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PHYSICAL AWKWARDNESS AND READING DISABILITY: A DESCRIPTIVE STUDY

by

(C) MARGARET JANE TAYLOR

A THESIS

SUBMITTED TO THE FACULTY OF GRADUATE STUDIES AND RESEARCH

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submitted by Margaret Jane Taylor

in partial fulfilment of the requirements for the degree of Master of Science in Physical Education.

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Jane Watkinson

Date October 8, 1982

ABSTRACT

The purpose of the study was to systematically define a research sample of learning disabled and control subjects; apply a reliable test for the purpose of detecting physically awkward behaviour; and thereby identify one or more subgroups who had common problems in motor skill performance.

One hundred and twenty-eight control children and one hundred and twelve reading disabled children, aged 8, 10 and 12 years were identified as the research sample. Subjects were screened for age, IQ, obvious neuro-muscular, behavioral and second language problems. Reading disability was determined by the Catholic School Board using th Tinker-Bond formula and was verified by subsequent screening with the Schonell Diagnostic Reading Test.

Subjects were individually administered a 15-item motor performanc test battery over a five month period. The results indicated that reading disabled children performed more poorly on the catching, balanc and jumping tasks. Performances on the fine motor tasks were mixed. N group differences were evident on the target throw. In contrast, grade five reading disabled children exceeded the control group on the dodge run.

Percentile ratings of individual scores according to age and sex enabled the identification of severely awkward (three scores below the 10th percentile) and generally awkward (two scores below the 10th and a number of scores below the 20th percentile) groups. Forty-eight children or 20 percent of the total sample were identified as awkward.

The incidence of awkwardness was equally distributed between the sexes. In contrast significantly more reading disabled boys were awkward compared to control boys. In addition, 27.7 percent of the reading disabled children compared to 13.3 percent of the control children were physically awkward.

Twenty-six children or 10.8 perce[illegible]le were identified as severely awkward. Seven[illegible] children also experienced reading difficulties. A subgroup of 8 year old severely awkward reading disabled children resulted from this identification process. The study provided substantial evidence for the concomitance of physical awkwardness and reading disability. Recommendations for further study of the strategic behaviours of the identified subgroup were made.

Unless one comes to an understanding concerning the nature of Change, one will have many difficulties.

Plato

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I would like to express my gratitude to Dr. A. E. Wall, who has both advised and encouraged me, during the past three years. He has continuously provided me with the confidence which I lacked and the support which I needed. It is my hope that my future academic pursuits will merit his faith in me.

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CHAPTER 1

INTRODUCTION

Over the past 20 years a renewed interest has developed in children who do not acquire adequate proficiency in movement skills. In view of the current concern for accurate identification and efficient remediation of physically awkward children, it is interesting to note that the following words were written by Galen almost 2,000 years ago.

> But in the young it is better to try to modify the pathological conditions, even if they have been accustomed to them from childhood, for their strength can sustain modification if it is made moderately, and there is hope that for the remaining time of life they will be assisted to better activities. (C200/1951)

Although Galen spent long hours cataloguing movement problems, their symptoms and his recommendations for treatment, modern researchers have found it increasingly difficult to progress beyond this stage of description to the creation of an effective method of early identification (Keogh et al, 1979; Gordon and McKinlay, 1980; Henderson and Hall, 1981).

Some of the difficulty which researchers have encountered has been brought to the problem because of the variety of disciplines they represent. Many of the early researchers in particular were trained in medicine and were therefore influenced by the deficit model approach. More recently psychologists and physical educators have viewed the problem from the perspective of motor learning theory. Not only have their theoretical commitments influenced their methods of inquiry but also the subjects whom they have chosen to study. Compilation of a descriptive profile of the physically awkward child based on research findings has therefore remained a problem. For example, in one study s/he may be a moderately mentally retarded child (Keogh, 1968) and in another be identified as minimally brain damaged (Prechtl and Stemmer, 1962).

Despite the confusion which has surrounded the attempts to define and describe the physically awkward, there is considerable agreement concerning the social and psychological concomitants which these children experience. "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" (McKinlay, 1978). A study by Symes (1972) indicated that the performance inadequacies of awkward children do not go unnoticed by their peers, and the humiliation which they feel is fueled by the rejection they encounter. Gubbay (1975b) and Keogh et al (1979) have indicated that self confidence can become so eroded that physically awkward children develop a pattern of disruptive behaviour in an effort to mask their movement difficulties.

