkward children

are clearly behind their peers in their possession of procedural knowledge, and stress the importance of developing techniques of measurement and evaluation that can adequately assess their true capabilities in this domain. They note that some of the motor performance tests that are currently used are relatively simple ones which do not reflect the level of performance that children must have to successfully be involved in sport and physical activity.

The authors note that a striking characteristic of physically awkward children is their difficulty in the affective domain:

> Their lack of interest in physical activity, their low self-esteem and confidence in movement situations, and their lack of persistence in challenging action situations reflect their metacognitive knowledge of their difficulties in the procedural, declarative, and affective domains. Again, assessment techniques that reflect these constructs should be created; more importantly, remedial strategies to overcome them need to be developed. (p. 38)

Wall and his colleagues discuss the negative implications that being socially rejected from physical activity can have for these children. They also suggest that withdrawal from physical activity can result in lower than normal levels of physical fitness. Unfortunately, this lower level of fitness may set the scene for a lifetime of non-challenging, non-physical, leisure time activity in these individuals. Clearly, this contention requires further research which should be completed as soon as possible.

PHYSICAL AWKWARDNESS - A SUMMARY ANALYSIS

The above review of the literature demonstrates that there has been continued interest over the past sixty years in the

problem of physical awkwardness or as many authors have called it, clumsiness.

In order to examine some of the common themes associated with the problem of physical awkwardness, a summary review of the literature was completed under four major headings: the definition of physical awkwardness, the syndrome of physical awkwardness, the developmental indicators of physical awkwardness, and remedial strategies for these children. Tables I through IV present a summary analysis of key points related to the above four aspects of the problem. In order to reflect the degree to which different authors have handled the various aspects of the problem, the following summary system was used:

1 = the concept is alluded to in the article,

2 = the concept is mentioned in the article,

3 = the concept is supported by empirical evidence in the article.

The basis for the summary analysis is the definition of physical awkwardness and the description of the syndrome which Wall (1982) outlined. The developmental indicators and remedial strategies to ameliorate the problem emerged from an analysis of the literature.

Table I presents the summary analysis related to the concepts which have been used in defining the problem of physical awkwardness. As Table I shows, there has been considerable agreement over the years that physical awkwardness or clumsiness refers to individuals who are cognitively competent, and who have no known neuromuscular involvement. In those cases where authors have included children with neuromuscular problems they have

Table I

Physical Awkwardness - 60 years of Definitions

AUTHOR (S)	Neuromuscular Invlovement	Cognitive Competence	Culturally Normative Demands	Degree of Proficiency	Unclear Aetiology	Term
McKenzie (1926)			2	1		
Orton (1937)		Average	2	2	2	Dev. Apraxia
Orton (1946)	None			2	2	Dev. Apraxia
Annell (1949)		Avg. to Below	2	2	2	Motor Infantilism
Brit. Med. Jnl (1962)	Some C.P.	Average		2	2	Clumsy
Walton et al., (1962)	None	Average	2	2	2	Dev. Aprax/Clumsy
Gubbay et al., (1965)	None	Average 3	2	2	2	Clumsy, Aprax/Agnos.
Ford (1966)	None	Average	2	2		Congen. Maladroitness
Brenner et al., (1967)	Some	Average	2	2	3	Clumsy
Reuben & Bakwin (1968)	None		2	2	2	Apraxia
Illingworth (1968)	Min. C.P.	Average		2	2	Delayed Motor Dev't.
Bakwin (1968)	None	Average	2	2		Dev. Clumsiness
Gordon (1969)	Minimal	Average	2	2	2	Clumsy
Dare & Gordon (1970)	Minimal	Average	2	2	3	Clumsy
Gubbay (1975)	None	Average	2	3	3	Aprax/Dev. Clumsiness
Henderson & Stott (1977)						Clumsy
Gubbay (1978)	Mixed	Average	2	3	3	Dev. Aprax/Clumsy
McKinlay (1978)	None	Average	2	2	2	Clumsy
Keogh et al., (1979)	None	Average	1	3		Clumsy
Hulme et al., (1982)	None	Average		3		Clumsy
Henderson & Hall (1982)	Mixed	Below to above Avg.	3	3		Dev. Clumsiness
Taylor (1982)	None	Average	3	3		Physically Awkward
Wall (1982)	None	Average	2	2	2	Physically Awkward
Knukey & Gubbay (1983)	Mixed	Average	3	3	3	Clumsy
Clifford (1985)	None	Average	3	3		Physically Awkward
Wall et al., (1985)	None	Average	2	2	2	Physically Awkward

Note. 1 = Alluded to in article; 2 = Mentioned in article; 3 = Supported by empirical evidence in article.

differentiated these children from those with no organic impairment. Clearly, the authors included in this summary analysis have recognized the fact that awkwardness is directly related to the culturally-normative demands of a child's social milieu. However, it is only in recent years that ecologically-valid test items, reflecting the notion of culturally-normative demands, have been included in quantitative measures and qualitative measures of physical proficiency. It is only in the last ten years that the degree of physical proficiency in such culturally-normative tasks has been empirically measured.

One common problem that emerges from an analysis of the literature on physical awkwardness is the difficulty of finding a cause or causes for the phenomenon. As noted in the column labled "unclear aetiology", nearly every author during the past 60 years has mentioned this problem. Clearly, more work needs to be done in this area.

Finally three terms seemed to have been commonly used to describe physical awkwardness: developmental apraxia, clumsiness, and physical awkwardness. All of these terms can be used interchangeably; however, the term physically awkward seems to be a less perjorative one than the other two terms that have been traditionally used. Furthermore, as Henderson and Hall (1982) point out, the term clumsy is used to describe children with neuromuscular problems and/or developmental disabilities. However, the term physically awkward clearly refers to children with movement difficulties who do not have these concomitant problems.

Table II presents the summary analysis for the different components in the syndrome of awkwardness which Wall (1982) outlined. A brief perusal of the table indicates that social and behavioural difficulties have been mentioned as part of the syndrome for many years. However, it has only been in recent years that empirical evidence has been presented to support the contention that these problems were an actual feature of the syndrome. The recent concept of low self esteem has also been mentioned; but scant empirical evidence is available to support it. Finally, it is only relatively recently that authors have even mentioned the problem of physically awkward children avoiding physical activity and recognizing that such a situation leads to decreased physical fitness. Clearly, more empirical evidence needs to be generated to support all of the purported components of physical awkwardness.

Table III presents the developmental indicators of physical awkwardness that many authors have included in their descriptions of physically awkward children. Clearly, one of the most common indicators has been a general delay in motor development. Late walking and general co-ordination difficulties have often been included with the description of such general delays in motor development. Two other common developmental problems that parents report are handwriting problems and slow dressing. Balance difficulties, a lack of skill in throwing and catching, and problems with gait have also been mentioned; however, the last three were much less common than the first three developmental indicators that are included in the table. Again, better empirical evidence on each of these indicators is needed.

Table II

Syndrome of Physical Awkwardness

AUTHOR (S)	Social Difficulties	Behavioural Difficulties	Low Self Esteem	Avoids Physical Activity	Fitness Level
McKenzie (1926)					
Orton (1937)	2		2		
Orton (1946)					
Annell (1949)	2	2			
Brit. Med. Jnl (1962)		2			
Walton et al., (1962)	2				
Gubbay et al., (1965)		2	2		
Ford (1966)			2	2	obese
Brenner et al., (1967)	3	3	3		
Reuben & Bakwin (1968)	2	2			
Illingworth (1968)		2			obese
Bakwin (1968)		2			
Gordon (1969)	2				obese
Dare & Gordon (1970)	2	2	2		
Gubbay (1975)	3	3	2	2	
Henderson & Stott (1977)	2		2		
Gubbay (1978)					
McKinlay (1978)	2	2	2		
Keogh et al., (1979)	2	2			
Hulme et al., (1982)					
Henderson & Hall (1982)	3				
Taylor (1982)	2	2	2	2	2
Wall (1982)	2	2	2	2	2
Knukey & Gubbay (1983)					
Clifford (1985)	3	2	3	3	
Wall et al., (1985)	2	2	2	2	2

Note. 1 = Alluded to in article; 2 = Mentioned in article; 3 = Supported by empirical evidence in article.

Table III

The Developmental Indicators of Physical Awkwardness

	Delayed Motor Development	Slow to Dress	Writing Problems	Balance	Ball Skills	Gait Problems
McKenzie (1926)						
Orton (1937)			2	2		2
Orton (1946)						
Annell (1949)		2	2			2
Brit. Med. Jnl (1962)	2		2	2		
Walton et al., (1962)	2	2	2			
Gubbay et al., (1965)			3			
Ford (1966)	2	2				
Brenner et al., (1967)	3		3			2
Reuben & Bakwin (1968)	2	2	2		2	2
Illingworth (1968)	2	2	2			
Bakwin (1968)	2					
Gordon (1969)	2		2			
Dare & Gordon (1970)	2	2	2	2		
Gubbay (1975)	3	3	3			2
Henderson & Stott (1977)						
Gubbay (1978)			3			2
McKinlay (1978)	2		2	2		
Keogh et al., (1979)						
Hulme et al., (1982)						
Henderson & Hall (1982)						
Taylor (1982)	2			3	3	
Wall (1982)	2			2	2	
Knukey & Gubbay (1983)						
Clifford (1985)				3	3	
Wall et al., (1985)	2			2	2	

Note. 1 = Alluded to in article; 2 = Mentioned in article; 3 = Supported by empirical evidence in article.

The final phase of the summary analysis is presented in Table IV. As the table shows, nearly every author has called for some form of remediation. However, it is especially interesting to note that it was Orton (1937) who first suggested that progressive instruction on one or two carefully prescribed skills might be the most optimal means by which to help physically awkward individuals.

It has only been in recent years that authors in the field have stressed the need for educating parents about the problem as well as suggesting that there is a need for counselling both children and parents about the implications of and strategies to ameliorate the problem of physical awkwardness.

Incidence of Physical Awkwardness

As can be seen in Table V the incidence of physical awkwardness has ranged from as high as 15% to as low as 4% in school children. In reviewing this incidence data, it is important to remember that each author used very different criteria for the selection of their sample as well as different test items in the performance tests that were used. Wall et al., (1985) identified the need for the development of test batteries that better reflect the culturally-normative performance demands that children now face. Further, more attention must be given to the types of profile analysis that is made in the selection of physically awkward children. The criterion used in this study will be based on a case by case analysis of the scores obtained by each child in relation to the norms of the IBM-University of Alberta Learning Disabilities Study.

Table IV

Recommendations of Remedial Strategies for Physically Awkward Children

AUTHOR (S)	Call For Remediation	Need For Progression	Prescription of 1 or 2 Skills	Need For Parental Information	Need For Counselling
McKenzie (1926)					
Orton (1937)	2	2	2	2	
Orton (1946)		2	2		
Annell (1949)					
Brit. Med. Jnl (1962)	2			1	
Walton et al., (1962)	2	2			
Gubbay et al., (1965)	2			2	
Ford (1966)			2		
Brenner et al., (1967)					
Reuben & Bakwin (1968)					
Illingworth (1968)					
Bakwin (1968)	2			2	
Gordon (1969)	2	2	2	2	2
Dare & Gordon (1970)	2		2	2	2
Gubbay (1975)					
Henderson & Stott (1977)	2			2	
Gubbay (1978)	2	2	2		2
McKinlay (1978)	2	2		2	
Keogh et al., (1979)					
Hulme et al., (1982)	1				
Henderson & Hall (1982)	2				
Taylor (1982)	2	2	2	2	2
Wall (1982)	2	2	2	2	2
Knukey & Gubbay (1983)					
Clifford (1985)	2	2	2	2	2
Wall et al., (1985)	2	2	2	2	2

Note. 1 = Alluded to in article; 2 = Mentioned in article; 3 = Supported by empirical evidence in article.

Table V

Incidence of Physical Awkwardness

Author(s)	Year	Incidence
Annell	1949	8%
Keogh	1966	7% severe 13% moderate
Keogh	1968	7%
Rutter	1970	5% severe 15% moderate
Gubbay	1975	6%
Booth	1976	4% severe 10% moderate
Keogh et al.	1979	9%
Taylor	1982	27% of reading disabled group 13% of control group

The Effects of Physical Activity on Growth

That which is used
develops and that which
is not used wastes away.