Proof that these children have become masters at deception is provided by the frequent inability of teachers to recognize the source of their disruptive behaviour (McKinlay, 1978). Researchers have joined forces therefore, in voicing the need for a reliable screening test which would help to identify the estimated six to ten percent of the population who are physically awkward (Brenner, Gillman, Zangwill and Farrell, 1967; Stott and Henderson, 1972). Although there is some support for a higher involvement of males than females (Gordon and McKinlay, 1980), it has been suggested that this belief stems from the overwhelming number of all boy studies which have been conducted (Keogh, B., 1982). Gubbay (1975b) did not find any sex differences in his study of 992 children, whereas Keogh et al (1979) indicated that a higher incidence of boys would coincide with the greater number of boys who are identified with other types of learning problems.

Statement of the Problem

Since movement difficulties have often been cited observationally as concomitant problems of children experiencing learning disabilities (Prechtl and Stemmer, 1962; Bax and McKeith, 1963; Knights and Bakker, 1976), it is quite probable that there is a definite subgroup of the learning disabled population which is also physically awkward (Wall, 1982). Since Stevens and Birch began using the term "Strauss syndrome" to describe children with learning and movement difficulties (Lerner, 1976), researchers have been trying to devise useful operational definitions. The best advice at present indicates that efforts should be directed at making accurate descriptions of the specific difficulties encountered by children, rather than attempting to assemble a large heterogeneous group under the one ill-fitting label of learning disabled (Morris and Whiting, 1971; Gordon and McKinlay, 1980; Torgeson, 1982). It was with this recommendation in mind that the present study was undertaken.

The purpose of the study was to systematically define a research sample of learning disabled and control subjects; apply a reliable and test to detect physically awkward behaviour; and identify one or more subgroups who had common problems in motor skill performance.

Careful definition of the research sample, including both the learning disabled and the control group, has been cited as a major concern in learning disabilities research (Torgeson, 1975). In additon, children with learning disabilities may have difficulties in any area of learning and development, but poor reading skills is the handicap of the greatest number of children in learning disabilities educational programs (Lerner, 1976). It was decided therefore that for this study learning disability would in fact be defined as reading disability.

The selection of a suitable test of motor impairment presented a number of initial problems. In addition to the concerns of reliability and replicability, it was necessary to find a measurement technique that could differentiate between awkward and efficient performers and also reflect the natural development of skill with age. A characteristic is said to be developmental if it can be related to age in an orderly or lawful way (Kessen, 1960). It became a sub-problem of this study therefore, to monitor the ability of each task in the test battery to illustrate a developmental trend in performance. The definitions which follow will help to clarify some terms of reference.

Definitions: Theoretical (T) and Operational (O)

Physical Awkwardness (T)

"Physically awkward children are children without known neuromuscular problems who fail to perform culturally normative motor skills with acceptable proficiency" (Wall, 1982, p. 254). Although the movement difficulties expressed by these children are real and visible, the designatioh physically awkward is somewhat subjective. That is, it is a response to the inability of a child to learn certain skills which in his particular environment are regarded as important or at least desirable. Running, jumping, throwing and catching are considered culturally normative skills in Canadian culture and will therefore be monitored in this study.

Physical Awkwardness (O)

Children whose test scores on the Motor Performance Test Battery (Appendix B) fall within the following criteria will be designated as awkward.

Severely Awkward

Three test scores are at or below the 10th percentile for his/her particular sex and age.

Less Severe or Generally Awkward

Two scores are at or below the 10th percentile and a number of other scores are below the 20th percentile.

Control Subject (O)

A control subject may be defined as any 8, 10 or 12 year old child in grade three, five or seven in the Edmonton Catholic School System who has: an intelligence quotient between 85 and 115 on the Primary Mental Abilities or Lorge-Thorndike IQ Tests; and no obvious physical or neuromuscular handicap, gross behavioural problem, predominant second language or detected reading difficulty.

Reading Disability (T)

> Specific reading disability may be defined as the failure to learn to read with normal proficiency despite conventional instruction, a culturally adequate home, proper motivation, intact senses,

normal intelligence, and freedom from gross neurological defect. (Eisenberg, 1960, p. 360)

Reading Disability (O)

A disabled reader in this study will be any student who meets all of the criteria outlined for a control subject, but who is reading at least one third below the rate of his peers [as determined by the screening system of the Edmonton Catholic School System and the Tinker Bond Formula (see p. 44)].

Hypotheses

A number of hypotheses have been developed to give direction to the descriptive statements concerning the concomitance of physical awkwardness and reading disability which may emerge from this study.