- Hippocrates -

Even if it is centuries old, this is a simple, though very powerful and accurate statement when we refer to physical growth of the human organism. Physical activity is necessary to enhance growth. On the one hand it is well known that when a limb is immobilized by a cast, atrophy of the muscles and some reduction in bone density occurs in that limb. On the other hand, research has shown that regular physical activity results in increased mineralization and density of bones (Bailey, 1976). The effects

of exercise by children on body composition, muscle, aerobic power and stature all appear to be positive.

Before reviewing some of the key studies on the affects of physical activity in children, it might be worthwhile to note that the validity of some of the studies has been called into question. Perhaps, the most difficult variable to control in these studies is the question of skeletal maturity. Very few developmental studies have been able to adequately take this important variable into proper account.

This section of the review of the literature will examine the effects of physical activity on stature, skeletal development, body weight and composition, muscle development, and aerobic power in children.

An important objective of this section is to highlight the importance of regular physical activity in the life of a growing child. A review of these studies will be helpful in understanding the relationship among physical awkwardness, physical activity, and physical fitness. The implications of a lower level of fitness will be discussed in the latter stages of this chapter.

STATURE

In the first few decades of the twentieth century, various studies claimed that participation in vigorous physical activity would result in greater than expected increases in stature for children involved in [illegible]ver, 1896; Schwartz, Britten & Thompson, 1928; Adams, 1938). However, one of the major problems of these early studies on exercise and stature was that

they failed to take maturational factors into account.

For example, Astrand et al., (1963), claimed that training (in this case, the training of 30 elite female swimmers) stimulated greater than expected growth in stature. However, Bailey, Malina & Mirwald (1984) note that the swimmers in Astrand's study were taller than average at age seven, and apparently entered adolescence at an earlier age than Swedish reference data for the 1950's. Bailey and his colleagues also suggest that this apparent acceleration in statural growth was not related to the intensity of training, but to the swimmer's somewhat earlier maturation. Clearly, these conclusions cast some doubt on the validity of Astrand's work. Studies by Milicer & Denisiuk (1964), Ekblom (1969), and Eriksson (1972), made similar claims regarding accelerated growth in stature due to physical activity compared to population specific norms. However, again maturity status was not controlled, and the results may have been completely confounded by the adolescent growth spurt.

In contrast to the findings of the above authors, data by Kato & Ishiko (1966) suggest that excessive compressive forces can retard epiphyseal growth of the lower extremities of children resulting in less than the expected stature of such children. However, Malina (1980) notes that these results are probably confounded due to the fact that these children were reared in poor economic environments and may have had substandard nutritional intake.

With developmental age taken into consideration (one of the few studies to do so), Mirwald, Bailey, Cameron & Rasmussen

(1981); did not observe any difference in stature for highly active and inactive boys studied over a ten year period from seven to sixteen years of age. A study by Parizkova (1968) also showed there to be no significant difference between growth in physical stature for boys participating in varying degrees of physical activity.

A longitudinal study was carried out by Parizkova (1968) to determine the effects of physical activity on various anthropometric measures in boys from 11 to 15 years of age. Parizkova identified four groups of boys based on different degrees of intensity in physical activity. The groups ranged from the most intense (group 1) to group 4, the least active group. At 15 years of age it was clear that "the height increments were harmonious in all the investigated groups, and did not differ significantly from the mean population" (p. 215). As the studies carried out by Parizkova (1968) and Mirwald et al., (1981) have controlled for maturation, it seems clear that their results would be more valid than those of the previously mentioned studies. Therefore, several authors agree that regular physical activity has no apparent effect on stature in growing individuals (Parizkova, 1968; Malina, 1969; Rarick, 1975; Mirwald et al., 1981; Shephard & Lavallee, 1981). Most of these authors have continued to see Steinhaus's 1933 conclusion as plausible: the pressure effects of physical activity (tensile, compressive) may stimulate epiphyseal growth to an optimal length, but excessive and prolonged pressure can retard linear growth. This view was also supported in studies by Weimann & Sicher (1955), Buskirk, Andersen & Brozek (1956), and Evans (1957).

SKELETAL DEVELOPMENT

The most common form of measuring skeletal maturity has been through using hand-wrist x-rays. Cerny (1969) examined skeletal maturity in boys engaged in three different levels of training. The only differences noted were between groups rather than within, and it was evident that there were no skeletal maturity differences at the start, during or upon completion of the study. Similar results were noted by Kotulan, Reznickova & Placheta (1980) who studied the skeletal maturity of male athletes and non-athletes over a three year period, starting at age 12. The gains in skeletal maturity did not differ between the athletes and controls throughout the study.

Novotny (1981) monitored the skeletal maturity of elite female athletes involved in a variety of sports, before and after three to four years of regular training and competiton. Initially, the skeletal maturity of the athletes was rated as retarded, normal or advanced. Although there were changes in category for some girls, there was no trend, that is, almost the same numbers of girls moved up a category as moved down. Furthermore, the mean chronological and skeletal ages did not differ significantly at the beginning and end of the study.

The decreased mineralization mentioned at the beginning of this section often results in osteoporosis, a brittleness of bone due to porosity from loss of mineral substances, which is most commonly found in the elderly. Smith (1985) examined femoral bone crossections from cadavers of active elderly people compared to bedridden elderly people. The results showed a remarkable increase in porosity in the latter group. It is conceivable

that, even though bone demineralization is basically a problem for the elderly, inactive children could suffer the same problems in that their bone mineralization might not be as complete as if they were participating in as much regular physical activity as normal children. It should be noted, however, that this process of bone mineralization is nearly always reversible, though the longer the period of inactivity, the longer the period required to achieve normal levels of bone mineralization again (Kottke, 1966).

BODY WEIGHT AND COMPOSITION

It is commonly accepted that regular physical activity is one of the major factors which contributes to the regulation and maintenance of body weight. Weight is a heterogeneous mass, quite frequently partitioned into lean body mass and fat for purposes of measurement (Malina, 1969).

Regular training produces an increase in lean body mass and a corresponding decrease in body fat in children and youth (Von Dobeln & Eriksson, 1972; Parizkova, 1963, 1973). In a longitudinal study, Parizkova (1968, 1970, 1974) studied teenage boys who were subjected to varying degrees of sports participation and physical training over a seven year period. Although relative body composition did not vary at the onset of the study, the most active boys had significantly more lean body mass and less fat than the least and moderately active boys (Malina, 1980). However, it is difficult to completely accept these results as the subjects were self-selected rather than randomly selected; hence, no causal statement can be made from

this data.

Von Dobeln & Eriksson (1972) examined total body potassium of 11 to 13 year old boys prior to, and following, a 16 week programme of endurance training. The average weight gain was 0.5 kg, but the 12 gram increase in potassium noted corresponds to a gain of approximately 4 kilograms of muscle tissue, which would indicate that the 0.5 kilogram gain in body weight was accompanied by a loss of 3 kilograms of fat during the endurance training programme. Again, Malina (1978), after a careful analysis of the data, suggests that the findings of Von Dobeln and Eriksson could be explained by the adolescent growth spurt which usually results in a concomitant increase in muscle mass. Though it would seem that the effects of physical training on body composition of growing children and youths result in leaner body mass, the confounding variables that exist, such as that presented above by Malina (1978), prevent us from making any firm conclusions on this matter at this time.

MUSCLE

Physiologists have repeatedly verified the commonplace observation that muscles increase in size as a result of regular periods of heavy physical exercise. Gains in strength also accompany increases in muscle size although the strength increments are usually proportionately greater than the increases in muscle girth (Rarick, 1960).

Rarick (1960) cites Morpurgo (1897) who demonstrated, over 80 years ago, that the muscular hypertrophy of exercise is due to an increase in the sarcoplasm of the individual muscle fibres and

not to any increase in the number or length of the fibres. Ethical limitations on experiments with human subjects make it difficult to substantiate much of the research in this area. Therefore, many of the conclusions that have been drawn to date have been as a result of animal studies. However, it has long been recognized that muscle cells undergo hypertrophy as a result of training, the magnitude of the increments being a reflection of the intensity and duration of the training programme (Rarick, 1975). Primarily, muscular hypertrophy is associated with high-resistance training activities like weight training (Bailey et al., 1984).

In a study on adolescent boys, Fournier, Ricci, Taylor et al., (1982), subjected groups to two different training stimuli: endurance training and sprint training. Muscle hypertrophy was observed following the former, but not the latter. There was an increase in cross-sectional area of both slow and fast twitch fibres which increased 10 to 30 percent following three months of endurance training. Bailey and his colleagues believe that there is no strong evidence to suggest that fibre type distribution in children can be changed as a result of training, however, the relative area of a muscle composed of slow or fast twitch fibres may change in response to exercise. As stated previously, the magnitude of this change is dependent on the type of training stimulus. While there is not a great deal of empirical data in the area of muscle growth with exercise in children and adolescents, studies that have been carried out indicate a similar pattern of muscle adaptation to training to that of adults (Bar-Or, 1983). However, before any firm conclusions can

be made about the effect of physical activity on muscular hypertrophy in growing children, studies that control or account for maturity development must be completed.

AEROBIC POWER

This parameter measures the efficiency of the oxygen transport system. A subject's maximal aerobic power is generally accepted as an index of overall physical condition (Lammert, 1983). Thoden and MacDougall (1982) described maximal aerobic power as that which can:

> . . . be quantitatively represented as the maximum amount of oxygen which can be consumed per unit of time by a person during a progressive exercise test to exhaustion. . . . It is normally expressed as the Volume (V) per minute ($\dot{V}$) of oxygen (O_2) which can be consumed by the organism at the maximum (max) workload which can be sustained for a criterion period of time and represented as "VO_2 Max".(p. 41)

Several authors agree that VO_2 Max increases in value for both girls and boys until maturity (Adams, Linde & Hisazumi, 1961; Rode & Shephard, 1973; Rarick, 1975; Andrew, 1979; Malina, 1980; Bailey et al., 1984). At puberty, boys show a spurt of aerobic power that is closely aligned to the adolescent growth spurt (Mirwald et al., 1981), and parallel gains in body mass (Shephard, 1982). Development in girls after puberty is slower (Bailey et al., 1984). Shephard (1982) suggests that in young girls, relative values are closely comparable to [illegible] until the age of ten at which time they show a progressive [illegible].

In discussing fitness training studies in children, there is a problem in determining if changes in maximal aerobic power are a result of training, growth, or both, since increasing size may result in changes similar to the training effect. Bailey et al.,

(1984)) report a consistent finding that physical activity or training has a small or limited effect on maximal aerobic power prior to adolescence. Bar-Or (1983) suggests four possibilities that may account for such equivocal findings: 1) With growth the child becomes mechanically more efficient; 2) Anaerobic capacity may be improving as a result of training; 3) Measurement techniques may not be sensitive enough to measure aerobic changes in children; and, 4) Free time activity is so high in young children that differences between control subjects who do not participate in the training programme and those children who do are beyond detection.

At adolescence, however, a higher increase in VO_2 Max has been observed in active or trained groups compared to non-trained groups (Kobayashi, Kitamura, Miura et al., 1978; Mirwald et al., 1981; Mirwald & Bailey, 1982). Mirwald & Bailey (1982) offer the following reasons for the adolescent increase in VO_2 Max: superior genetic endowment, habitual physical activity pattern, increased intensity of training, and testosterone secretion during adolescence.

At this stage no definite conclusions can be drawn about the effects of regular physical activity on the aerobic power of both pre and post pubescent children. Bar-Or (1983) briefly sums up the problem (cited in Bailey et al., 1984):

> In adults, changes in function between pre- and post-intervention can be attributed with fair certainty to the conditioning program. Not so with children or adolescents. Here, changes due to growth, development and maturation often outweigh and mask those induced by the intervention. It is intriguing that many of the physiologic changes that result from conditioning and training also take place in the natural process of growth and maturation. (p. 36)

SUMMARY

From the preceding discussion, a number of empirically supported findings indicate that physical activity is not only essential and beneficial to the growing child, but also that lack of regular physical activity may actually be harmful to the growing child. Although stature is not affected in either a positive or negative direction by the amount of physical activity engaged in by children and adolescents, the structure of the bones themselves can be affected in either direction. Where it has been shown on the one hand that regular physical activity enhances the mineralization and density of bones, it has been shown, on the other hand, that inactivity results in loss of mineralization and density of bones. Research in the area of anthropometry strongly suggests that inactive children will have a greater percentage of adipose tissue than very active children. This higher percentage of adipose tissue is likely to result in greater than normal chances of cardiovascular heart disease as these children grow older. It should also be noted that obesity is not only a health risk, but can impair physical performance as well.