Sex Differences

Hypothesis 1

On the test battery as a whole, sex differences will be negligible.

Hypothesis 1-2

Boys will out perform girls on the ball skills tasks.

Group Differences

Hypothesis 2

As a group, the reading disabled children will perform more poorly than the control children on all tasks.

Hypothesis 2-1

The differences between group performances will be most evident at age 8 and will decrease consistently with increasing age.

Hypothesis 3

There will be more reading disabled than control children identified as physically awkward.

Hypothesis 3-1

There will be more reading disabled than control children identified as severely awkward.

Delimitations

The control subjects in the study were 8, 10 and 12 year old boys and girls selected from nine schools in the Edmonton Catholic School System. The reading disabled subjects were selected from 40 schools in the same system. The children were tested on an individual basis in their own school gymnasium over a period of four months.

Although the performances on 12 of the 15 tasks in the test battery were monitored over three trials, the screening procedure was performed in a single session. It was intended as a monitor of existing physical skill performance and not as a measure of potential.

Limitations

The most serious limitation to the study was the three month break between test administrations to each group. It would have been most desirable to gather data from both groups simultaneously, but this was not possible. It could be argued, however, that this procedure was actually in the favour of the reading disabled group since they were tested three months later than the control group, and would have the benefit of increased maturation and practice time.

CHAPTER 2

A SELECTIVE REVIEW OF THE LITERATURE

Physical Awkwardness

Does it Exist? - Historical Evidence

Although investigative research specifically aimed at physical awkwardness did not emerge until 1962 with Walton's coining of the term the clumsy child syndrome, his efforts were made in direct response to a growing number of observations recorded by pediatricians and pediatric neurologists concerning the behaviour of their clinical subjects. Walton's own clinical work lead him to the conclusion that the syndrome was much more widespread than generally believed. Documentation of some of the early observations may help to provide an historical framework in which to place more recent research.

As early as the second century Galen described children whom he observed having difficulty performing skilled movements with either hand (Orton, 1937). Galen's term for these children was ambilevous; or doubly left-handed. The image although somewhat unfair to left handers, is an effective one. These children displayed a lack of skill on both sides of the body which produced a performance reminiscent of the ineptness shown by a nonpreferred hand. Galen's observations were to be verified many times over.

The following comments made by Morgan in 1896, are of note, not because of the disability described, congenital word blindness, but because they represent the recognition of the existance of an isolated developmental disturbance.

> He has always been a bright and intelligent boy, quick at games, and in no way inferior to others of his age. His great difficulty has been - and is now - his inability to learn to read. This inability is so remarkable, and so pronounced, that I have no doubt it is due to some congenital defect. (p. 1378)

Morgan's account established the groundwork for future observations and investigation of seemingly non pathological developmental disorders.

It was not until 1937, however, and the publishing of Orton's excellent book Reading Writing and Speech Problems in Children that a link was made between the difficulties of learning the complex movement patterns of speech and writing and the expressive problems experienced in performing movements of the body and limbs. He formulated his approach for treatment of these handicaps from the study of close to one thousand cases referred to the Language Research Project of the New York Neurological Institute between 1930 and 1936. In his approach, Orton realized the importance of not only evaluating language and motor functions, but also of assessing economic, social, educational and emotional factors impinging on the development of the child. Although his main interest was in the remediation of reading, writing and speech problems, Orton showed remarkable insight in his descriptions of children with developmental apraxia.

> 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)

> At times the motor [illegible] 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 used the term motor intergrading to denote the characteristic of mixed laterality which he found to be common among children with developmental difficulties. He indicated that of those children who exhibit a high degree of ambivalence between left and right hands, none could be termed ambidextrous, and most showed less than the usual skill for their age in performing intricate movements with either hand.

He was also acutely aware of the feelings of inferiority that his apraxics inevitably demonstrated even though their clumsiness was manifested in many different ways. He felt it was the responsibility of the clinician to relieve the child and the parents of their guilt feelings by providing expert diagnosis and proper training. Orton, rightly or wrongly, truly believed that any technique or skill could be mastered with sufficient application and practice.

In 1942 Spillane gave a detailed account of congenital Gerstmann's syndrome. This disorder, which had previously been identified by Gerstmann in 1924 as resulting from lesions in the left parietal-occipital area of the brain in adults, resulted in finger agnosia, confusion of right and left, acalculia and agraphia. The symptoms of finger agnosia are difficulty in recognising, naming, selecting, differentiating, and indicating not only the fingers of ones own hands, but also those of others. The subject had a history of slow early development, difficulty in reading and poor right-left discrimination.