Another positive effect of regular physical activity on the growing child is that of gains in muscular strength, often accompanied by muscular hypertrophy. While complete immobilization results in muscle atrophy, inactivity can result in low levels of muscular strength. In terms of the child who chooses not to participate, it would seem obvious that the greater period of time the child avoids activity, the further his or her level of muscular strength falls behind that expected of

his or her age-matched peers. Needless to say, those physical activities that require muscular strength and endurance would eventually be out of the range of children who continually avoid participation in such activities. The final and most important effect of exercise on growth discussed was that of aerobic power. Though conclusions are sometimes confounded with changes in maturity status, much of the research points to the fact that inactive children will not develop their aerobic power to the same extent that very active children will. Clearly, unskilled children who avoid physical activity will have less than optimal cardiovascular endurance; this condition could certainly act as a deterrent from joining in sports which require such endurance. As physically awkward children often fall into the category of non-participants, it seems likely that their level of physical fitness will be lower than that of their age and sex-matched peers. However, no studies to date have empirically examined the physical fitness of physically awkward childen.

With so many indefinite answers to the question of "to what extent does regular physical activity affect the growing child and adolescent," it is clear that this area is in need of more longitudinal studies of boys and girls, controlling for maturity status. As society of the late twentieth century drifts towards sedentary living patterns, poor dietary habits and higher levels of emotional stress the need for physical activity becomes paramount. To create favourable attitudes toward physical activity, the process must begin in early childhood, and be nurtured throughout school life. Until it is proven that regular physical activity is of no assistance to the growing child (an

unlikely conclusion), we cannot reject the positive effects that it may have.

CHAPTER III

METHODOLOGY

This study was part of a program development project for physically awkward children taking place in four elementary schools within the Edmonton Public School Board. The four schools were chosen because of the willingness of the teaching staff to work in the project and because of their proximity to the University of Alberta, in Edmonton, Alberta.

Once permission to carry out the study was granted by the Edmonton Public School Board, a team of researchers met with the teaching staffs of the four schools in May, 1985 (it was decided that May was a good time as the teachers would have been observing students for a full academic year, and would thus have a better opportunity to report on their motor proficiency). At these meetings, the researchers presented a brief, 15 minute overview of the syndrome of physical awkwardness, giving pertinent examples of skill difficulties that might assist the teachers in identifying children that are physically awkward.

Following the discussion, and a question period, a ten item Motor Behaviour Checklist (see Appendix A) was distributed to the teachers who were involved with teaching Physical Education in the respective schools. The key statement on the checklist was, "I am concerned with the motor development of this child." If teachers answered "yes" to this statement, they were asked to complete a Motor Behavior Checklist on that child. Hence, the fact that a Motor Behaviour Checklist was completed for a child was, in itself, a screening process. Those children for whom

checklists were returned would form the initial sample of physically awkward children.

The Sample

A total of 94 checklists were returned by 16 teachers in the four schools. Six additional children could have been included in the project but they were moving out of the school district. The resulting figure of 100 students represents 17.9% of 558 children which comprised the total population of the four schools. Table VI presents the number of boys and girls by grade and school who were identified as possibly being physically awkward. The most striking feature of table VI is the fact that teachers in some schools felt that none of their children had motor problems. Discussion with these teachers suggests that they did not fully understand what was expected of them in this study. Appendix B includes the covering letter that was sent to all parents requesting permission to test their children. Many permission slips were returned immediately. When the permission slips were not returned, the Principals followed-up by telephoning parents who had not returned them. This resulted in a few more slips being returned. Of the 94 letters sent to parents, permission slips were returned by 55, representing 58.5% of the identified group, and 10.1% of the total school population.

The testing of these 55 children was carried out in November and December of 1985. There were eight testers, all of whom were graduate students in the Department of Physical Education and Sport Studies at the University of Alberta. Six of these eight

Table VI

CHILDREN ORIGINALLY IDENTIFIED BY TEACHERS AS POSSIBLY PHYSICALLY AWKWARD (by school and grade)

SCHOOL	SEX	GRADE						TOTAL
		1	2	3	4	5	6	
School A	M	2	2	3	3	3	2	15
	F		3	5	6	1	7	22
School B	M		4	2	1	2	5	14
	F		2	3	2	2	2	11
School C	M		2	2	4			8
	F		2	1	2			5
School D	M	2	2	2	6	2		14
	F	1	1	1	3	1	4	11
TOTAL BY SEX	M	4	10	9	14	7	7	51
	F	1	8	10	13	4	13	49
TOTAL		5	18	19	27	11	20	100

had undergone training sessions which covered the administration of the Motor Performance Test Battery (Taylor, 1982). These training sessions were followed by a written and practical exam. All of these graduate students achieved the 80% criterion on this examination before they were permitted to act as test administrators (see Appendix B - Taylor, (1982) for details on this exam). The other two graduate students were not involved in testing motor performance, but in their own areas of expertise, namely, submaximal bicycle ergometer testing for one student, and anthropometry for the other. For reliability and consistency, all of the anthropometry was carried out by the latter student. As we were testing both boys and girls, it was decided that fewer problems would be encountered if the anthropometrist was female.

According to recent research in Edmonton, (Taylor, 1982), the best descriminators of awkward behaviour are: balance tasks, ball skills and fine-motor tasks. As reported in the review of the literature, many other authors have identified these items as descriminators of awkwardness. Other motor performance items that were used included: the controlled jump "...because it allowed observation of the reaction to risk and the ability to discriminate right from left" (Taylor, 1982, p. 50), and; the Throw, Clap and Catch task of Gubbay (1975), which has been found to be a valid indicator of awkwardness (Gubbay, 1975; Taylor, 1982).

Since the purpose of this study was to examine the physical fitness of physically awkward children, it was decided that the major components of fitness should be measured. For the cardiovascular component, the PWC-170 bicycle ergometer test was

chosen for its proven reliability and validity, as well as the fact that updated norms were available for it (Gauthier, 1983).

As the Canada Fitness Award Programme (1984) is a nationally accepted and used programme, it was decided that four of the six tests on it would be used in this study. Unfortunately, the sprint and endurance run could not be tested as it was winter, and these tests usually need to be conducted outdoors. The following four tests were used: Shuttle Run, Standing Long Jump, Partial Curl-up and Push-up. From a different testing protocol, The Standardized Test of Fitness (1981), the Sit and Reach test was used as a measure of hamstring and lower back flexibility. The following comprehensive anthropometry measurements were taken: height, weight, girth measurements for the upper arm, forearm and calf, and skinfold measurements for the tricep, bicep, subscapular, suprailiac, supraspinale, abdominal, front thigh and medial calf areas. Such a comprehensive package was carried out so that more detailed analysis may be carried out in the future. For the purpose of this thesis, the cumulative total of four skinfold sites (tricep, bicep, subscapular and suprailiac) was evaluated in the form of percentile scores (Canada Fitness Survey, 1984).

Testing Procedure

The testing took place over two 30 to 45 minute sessions, spaced approximately a week apart. During the first session, all students were shown how to perform the Partial Curl-up and Push-up. Their technique was corrected as they practiced these exercises. The students were told that these two tests would be

carried out the following week and that it would benefit them to practice at home. In the first of the two testing sessions, the following tests were carried out: PWC-170, Anthropometry, Sit and Reach test, Standing Long Jump, Shuttle Run, and if time permitted, some fine-motor tasks and ball skills. During the second session, some PWC-170 tests had to be completed, and the Partial Curl-ups and Push-ups were measured. The major tests carried out during this session included: fine-motor tasks, ball skills, balance activities and lower limb coordination. It was found that the two sessions provided ample time to complete all test items for each child (including a video of the Shuttle Run). On each testing day, the research team arrived at the school approximately 30 minutes prior to the scheduled testing time. This allowed the testing team to set up all the equipment, and to calibrate the Monark bicycle ergometers. Following, is a description of each test, in the order that they are listed on pages two, three and four of the testing proforma (Appendix C).

Motor Performance Measures

Following is a brief description of the test items. For more detailed information, see Appendix D.

Area of Measurement	Task Description
Ball Skills (upper limb coordination)	1. Bouncing, One Hand Catch The child bounces a tennis ball on the ground and catches it with the preferred hand. After 10 trials, the task is repeated with

the non-preferred hand.

2. Two hand catch

The tester throws an eight inch utility ball to the child (chest area) from a distance of six feet. After 10 trials, the task is repeated from eight feet.

3. Throw and Catch (Wall Throw)

The child executes an underarm throw of a tennis ball to a wall 8 feet away. The ball is thrown with the preferred hand and caught with both hands.

4. Throw, Clap and Catch

The child throws a tennis ball into the air with the preferred hand and catches it with both hands. If successful, the child repeats the task, executing a clap before catching the ball. The task is repeated until 4 claps are completed and the ball is caught with the preferred hand, or until failure occurs after three trials.

Fine Motor Coordination

5. Board Lacing

The child laces a 6-holed board with one or both hands as quickly as possible.

Lower Limb Coordination

6. Toe Balance

With both feet together, and hands on hips, the child raises to balance on the toes for 10 seconds.

7. One Leg Balance

The child slowly lifts one foot off the ground and attempts to hold balance for 15 seconds. This task is performed on right and left feet.

8. Stork Balance Right and Left

The child maintains a stationary pose while standing on one foot for 20 seconds. The other foot is placed on the supporting knee and the hands are on the hips. The task is performed on the right and left feet.

9. Graduated Jump

The child is required to jump over a cord at ground level, half knee height, and knee height. Three attempts are allowed. Three consecutive misses constitute failure.

10. Controlled Jump

The child jumps over a knee high cord. The child takes off from two

feet and lands on the preferred foot. The task is repeated with the non-preferred foot.

Note. Many of these descriptions are taken directly from Taylor, (1982, pp. 51-53).

Fitness Measures

Sit and Reach

The child, barefoot, sits with legs fully extended with the soles of the feet placed against the two horizontal crossboards of the flexometer (Modified Wells and Dillon). The inner edge of the soles are placed two centimetres from the edge of the scale. Keeping legs fully extended, arms evenly stretched, palms down, the child bends and reaches forward (without jerking), pushing the sliding marker along the scale with the fingertips (one hand placed directly on top of the other) as far forward as possible. The position of maximum flexion is held for approximately two seconds. The child is reminded that lowering the head will maximize the distance reached. The test is repeated twice, recording the maximum reading each time to the nearest 0.5 cm (Canadian Standardized Test of Fitness, Operations Manual, 1981). For purposes of reliability, each child was allowed a warmup which included five sit and reach stretches of six seconds duration.

Shuttle Run

Two parallel lines were drawn 10 metres apart. The child begins by lying face down, forehead on the starting line, and hands at the side of the chest. One beanbag is placed beside the

child just behind the starting line, and the other two are placed just behind the far line. On the signal ("ready") "GO!", the child runs to the far line and picks up a beanbag, returns to the starting line, drops the beanbag and picks up the other beanbag (i.e., exchange), runs to the far line, exchanges beanbags and carries the beanbag across the finish line. The best of two trials, each measured to the nearest tenth of a second is used for scoring (Canada Fitness Awards, 1984, p. 8).

Standing Long Jump

On a three metre gymnastic mat, a starting line is marked approximately 40 cm from one end of the mat with masking tape. The measuring tape is secured from the starting line, along the mat, close to one edge. The tester provides a demonstration, and the child is allowed a few practice trials, with feedback. They begin with feet slightly apart, toes behind the starting line. They then bend the hips, knees and ankles, and push vigorously with the legs while swinging the arms forward. Upon landing, the heel nearest the starting line is used for measurement (i.e., from the heel, extend an imaginary line perpendicularly to the measuring tape). Two trials are recorded, and the better of these is used for scoring (Canada Fitness Awards, 1984, pp. 12-13).

Partial Curl-ups

The child lies on his/her back, knees slightly bent at an angle of 140 degrees (approximately 6-10 cm off the floor), heels on the ground, arms extended along the thighs with fingers pointing towards the knees. Feet are not anchored. Initially, the lower back flattens, and is followed by a slow curling-up of

the upper spine, sliding the hands along the thighs until the fingertips touch the knees. The trunk should be raised at an angle no greater than 30 degrees to the floor. The movement is slow and well controlled. A metronome is set to 40 per minute, providing 20 curl-ups per minute, at 3 seconds per movement. The "up" and "down" movement is slow and well controlled, and each take one and a half seconds. The test is terminated if the child:

a) appears to be experiencing severe discomfort and or pain;

b) is unable to maintain correct rhythm and must rest (test stopped if child falls behind more than 3 repetitions);

c) consistently displays poor technique despite repeated corrections by the tester (a maximum of three corrections may be tolerated). Examples of poor technique include: lifting heels off floor, failure to touch knees, failure to maintain desired angles at knees or trunk, failure to slide hands along thighs (Canada Fitness Awards, 1984, pp. 10-11).

One attempt is allowed, and the total number completed is the score.

Push-up

The child begins in a front lying position on a mat with hands placed approximately under the shoulders, legs straight and together, and toes tucked under so that they are in contact with the mat. The child then pushes with the arms until they are fully extended, keeping back and legs straight. The body is then lowered, using the arms, keeping a straight line from head to toes, until the elbows reach 90 degrees, and the upper arms are parallel to the ground. The child aims for the maximum number

possible. While there is no time limit for this test, it is important that the push-ups be performed correctly, rhythmically and continuously. The test is terminated if the child:

a) appears to be experiencing severe discomfort and/or pain;

b) is unable to maintain a rhythmic movement and must rest (the test is stopped if the child falls behind more than three repetitions);

c) consistently displays poor technique, despite repeated corrections by the examiner (a maximum of three corrections may be tolerated. Examples of poor technique include: knees touching the floor; upper or low back swaying; failure to reach a complete arm extension; failure to attain an approximate 90 degree bend at the elbow (Canada Fitness Awards, 1984, p. 6).

Physical Working Capacity 170 Test (PWC-170)

> The bicycle ergometer used in the study was the von Dobeln type manufactured by the Monark Company, in Varberg, Sweden, and modified at the University of Alberta to accommodate children as young as seven years of age. The modifications of the Monark bicycle which enabled a combination of greater range of seat height, shorter pedal arms and lighter pendulum giving lighter work loads and finer work load gradations, permitted testing of children as young as seven years of age.

The following procedure for the administration of the PWC-170 test was used:

1. An Exersentry (heart rate monitor) was worn throughout the duration of the test. This was fitted prior to the child mounting the bicycle.
2. The sinus balance scale on the bicycle was adjusted to zero, having loosened the belt until it exerts no tension. Care should be taken that the pedals are not touched during

this procedure.

3. The seat height was adjusted so that the knee is slightly bent when the lower pedal rests directly below the longitudinal arch of the foot.
4. The pre-exercise level is calculated and an attempt made to relax the child by conversation so that the pre-exercise heart rate is below 100 beats per minute.
5. The child is given a brief explanation of the test, and asked to keep the speedometer needle at 21 Km/hr, which is the equivalent of 60 revolutions per minute. The subject is asked to begin pedalling, and is allowed to adjust to the pace with no load. When the pace is achieved the first load is set, and the watch, and revolution counter started simultaneously. The normal workloads for the three levels are set according to Table VII. However, through a pilot study which examined the PWC-170 of 8 physically awkward children (Paton, 1985), it was found that the starting level for many of the 7 and 8 year olds would need to be 0.25 kpm rather than the suggested 0.5 kpm, as the latter workload was too difficult for them to sustain. Table VIII gives the heart rate response that is desired at the end of each workload. The nature of the alteration of the workload is dependent on the heart rate response at the end of the third and seventh minutes of exercise.
6. The heart rate is recorded at the end of each minute, and the number of pedal revolutions is recorded at the end of each minute of the ride.
7. At the end of the fourth and eighth minutes the workload is

TABLE VII

RECOMMENDED SINUS BALANCE SCALE

SETTINGS BY AGE AND SEX

Sex	Age	Sinus Balance Scale Setting For The Three Work Levels			Notes
MALE	7,8	0.5	1.0	1.5	A,F
	9,10,11	1.0	2.0	3.0	B,C,F
FEMALE	7,8	0.5	1.0	1.5	A,F
	9,10,11	0.5	1.5	2.0	D,E,F

Notes:

A. If the first or second workload results in the heart rate not reaching the respective lower limit of the desired heart rate response, increase the scale setting for the succeeding work level by one unit rather than half a unit.

B. If the first or second workload results in the heart rate not reaching the respective lower limit of the desired heart rate response, increase the scale setting for the succeeding level by one and one half units rather than one unit.

C. If the first or second work load results in the heart rate exceeding the upper limit of the desired heart rate response, increase the scale setting for the succeeding work level by half a unit rather than one unit.

D. If the first workload results in the heart rate not reaching the lower limit of the desired heart rate response (115) use settings of 2.0 and 2.5 for levels two and three respectively.

E. If the first workload results in the heart rate exceeding the upper limit of the desired heart rate response (130) use settings of 1.0 and 1.5 for levels two and three respectively.

F. If the heart rate exceeds 165 after two work levels terminate the test.

TABLE VIII

DESIRED HEART RATE RESPONSE TO THE THREE WORK LEVELS

Work Level	Stage of Test	Desired Heart Rate Response
1	4th min.	115-130
2	8th min.	130-145
3	12th min.	160-180

increased. However, if the heart rate at the end of the second work level is greater than 165 beats per minute the test is terminated. Normally, the test is completed at the end of three workloads.

In the analysis of the PWC-170 data, a regression equation was used to determine what workload would heve been required to produce a working heart rate at stage three of 170 beats per minute. As there were not many children in each age category for each sex, it was decided that converting the PWC-170/Kg to percentiles would be the most useful way to view the data for this test.

Note. The key points listed above for the PWC-170 are taken directly from The Physical Working Capacity of Children, (CAHPER, 1968, pp. 16-25).

Skinfold Scores

As mentioned earlier, extensive anthropometric measures were taken. However, for the [illegible] of this study, the four

skinfold sites that were chosen for comparison with normative data were the bicep, tricep, subscapular and suprailiac. The protocol for these measures can be found in the Standardized Test of Fitness, (Gov. of Canada: Fitness and Amateur Sport, 1981).

CHAPTER IV

RESULTS AND DISCUSSION

The results of this study will be presented under three main headings. The initial section presents the number of boys and girls who were identified by their teachers as being physically awkward in each of the four schools. The second section presents the scores of the children on the Motor Performance Battery, while the third section presents the scores of the children on the Fitness Tests and the skinfold measures.

The Physically Awkward Sample

As noted earlier, the teachers identified an initial sample of 100 potentially awkward children from a total target population of 558 children. Parents allowed the testing of only 55 of the 100 potentially awkward children. Even though the Principals were very supportive of the project, only 55% of the parents granted permission for their children to be included in the study. This is a relatively low percentage and is probably due to the fact that the parents were concerned about labeling their children physically awkward. Furthermore, the parents probably did not understand that professional help is available to ameliorate the problem to some extent. The 55 potentially physically awkward children were evaluated on the basis of the Motor Performance Test Battery and the fitness tests outlined in the last chapter.

The children's raw scores were converted to percentile scores based on the normative data from the IBM-University of

Alberta Learning Disabilities project (Taylor, 1982); the Canada Fitness Awards program (1984); the national norms from a recent PWC-170 test conducted by Gauthier (1983); and The Canada Fitness Survey (1984). A profile sheet summarized each of the test items used and indicated the percentile score that each child obtained on each of the items.

The following decision rule was used to categorize children as physically awkward: if the children had three measures at or below the 10th percentile they were categorized as being physically awkward.

Table IX reports the number of boys and girls who were categorized as physically awkward by school, sex, and grade. Using the above rule, 41 of the 55 potentially physically awkward children were so classified; hence, the teachers had identified 75% of the children correctly. However, it should be noted that classification errors certainly could have been due to the motor performance tests and the decision rule; hence, further research on this issue is needed. It should be noted that when physically awkward children are referred to in this section it refers only to the 41 youngsters who met the above criterion. The breakdown of this group of 41 children was 23 boys and 18 girls.

Results of the Motor Performance Test Battery

Table X presents the results of the physically awkward children on the Motor Performance Battery expressed as percentile scores. As mentioned above, these percentile scores are based on the norms generated from the IBM-University of Alberta Learning

Table IX

CHILDREN IDENTIFIED AS PHYSICALLY AWKWARD (by school and grade)

SCHOOL	SEX	GRADE						TOTAL
		1	2	3	4	5	6	
School A	M	2	1	2	1	2		8
	F		1	1	3		3	8
School B	M		2		1	1	1	5
	F		1	2	1	2	1	7
School C	M		2		4			6
	F				1			1
School D	M		2	2				4
	F	1			1			2
TOTAL BY SEX	M	2	7	4	2	7	1	23
	F	1	2	3	6	2	4	18
TOTAL		3	9	7	8	9	5	41

Table X

Results of the Physcially Awkward Children on the Motor Performance Battery

	Percentile Scores					
	Total Group		Males		Females	
n	41		23		18	
Test(s)	$\bar{x}$	S.D	$\bar{x}$	S.D	$\bar{x}$	S.D
Motor Performance Test Battery						
Wall Throw	16.1	21.3	18.4	23.8	12.6	17.8
Clap and Catch	21.1	23.2	23.6	27.1	17.9	17.6
Stork, Right Leg	23.5	27.9	22.2	26.1	25.0	29.9
Stork, Left Leg	36.9	31.3	40.1	30.1	33.1	33.9
Control Jump, Right	19.2	27.6	20.3	26.3	17.7	30.0
Control Jump, Left	29.9	34.4	27.9	33.4	32.7	36.8

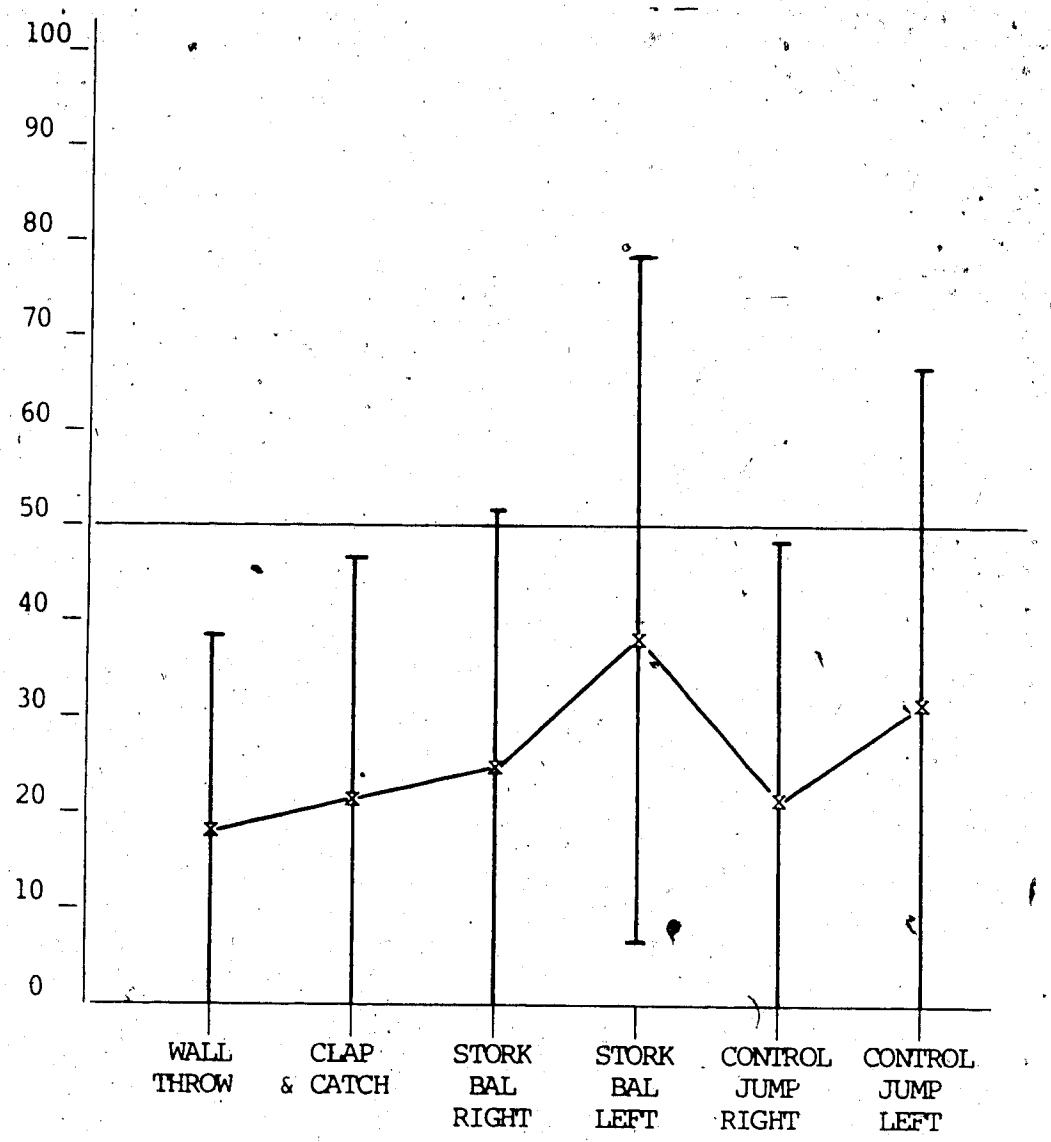
Disabilities study reported by Taylor in 1982.