> The most striking defect was his failure to orientate himself for right and left. When asked to show his right or left hand, he did so hesitatingly, and after much thought. But if requested to take two steps to the left and turn right he was at a complete loss and would execute clumsy and confused movements. (p. [illegible])

It is interesting to note that the man in question had managed to compensate for his inabilities and keep them relatively well hidden until he was required to perform on the parade ground for military service.

The work of Gesell and Amatruda (1947) on developmental diagnosis lent substantial support to the belief that many of the children being referred to pediatric clinics were experiencing problems as a result of minimal cerebral injury. Their work complimented that of Orton with respect to the concern for acquiring a total picture of influencing factors, including general physical endowment and infant temperament, environmental integrity and quality of management. Although they cautioned that diagnosis of minimal injury might be guesswork at best, their suspicions were aroused if the child was first born, if s/he was premature, if the birth history was at all adverse, or if encephalitis was suspected. The following description illustrates a typical case of delayed development reported by the authors.

> The infant cried normally and seemed vigorous. However she showed a well-defined deficiency in her ability to nurse. This disability in motor coordinations required for sucking was the forerunner of similar coordination difficulties which showed themselves in stammering, faulty verbal associations, delayed unilateral dominance, and in failure with simple block building and form matching as late as 4 1/2 years. (p. 245)

Though Gesell and Amatruda stated that minimal cerebral injury frequently resulted in postural, locomotor and prehensory retardation, they also observed that these motor deficits often ameliorated as the child grew older. The one common residual however was serious difficulty in the acquisition of reading. The prevalence of this symptom led the clinicians to the conclusion that minimal cerebral injury was much more common than generally recognized.

The psychiatrist, Anna-Lisa Annell, felt that motor dysfunction was a limiting factor in school performance, even in children with average or superior intelligence (1949). She found that approximately 13 percent of 600 referrals between 6 and 17 years experienced deviations from normal motor development. Of these, roughly 10 percent were of normal or above average intelligence. Annell developed seven distinct groups in her attempt at classifying different combinations of symptoms. The following represents a description of an 8 year old boy with an IQ of 135 who showed symptoms of motor infantilism, her most common category.

> He has always been left handed. He learnt to dress himself late and still dresses slowly, finding it difficult to do up buttons, and cannot tie shoe-laces without their coming undone. He has not wanted to learn to ride a bicycle or to skate. . . . . Sometimes he makes athetoid accessory movements with his fingers, particularly in movements of precision. His gait is slightly wide-stepped like that of a small child. He is very uncertain when he makes movements without visual control. (p. 906)

Annell concluded her paper with a plea for an interdisciplinary research and treatment plan as the most fruitful approach to understanding and remediation of these developmental problems.

An attempt was made by Doll in 1951 to describe the series of behavioral symptoms resulting from central nervous system impairment by the term neurophrenia. Doll differentiated neurophrenia from cerebral palsy, because it encompassed all behavioural manifestations of the anomaly, both physiological and psychological, and was restricted to the years from conception to late adolescence. One of the most striking characteristics of neurophrenia was an obvious decrease in symptoms with maturation. From interviews, observation, clinical work and literature review, Doll compiled the following list of symptoms: disturbances of neuromuscular coordination, deficits in sensory perception or receptive aphasia, difficulties of expressive language, emotional depression and confused laterality. Doll emphasized the importance of careful assessment because of the complications induced by such serious expressive inadequacies.

Further evidence of the psychological concomitants of physical awkwardness is supplied by Ford's description of congenital maladroitness (1960).

> 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. (p. 197)

Ford identified the main problem as a difficulty in learning complex motor actions. It is worthwhile noting that he attributed the lack of handicap noticeable in adulthood, to an avoidance of physical activity rather than amelioration through maturation, as previously suggested by Gesell and Amatruda (1947) and Doll (1951).

A final reference is made to the work of Prechtl and Stemmer (1962) in detailing the characteristics of 50 hyperkinetic children who exhibited in common, chorea-like twitchings of the limbs and head.

> The majority of the children's parents declared that even at an early age their children had displayed particularly wild, unrestrained behaviour, clumsiness, inability to concentrate on any plaything for long, and very labile mood fluctuating between timidity and outbursts of aggression. (p. 123)

The authors reported that 90 percent of the group under study had reading difficulties and many experienced disordered spatial perception and orientation. Prechtl and Stemmer concluded from their clinical findings that these children suffered from a type of cerebral palsy due to minimal brain damage.