It should be noted that only 6 of the original 13 tests of motor impairment are reported in the table. The Toe Balance, One Leg Balance (right and left), and the Graduated Jump were excluded from the results due to the fact that the number of subjects in each cell for these tests was too small. Such small frequencies were due to the structure of the Stott Test which, uses different tests for the various age groups. Hence, the number of physically awkward children in each of the test means were very small. The results of the two hand catch at six feet and eight feet were excluded from the results due to the ceiling effects associated with them. In other words, physically awkward children obtained absolute scores that were converted into high percentile scores due to a heavy skewing of the distribution of scores on a particular test item. Quite simply, in reviewing the profile of physically awkward children it became clear that the percentile scores on those test items did not truly represent the performance of the subjects in relation to their non-awkward peers. The results of the lacing task were excluded because it was a fine motor test which had very little bearing on the gross-motor proficiency and fitness aspects of this study.

Table X presents the mean percentile scores for the physically awkward children on the Motor Performance Test Battery. Figure 1 presents these percentile scores in graphic form. As was expected, the mean percentile scores on all of the items are well below the 50th percentile. In fact, five of the six criterion items were below the 30th percentile with only the Stork Balance Left Foot being above this figure. Furthermore,

Figure 1

Motor Performance Test Scores for Total Group - Means and Standard Deviations (N.B. For all figures: x = mean
T = 1 std. dev.)



the plotted standard deviations for each item reflect the fact that except for the Stork Balance Left Foot, nearly all of the children were below the 50th percentile on every test item.

As Figures 2 and 3 demonstrate, there were generally few discrepancies, in terms of percentile, between the performance of the girls and the boys on those six items especially considering the relatively large standard deviations associated with each item.

In sum, the mean performance scores on the Motor Performance Test Battery were consistently low across the six items that were measured. Clearly, the percentile results show that this group of children were well below their age-matched peers on these test items. The above results provide further support for categorizing these children as physically awkward on the basis of the reports of their teachers, and the profile analysis of the motor performance items described at the beginning of this chapter.

Results of Fitness Tests

Table XI and Figure 4 present the mean percentile scores for the physically awkward children on the seven fitness measures that were used in the study. It is interesting to note that the mean skinfold percentiles were well within the normal range whereas all of the other mean scores were very low. Perhaps, the most serious fitness score result was the extreme low mean percentile score which both the boys and the girls obtained on the push-up. Clearly, some degree of co-ordination is required to perform this item; however, performing push-ups is a very culturally-normative fitness activity which taps muscular strength and endurance. It was quite shocking to find that most

Figure 2

Motor Performance Test Scores for Males - Means and Standard Deviations

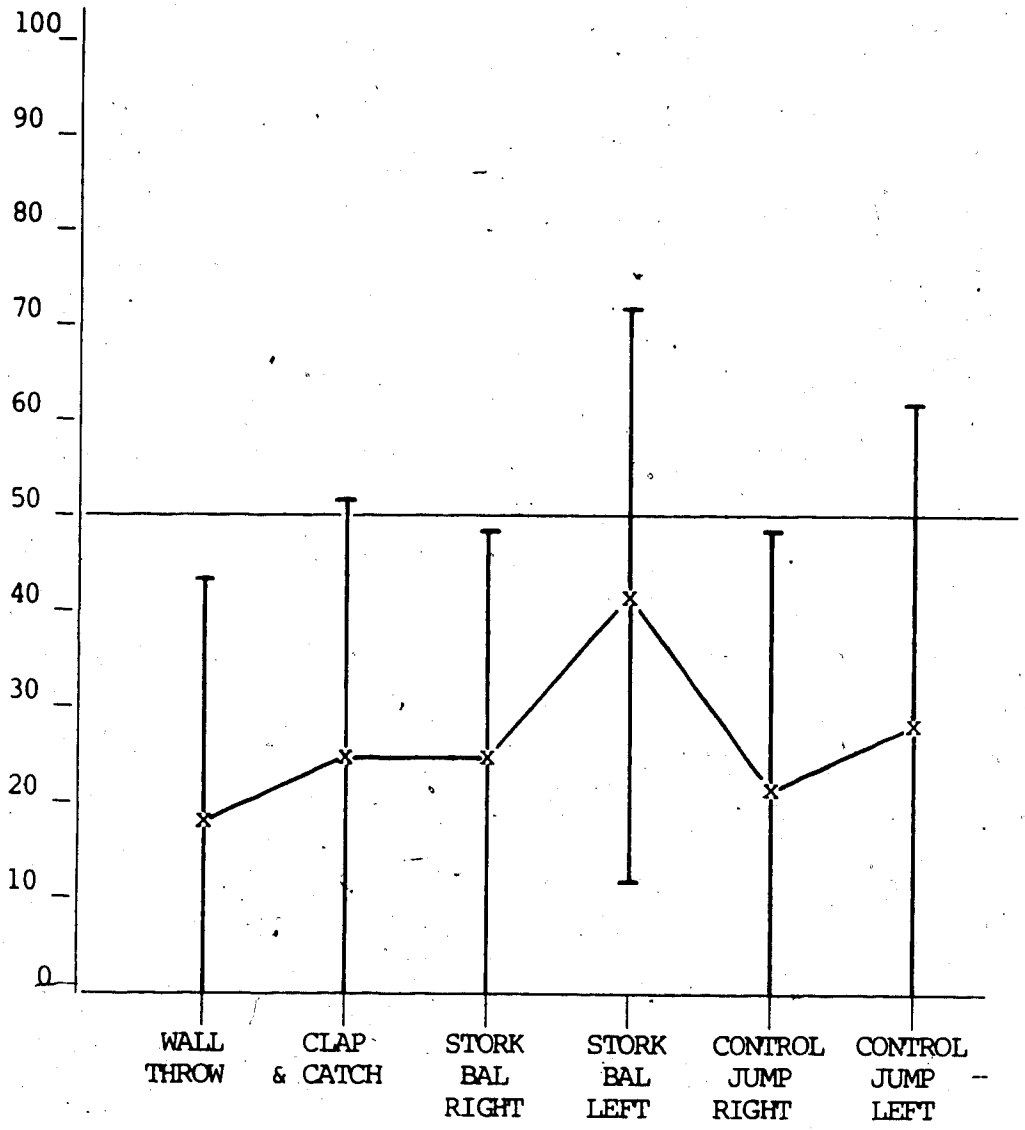
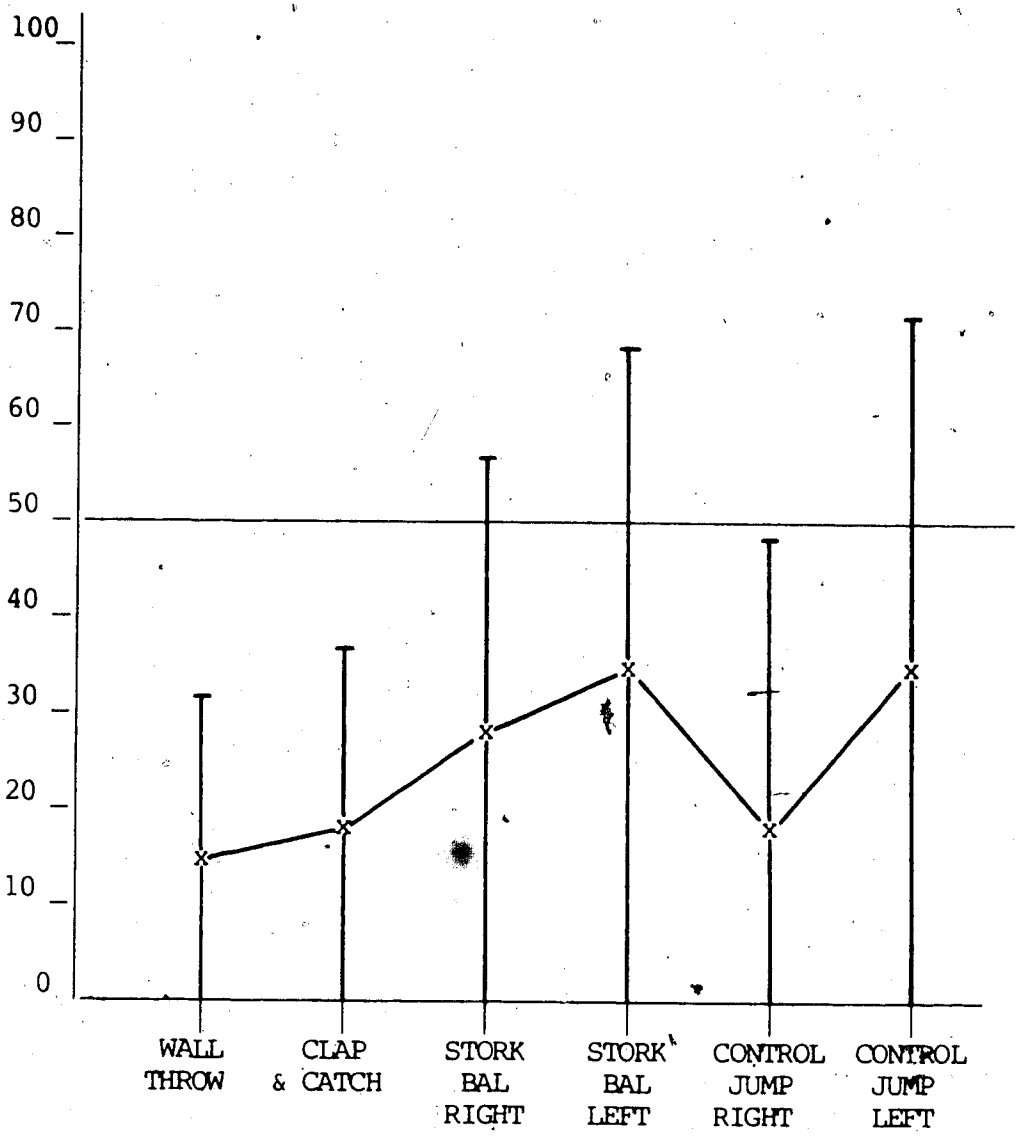


Figure 3

Motor Performance Test Scores for Females - Means and Standard Deviations



of the physically awkward youngsters could not even do one push-up. The results of the skinfold tests provide considerable confidence that this very poor result was not due to obesity but rather to a lack of fitness and perhaps to a lack of movement skill. It should be noted at this point that according to the height and weight means and standard deviations developed by Quinney, Watkinson, Massicotte, Conger & Gauthier (1981), 9 of the 41 physically awkward children fell outside one standard deviation from the mean for either height, weight or both. However, there was no trend towards obesity or vice-versa, and no trend towards being significantly taller or shorter than the norm. This indicates that the heights and weights of these physically awkward children reflect normal growth and development, and that these scores have not had any significant effect of the test results.

The results on the PWC-170 test were also very low. As figure 4 shows, the mean for both sexes on the PWC-170 percentile score was below the 25th percentile. Figure 5 and 6 report the gender differences for the fitness items. The boys were, in fact, below the 20th percentile while the girls were below the 27th percentile on this important measure of aerobic fitness.

An overall analysis of Figure 4 indicates that the total group was below the 30th percentile on six of the key fitness items. The low scores on the PWC-170, curl-ups, and push-ups, provide considerable support for the contention which Wall (1982) made about the relationship among awkwardness, lack of physical activity and low fitness. Clearly, further research is needed both to confirm this initial finding and to examine more fully

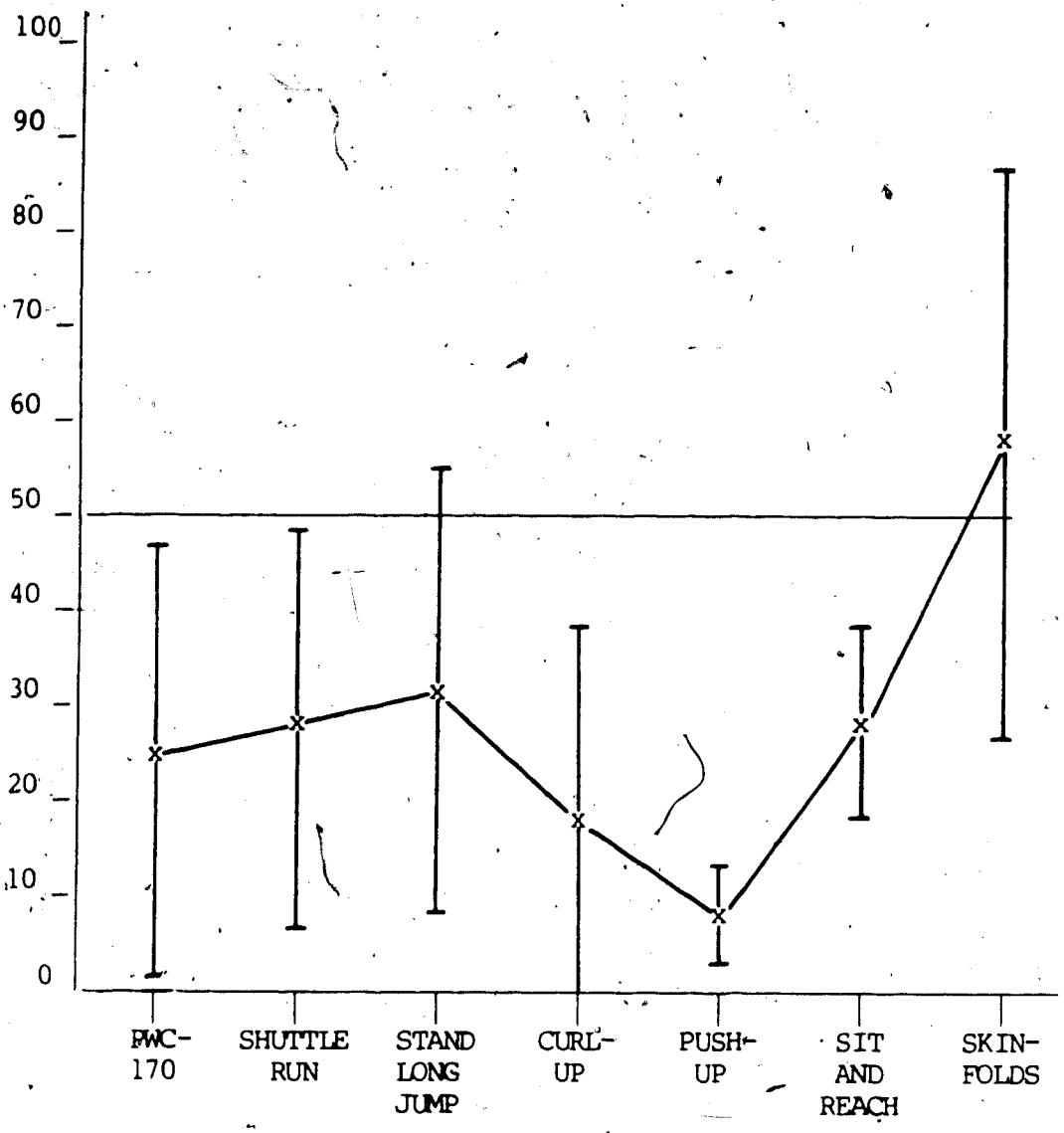
Table XI

Results of Physically Awkward Children on Fitness Tests

	Percentile Scores					
	Total Group		Males		Females	
n	41		23		18	
Test(s)	$\bar{x}$	S.D	$\bar{x}$	S.D	$\bar{x}$	S.D
Fitness Tests						
PWC-170	22.5	21.8	19.3	18.5	26.8	26.0
Shuttle Run	28.5	24.0	32.8	28.5	22.5	16.4
Standing Long Jump	30.3	22.8	35.5	23.7	23.0	22.0
Partial Curl-up	18.4	19.1	15.3	20.3	22.7	18.0
Push-up	4.6	6.5	5.0	7.7	3.9	4.3
Sit and Reach	26.4	8.3	25.5	8.2	27.8	8.6
Skinfolds	55.3	30.6	55.8	32.5	54.6	28.6

Figure 4

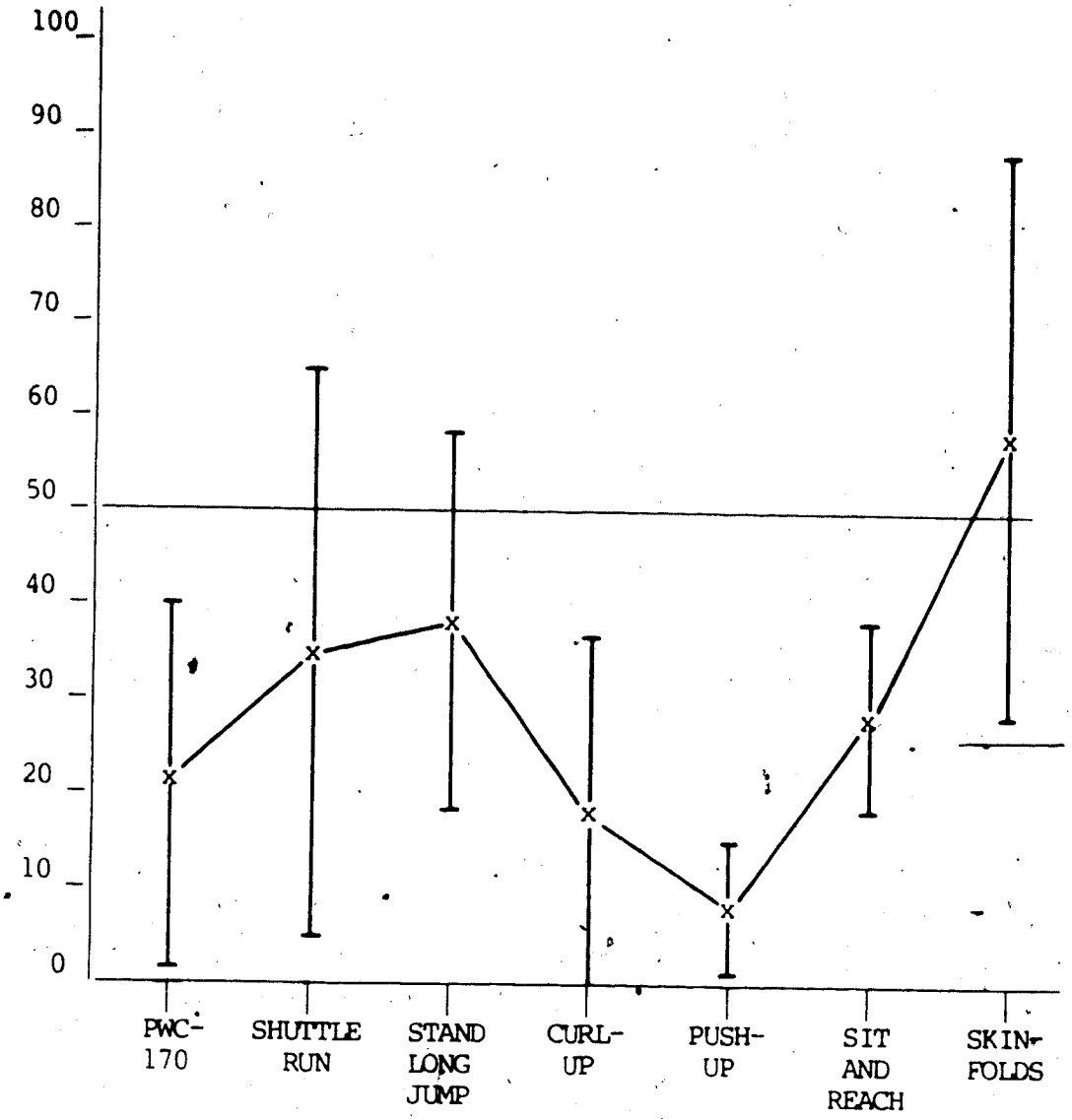
Fitness Test Scores - Means and Standard Deviations



Note. For the skinfold scores, the higher the percentile, the leaner the child.

Figure 5

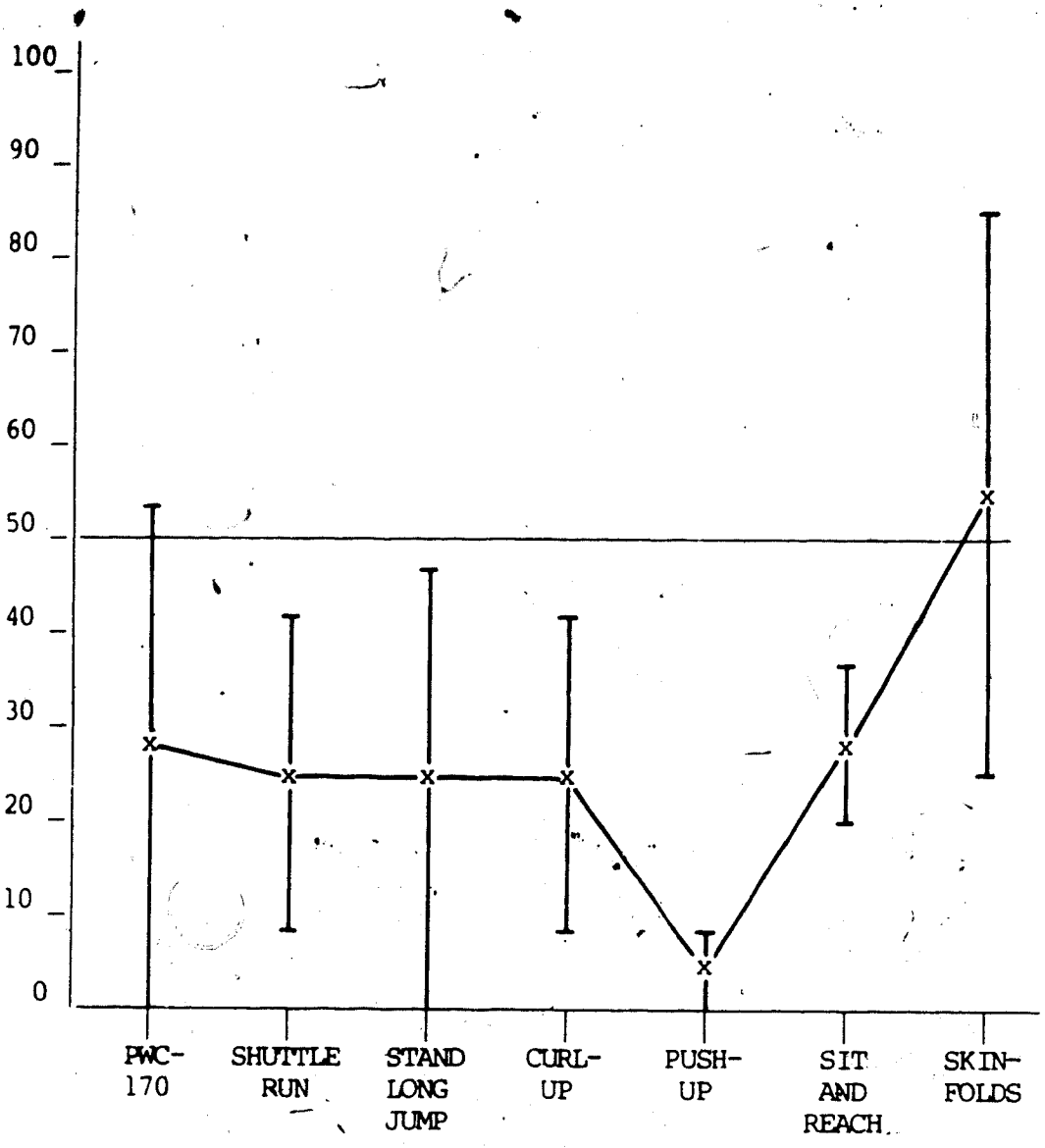
Fitness Test Scores, Males - Means and Standard Deviations



Note. For the skinfold scores, the higher the percentile, the leaner the child is.

Figure 6

Fitness Test Scores, Females - Means and Standard Deviations



Note. For the skinfold scores, the higher the percentile, the leaner the child is.

the relationship between the syndrome of awkwardness outlined by Wall (1982), Taylor, (1983), Wall et al., (1985), and Clifford (1985), and the physical fitness of physically awkward children. However, these results certainly indicate that the children in this study who were classified as awkward by their teachers and by low motor performance scores certainly were very low on these measures of physical fitness.

Table XII (a) and (b) present the individual PWC-170 scores for each of the physically awkward children in the study. Clearly, the great majority of the children are very low on this measure in comparison to their age-matched peers. In fact, over half of the children scored below the 20th percentile while one scored at the 80th percentile, and only one other scored above the 60th percentile. Further research should examine why these few physically awkward children scored so well on this measure.

In conclusion, the above steps are an important first step in the investigation of the relationship between physical awkwardness and physical fitness. This exploratory study describes the fact that physically awkward children certainly are low in physical fitness. However, one might ask whether the reason these children are awkward is because they are unfit, or, vice versa. Nevertheless, the initial step in examining any phenomenon is to describe it. Clearly, longitudinal studies of children who are physically awkward need to be done. At the same time, experimental studies demonstrating that fitness can be improved in physically awkward children but with no concomitant improvement in motor skill proficiency might provide greater support for the contention that physical awkwardness leads to low

Table XII(a)

Scores for PWC-170 test

Subject	Age	Sex	Height cm	Weight kg	PWC-170 Watts	KPM/Min	Watts/ kg	PWC-170/ kg	% ile (relative)
2	11.2	M	137.3	30.0	35.1	214.7	1.170	7.16	1.0
3	9.5	F	136.0	27.5	44.2	270.4	1.607	9.83	30.0
5	10.2	M	148.1	30.5	79.9	488.8	2.618	16.02	80.0
6	8.5	M	132.5	26.5	29.7	181.7	1.121	6.86	1.0
8	11.0	F	155.9	48.0	70.8	433.0	1.476	9.03	19.5
10	7.0	M	128.0	27.0	43.8	268.0	1.620	9.91	17.5
11	8.1	M	135.2	31.5	46.2	282.7	1.466	8.97	10.0
12	11.3	F	148.0	34.5	53.9	329.8	1.563	9.56	25.5
13	6.2	M	117.6	20.9	28.9	176.8	1.447	8.85	9.0
14	10.6	F	156.4	57.5	59.5	364.0	1.036	6.34	1.0
15	9.5	F	121.8	21.0	36.3	222.0	1.730	10.58	40.0
16	10.0	F	137.4	30.5	68.0	416.0	2.229	13.64	76.0
17	8.8	M	138.0	35.0	56.4	345.1	1.612	9.86	17.0
21	7.8	F	134.4	28.5	36.6	223.9	1.284	7.86	8.0
22	7.2	M	118.9	21.5	21.0	128.5	0.976	5.97	1.0
23	7.3	F	120.0	26.0	35.3	216.0	1.356	8.30	13.0
24	10.0	M	138.7	27.0	37.5	229.4	1.388	8.49	16.0
25	11.4	M	147.4	34.5	64.1	392.2	1.858	11.37	22.1
26	9.0	M	142.9	37.0	60.0	367.1	1.623	9.93	11.3
27	9.0	F	129.2	32.5	44.7	273.5	1.376	8.42	15.2
28	9.1	F	138.4	38.0	Test Incomplete				
29	10.0	F	163.0	54.0	75.0	458.9	1.388	8.49	14.9
30	11.0	F	147.7	44.5	74.8	457.6	1.680	10.28	32.4

Table XII(b)

Scores for PWC-170 test

Subject	Age	Sex	Height cm	Weight kg	PWC-170 Watts	KPM/Min	Watts/ kg	PWC-170/ kg	% ile (relative)
31	10.4	F	159.3	42.0	76.7	469.3	1.827	11.18	44.6
33	7.6	M	129.7	29.0	44.7	273.5	1.543	9.44	15.0
34	7.1	F	122.6	20.5	37.2	227.6	1.816	7.25	5.0
35	7.5	M	115.3	21.5	41.0	250.8	1.412	8.64	8.2
37	8.7	F	135.8	31.5	57.9	354.2	1.838	11.24	57.5
41	9.9	M	130.2	25.0	57.9	354.2	2.317	14.13	53.0
42	8.1	F	126.7	22.0	37.5	229.4	1.703	10.42	47.2
43	7.2	M	138.0	34.5	46.1	282.0	1.335	8.17	6.7
45	10.7	M	134.5	25.5	51.7	316.3	2.026	12.40	35.0
46	9.0	M	138.0	36.5	63.0	385.4	1.726	10.56	22.6
47	7.2	M	129.2	25.0	Test Incomplete				
48	9.6	M	123.6	21.0	31.7	193.9	1.508	9.23	7.1
49	9.2	F	140.1	29.5	37.0	226.4	1.255	7.68	11.0
50	8.1	M	135.4	29.5	58.3	356.7	1.975	12.08	36.1
51	7.3	M	124.4	22.5	38.2	233.7	1.696	10.38	20.5
53	7.1	M	126.3	32.5	56.5	345.7	1.739	10.64	22.6
54	6.1	F	121.5	20.5	Test Incomplete				
55	8.0	M	136.5	27.0	42.9	262.5	1.590	9.73	16.0

fitness. The fact that Clifford (1985) found physically awkward children avoided physical activity provides at least some support for the contention that there is a direct link among poor motor proficiency, avoidance of physical activity, and low fitness. Clearly, further research is needed to tease out this complex interaction of variables.

CHAPTER V

SUMMARY, CONCLUSIONS AND RECOMMENDATIONS

Summary

Teachers in four schools were provided with a Motor Behaviour Checklist and asked to complete one of these checklists for only those children whose motor performance they were concerned about. Of the 100 initially identified as having motor performance problems, 55 were able to be tested using the Motor Performance Test Battery (Taylor, 1982), and a variety of fitness measures. As a result of the Motor Performance testing, 41 children were found to be physically awkward.

The physical fitness of these 41 children was examined, using normative data that had been generated from tests performed on "non-physically awkward" age and sex-matched peers. Except for the skinfold scores which fell within the normal range, the mean scores of the physically awkward group on the other six tests were all at or below the 30th percentile. Clearly, the scores of these physically awkward children were far below what would normally be expected of children their age.

Conclusions

Within the limitations of this descriptive study, the following conclusions can be made:

1. Teachers are able to use the Motor Behaviour Checklist to identify quite accurately children who are physically awkward. As noted in the last chapter, the fact that the teachers were in agreement approximately 75% of the time with the profile

analysis results from the Motor Performance Test Battery indicates that more refinement of the Motor Behaviour Checklist is needed, and that the teachers might benefit from a more intense training session prior to using it. At the same time, it should be noted that the Motor Performance Test Battery may require further refinement as well as the criteria used for the profile analysis. Further research on these aspects of the study are obviously needed.

2. The physically awkward children in this study are definitely not obese. The results of the skinfold tests clearly indicate that this group of physically awkward children are certainly within the normal range on this important variable.
3. The 41 awkward children in this study were quite unfit in relation to their peers. Both the boys and girls were very low on the PWC-170 test of aerobic power. This finding is an important one as aerobic power is an essential component of cardiovascular fitness which is recognized as the most important aspect of total fitness.
4. As expected prior to the study, the physically awkward children performed very poorly on the two strength and endurance items; namely, the push-up and the partial curl-up. The fact that both the boys and the girls were below the 10th percentile on the culturally-normative push-up test certainly was a shocking finding. Clearly, these children need a fitness program to ameliorate this situation.
5. The shuttle run and standing long jump surely measure muscular strength and co-ordination. Again, on both of these test items the physically awkward children performed well below the

expected range for their age group.

6. The final fitness item was a measure of the flexibility of the lower back and hamstrings. The results indicated that the physically awkward children in this study were much less flexible than their peers.

In conclusion, the above findings are definitely congruent with the hypothesis that physically awkward children would be less fit than their peers. However, it is important to note that further research is needed to determine whether it is the syndrome of awkwardness that actually causes such low fitness performance.

Recommendations

1. Further research needs to be done on the Motor Performance Test Battery. The ceiling effect which was found on a number of sub-tests needs to be investigated. The Battery would be improved if more items which were culturally-normative were included.
2. Future studies should include a control group to ensure that any possible biases on the part of the research team are eliminated.
3. If feasible, replication of the test of aerobic power would be more accurate if it was a maximal test; however, as there were problems motivating some physically awkward children to finish the PWC-170, this may become an even greater problem if a test of maximal aerobic power is used.
4. Clearly, physically awkward children are quite unfit. Further research needs to examine how their fitness can be improved.

Research is especially needed in the area of strength training for these children.

5. Replication of the results of this study would be desirable to confirm that physically awkward children have a very low level of physical fitness.

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APPENDICES

APPENDIX A

MOTOR BEHAVIOUR CHECKLIST

MOTOR BEHAVIOUR CHECKLIST

Teacher's Name _____ Student's Name _____

School _____ Birthdate _____ Sex _____

Age _____ Grade _____

Please answer the following question.

I am concerned about the motor development of this child. YES NO

If you answered YES, please complete the rest of the form.

1. When running this child is usually:

Very Uncoordinated	Uncoordinated	Coordinated	Very Coordinated

2. This child dresses quickly and efficiently before recess:

Rarely	Sometimes	Usually	Always

3. This child uses playground equipment:

Rarely	Sometimes	Usually	Always

4. This child usually catches a ball:

Awkwardly	Fairly Well	Easily	Very Easily

5. This child participates in ball games:

Rarely | Sometimes | Usually | Always

6. This child enjoys playing on climbing equipment:

Rarely | Sometimes | Usually | Always

7. This child tires easily and needs frequent rest:

Rarely | Sometimes | Usually | Always

8. This child seems to be:

Very Unfit | Unfit | Fit | Very Fit

9. This child avoids participating in games with his/her peers:

Rarely | Sometimes | Usually | Always

10. This child avoids participating in physical education classes:

Rarely | Sometimes | Usually | Always

APPENDIX B

COVERING LETTER

DEPARTMENT OF PHYSICAL EDUCATION AND SPORT STUDIES

FACULTY OF PHYSICAL EDUCATION AND RECREATION

October 18, 1985.

Dear Parents,

Over the past six years, the Department of Physical Education and Sport Studies at the University of Alberta has developed a number of strategies to identify children who tend to avoid participating in physical activities. Often these children have minor motor difficulties, relatively poor physical fitness, and tend to avoid group play situations. We have found that these children require advice and support from teachers and parents if they are to begin to enjoy participating in play and sport activities. Therefore, we are involved in a joint research and service project with the Edmonton Public School Board to help these children. Your child is one of a fairly large group of children who we believe might benefit from this project.

The Motor Development Clinic at the University of Alberta has helped many such children to overcome, or at least cope with, such movement difficulties. This Clinic is operated by students and staff members in the Department of Physical Education and Sport Studies who have been trained in the implementation of appropriate remedial techniques. However, the staff of the Clinic believes that such children can be more effectively served in school-based programs; hence, it has decided to offer two such programs within the Edmonton Public School Board area.

The assessment, prescription, and remedial aspects of these school-based programs will be under the supervision of experienced physical educators who are currently involved in Ph.D. or M.A. programs at the University of Alberta. Positive administrative and professional support has been received from Mike Hay, Physical Education Consultant, Edmonton Public School Board. Furthermore, the Principals of the four schools involved in the project (Belgravia, Garneau, Lendrum and Windsor Park schools) will be available for advice and support throughout the year.

The Project Coordinator will be Mrs. Jacquie Weir who works with Dr. A.E. Wall and Mrs. Jane Taylor in the Motor Development Clinic. Under their guidance and with your approval, an opportunity will be provided for your child to be assessed in the areas of motor performance and physical fitness within the local school setting. If the results of your child's performance indicates that a remedial program might be beneficial, then consultation with you and your child's teacher will be arranged. Furthermore, if your child would benefit from involvement in a specially-designed program, then you will be given the opportunity to allow your child to participate in such a program. This program is designed to progressively teach basic motor skills, increase physical fitness, and encourage the children to enjoy group play activities with their peers. In conjunction with these child-centred programs, parents and teachers will be given information on the wise selection of leisure-time activities. This leisure counselling process is extremely important as it will help teachers and parents provide positive support to their children in physical activity settings.

If you agree to have your child take part in the initial assessment phase of this project, please indicate this fact on the attached Consent Form. We will contact you again for your support and approval if your child would benefit from the remedial phase of this project which will begin in January, 1986. It should be understood that we will operate only two school-based programs due to resource limitations. The schools in which the programs will be offered will be selected after the assessment phase of this project. Furthermore, if you decide not to have your child participate in the remedial programs information will still be made available on how you can help your child become involved in positive physical activity experiences. Further information can be obtained from staff of the Motor Development Clinic, 432-5211.

Sincerely,

A. E. Wall, Ph.D.
Professor and Chairman.

AEW/nm

CONSENT FORM

I, _____, grant permission for

_____, age _____, to be involved in two

half-hour motor performance testing sessions.

_____

Signature of Parent or Guardian

APPENDIX C

TESTING PROFORMA

MOTOR PERFORMANCE and FITNESS MEASURES

NAME (written by child)_____

SEX _____ AGE_____

BIRTHDATE _____

SCHOOL _____

GRADE _____

PREFERRED HAND _____

HEIGHT (cm) _____ WEIGHT (kg) _____

PWC/170/kg _____ PERCENTILE _____

SKINFOLDS - SUM OF 4 _____mm PERCENT BODY FAT _____

PERCENTILE _____

FITNESS MEASURES

Shuttle Run (best) _____ seconds PERCENTILE _____

Standing Long Jump (best) _____ metres PERCENTILE _____

Partial Curl-Ups (maximum) _____ PERCENTILE _____

Push-Ups (maximum) _____ PERCENTILE _____

Sit and Reach (flexibility) _____ PERCENTILE _____

MOTOR PERFORMANCE MEASURES

Balance _____

Ball Skills _____

Lower Limb Coordination _____

_____

Fine Motor _____

NAME_____ SCHOOL_____ AGE_____

ITEM	SCORING	CRITERIA	SCORE	%	COMMENTS
Bouncing, 1 Hand Catch - Preferred Hand		10 Trials			
Bouncing, 1 Hand Catch - Non-Preferred Hand		10 Trials			
Two Hand Catch - 6 Feet		10 Trials			
- 8 Feet		10 Trials			
Throw against Wall - 8ft		10 Trials			
Throw, Clap, Catch	- 0 1 2 3 4 4D	3 Trials at each			
Lacing		3 Trials Averaged			
Toe Balance (10 sec)		3 Trials Averaged			
One Leg Balance (15 sec) Right		3 Trials Averaged			
Left		" " "			
Stork Balance (20 sec) Right		3 Trials Averaged			
Left		" " "			
Graduated Jump	Floor 1/2 Knee	3 Trials 2 Foot Landing 9 Points			
Controlled Jump Right	Floor 1/2 Knee	3 Trials 1 Foot Landing 5 sec			
Left	Floor 1/2 Knee	" " "			

NAME_____ SCHOOL_____ AGE_____

FITNESS TESTS

ITEM	SCORING		CRITERIA	SCORE	COMMENTS
SIT AND REACH			BEST/2 TRIALS		
SHUTTLE RUN			BEST/2 TRIALS		
LONG JUMP			BEST/2 TRIALS		
CURL-UPS			1 TRIAL PACED TOTAL NUMBER		
PUSH-UPS			1 TRIAL - NO TIME LIMIT TOTAL NUMBER		

PWC
170

NAME: _____ DATE: _____

WEIGHT: _____ Kilograms BIRTHDATE: _____ AGE _____

LEVEL 1

KP _____

RPM _____

HR 1 _____

HR 2 _____

HR 3 _____

HR 4 _____

LEVEL 2

KP _____

RPM _____

HR 1 _____

HR 2 _____

HR 3 _____

HR 4 _____

LEVEL 3

KP _____

RPM _____

HR 1 _____

HR 2 _____

HR 3 _____

HR 4 _____

PREDICTED VO_2 _____ l/min

_____ ml/kg/min

NAME: _____ _____ DATE: _____

AGE: _____ SEX: _____

DOB: _____

ANTHROPOMETRIC DATA

HEIGHT: _____ WEIGHT: _____

GIRTHS:	ARM GIRTH	____	____	____	____
	FOREARM	____	____	____	____
	CALF GIRTH	____	____	____	____
SKINFOLDS:	TRICEP	____	____	____	____
	SUBSCAPULAR	____	____	____	____
	BICEPS	____	____	____	____
	SUPRAILIAC	____	____	____	____
	SUPRASPINALE	____	____	____	____
	ABDOMINAL	____	____	____	____
	FRONT THIGH	____	____	____	____
	MEDIAL CALF	____	____	____	____

TRICEP, SUBSCAPULAR, BICEP, SUPRAILIAC TOTAL ____

TRICEP, SUBSCAPULAR, SUPRASPINALE, ABDOMINAL, FRONT THIGH, CALF TOTAL ____

MUSCULAR STRENGTH AND ENDURANCE, FLEXIBILITY TEST

GRIP STRENGTH RT ____ LT ____ TOTAL ____

TRUNK FLEXION ____ CM

60 SEC SIT UPS ____

PUSH-UPS ____

APPENDIX D

MOTOR PERFORMANCE TEST BATTERY

THROW AND CATCH

EQUIPMENT	Tennis ball
	Scoring grid on Record Sheet
STARTING POSITION	Subject stands facing a smooth wall at a distance of 8 feet. (mark with tape)
TASK	Subject throws the ball to hit the wall and catches it on the return with both hands. He must use an underarm throw.
	The ball must be caught clear of the body, not trapped against body or clothing.
	The tester should demonstrate the proper way to catch if the subject holds his hands too closed or too open, does not move his body or arms to meet the ball, or commits some other error of technique.
	The tester should also show the child that the ball must be thrown high enough to give a good rebound.
	Success or failure should be entered on the grid after each attempt.
TRIALS	15. Do all of them.

THROW AND CATCH

EQUIPMENT	Tennis ball Scoring grid on record sheet Smooth wall and 8' distance marked on floor.
PROCEDURE	a) Say, "Now I want you to stand behind this line and throw the ball to the wall, underhand. When the ball returns, catch it with both hands. Try not to use your body to trap the ball." Then demonstrate and say, "It should look like this. Throw the ball to the wall, and catch it with both hands. Now you try it. Good. Can you do 15?" The tester should correct errors of technique if the subject has difficulty and indicate that the ball must be thrown high enough to give a good rebound.
TRIALS	15 with preferred hand. Do all of them. Record after each trial. Give two practice trials.

THROW, CLAP AND CATCH

EQUIPMENT	Tennis ball Scoring grid on record sheet
PREPARATION	The starting position must be away from walls and furniture. Tester stands in front of and to the side of the subject.
TASK	Subject throws the ball into the air with preferred hand, and catches the ball cleanly in two hands. The ball must not be trapped against the body or clothing. Test to three trials or success, whichever comes first in the following categories. Discontinue testing with three consecutive failures.
TRIALS	a) Catch the ball with both hands. b) Catch the ball with both hands after 1 clap. c) Catch the ball with both hands after 2 claps. d) Catch the ball with both hands after 3 claps. e) Catch the ball with both hands after 4 claps. f) Catch the ball with preferred hand after 4 claps.
FAILURE	If ball is not caught in prescribed manner, or clap is not visible or audible before the ball is caught.

THROW, CLAP AND CATCH

EQUIPMENT

Tennis ball
Scoring grid on record sheet

PROCEDURE

a) Say, "Now I want you to throw the ball into the air with one hand and catch it with two. Try not to use your body to trap the ball." Give three trials. If successful continue in this manner. "Now, throw the ball into the air with one hand and clap once before you catch it with both hands." Then demonstrate and say, "It should look like this. Throw the ball up, clap, and catch. Now you try it."

The tester should correct errors of technique if the subject has difficulty and indicate that the ball must be thrown high enough to allow time for the clap.

TRIALS

Allow three trials or success whichever comes first. Record after each trial. If successful continue to the next condition.

FAILURE

If ball is not caught in prescribed manner, or clap is not visible or audible before the ball is caught.
Score expressed in one of the following categories.
a) Cannot catch the ball with both hands.
b) Can catch the ball with both hands after 0 claps.
c) Can catch the ball with both hands after 1 clap.
d) Can catch the ball with both hands after 2 claps.
e) Can catch the ball with both hands after 3 claps.
f) Can catch the ball with both hands after 4 claps.
g) Can catch the ball with preferred hand after 4 claps.

STORK BALANCE
Right and Left

EQUIPMENT	Stop watch
PREPARATION	Subject must wear running (gym) shoes. The starting position must be away from walls and furniture. Tester must stand in front of and to the side of the subject so that the feet can be observed clearly.
TASK	Subject stands on one foot and places the sole of the other foot against the side of the supporting knee. The hands are placed on the hips with the fingers facing forwards. Tester should ensure that subject is in the correct position before starting the stopwatch. The task is repeated with the other leg raised.
TRIALS	Three for each leg.
SCORING	Discontinue timing after 20 sec. Record time for each trial. Stop watch: If the standing leg is moved from the original position. If the free foot is moved from the inside of the knee. If the hands are removed from the hips. If the subject cannot adopt the balancing position, assess score of 0.

STORK BALANCE
Right and Left

EQUIPMENT Stop watch

PROCEDURE Starting position must be away from walls and furniture. Subject must wear running shoes.

a) Say, "Watch me." Then demonstrate task. Stand on one foot and place sole of the other foot against the side of the supporting knee. Place hands on hips with fingers facing forward.

b) Then stand in front of and to the side of the subject so that the feet can be observed clearly and say, "Now you try it. Let's see how long you can do it. Now do it with the other foot."

Tester should ensure that correct position is attained before starting watch.

TRIALS Give three for each leg.

FAILURE Standing leg is moved from the original position.

Free foot is moved from the inside of the knee.

Hands are removed from the hips.

Subject cannot adopt the balancing position.

BOARD LACING

EQUIPMENT	Lacing board Lace Stop watch
LAY OUT	The subject takes the board in one hand. He holds the lace, which is quite separate from it, near the unknotted end ready for lacing.
TASK	On a signal the subject threads the lace back and forth through the holes, pulling it as far as it will go each time. The lace must not be wound round the edge of the board, but threaded straight in and out. The tester should demonstrate threading with one hand, and may remind the subject that this is easier, but he is not disqualified if he uses both hands.
TRIALS	Three

BOARD LACING

EQUIPMENT

Lacing board
Lace
Stop watch

PROCEDURE

a) Say, "I am going to show you how to thread the board. Hold the board in one hand, and hold the lace in the other, at the unknotted end. Now pull the lace through the holes as far as it will go. Keep threading in and out, like this. You may use two hands if you wish.

b) Remove the lace and give the lace and board to the subject. Then say, "Ready? Go."

TRIALS

Give three trials.
Record time for each trial, and any errors in lacing.

CONTROLLED JUMP
Right and Left

EQUIPMENT

Set of jumping stands
Weighted cord
Stop watch

PREPARATION

Tester measures subject's knee height from the floor to the lower border of the kneecap and places the cord on the pins at the same height. The pins should be on the far side of the child as he jumps to allow the cord to fall off without pulling down the stand.

The jumping stands should be rather more than shoulder width apart.

TASK

Subject takes off with the feet together, jumps over the cord, and lands on one foot. Subject must remain on the landing foot for 5 seconds without the other foot touching the ground. (A minor adjustment of the landing foot is permitted.)

Both feet are tested.

The stop watch should be started when the subject lands.

TRIALS

Give three for each leg.
Record time of each trial.

SCORING

Indicate failure and assess time of 0:
If subject does not take off with two feet together.
If subject does not land on one foot and maintain the position for 5 seconds.
If subject displaces the cord.

CONTROLLED JUMP
Right and Left

EQUIPMENT

Set of jumping standards
Weighted cord
Stop watch

PROCEDURE

Measure subject's knee height from floor to the lower border of the kneecap. Place cord on pins at this height. Standards should be slightly more than shoulder width apart. Pins face direction of jump.

Say, "First we will measure your leg. Now stand with your feet together, jump over the cord, and land on your right (preferred) foot. When you land keep your position as long as you can."

Start the stopwatch when the subject lands.

TRIALS

Three trials for each leg.

FAILURE

Subject does not take off with 2 feet together.

Cord is displaced.

Subject does not land on one foot and keep position for 5 seconds.

Note: A minor adjustment of the landing foot is permitted.