Considering that most of the cases cited were referred for difficulties other than their awkwardness, one cannot fail to be impressed by the similarity of symptoms described. Most of the subjects were of average intelligence yet experienced school failure and frequently an inability to read. Often no obvious cause could be identifed other than minimal brain injury, for which there was no definite test. Invariably the child had difficulty dressing, was unsure and clumsy in performing complex motor tasks, and could not differentiate right from left. Recurrent observations of the feelings of inadequacy and inferiority expressed by these children gave added impetus to the study of physical awkwardness as a behaviour syndrome in its own right. Researchers have continued to document case studies of children with developmental difficulties who also experience awkwardness in performing physical skills (Paine, 1968; Kinsbourne, 1968; Critchley, 1970; Harvey & Wallis, 1979), however, a growing number have attempted to study this heterogeneous group of children from the viewpoint of one common symptom, physical awkwardness.

Definition

Direction was given to the field by the reporting of Walton, Ellis and Court (1962) on the significant characteristics of five children diagnosed as having developmental apraxia or agnosia. The children who ranged in age from 9 to 14 displayed normal intelligence, with an accompanying large discrepancy between verbal and performance subtests on the Wechsler Intelligence Scales for Children. Although no visible sign of neurological disorder other than their obvious clumsiness was evident, Walton et al described the syndrome as a defect of cerebral organization which caused problems of recognition and execution. Although the authors were reluctant to specify a particular etiology, they did not feel at this time that the syndrome was a maturational delay. "We see developmental apraxia and agnosia as bands in a spectrum of developmental disorders involving speech, reading, movement and spatial orientation which is slowly being defined" (p. 609).

Proof that people were listening to Walton's pleas for wider recognition of clumsiness as a developmental disorder came in an acknowledgement printed in the British Medical Journal (1962). Three important guidelines for research into physical awkwardness resulted from this paper. One, the etiologies are diverse, but generally fall into two categories, brain damage and delayed maturation of the nervous system. Two, clumsy children are prevalent and deserve careful diagnosis and treatment. Three, the route for future research is to determine etiology and thereby ascertain remedial techniques.

Although most researchers recognized the heterogeneity of causes, their work tended to adopt one of two basic models. The medical model, accepted the fact that there was a basic deficit in performance due to brain damage although not necessarily of an anatomical or detectable nature. The developmental lag model, in contrast, accepted the fact that physical awkwardness was a developmental disorder due to delayed maturation of the nervous system which resulted in perceptual and organizational difficulties.

A third and more recent approach to the problem of physical awkwardness discards in a sense, the concern with etiology and focusses instead on the processes involved in accurate skill performance as a guide to the understanding of those who fail to perform in a skillful manner. A brief review of some of the major contributions to each model and the consequent efforts at definition will follow.

The Deficit Model

One of the most comprehensive of the early studies was done by Brenner, Gillman, Zangwill, and Farrell (1967). This was the first attempt to apply a visuo-motor test battery to a group of normal children in an effort to illustrate the incidence of handicap in the general population. The screening test which purported to measure dexterity, perceptual analysis and constructional skill identified 54 of the 810 children or 6.7 percent as experiencing visuo-motor handicap. A three year follow-up study on 14 of the most severe cases as compared to 14 control subjects matched for age, sex, handedness, verbal IQ and home and school background indicated some significant differences. The experimental group displayed a significantly lower performance IQ than verbal score; they performed more poorly on tests of spatial judgment and manual skill; they experienced spelling and arithmetic difficulties and had a high incidence of behaviour problems. The authors concluded that agnosic-apraxic disabilities were probably due to minimal cerebral dysfunction, although this was an inference from developmental history since no EEG's were performed.

Brenner's work had been a direct reply to the studies of Gubbay, Ellis, Walton and Court (1965), in which they restated the need for suitable screening tests, and early recognition and treatment of the physically awkward child. From case studies of 21 apraxic children, four of whom had been reported in the paper by Walton, et al (1962), the authors concluded that three etiologies were probable; inadequate establishment of cerebral dominance, delayed maturation, and structural lesions in one or other parietal lobe. Because there had been a striking improvement in the performance of some of their subjects, maturational delay did seem to be a plausible explanation, however, the authors eventually concluded that "underlying brain damage is usually present" (p. 311), and indicated that the majority of their subjects manifested a form of minimal cerebral palsy. In addition to their severe clumsiness and poor school performances, the children presented with a noticeable incidence of crossed laterality; poor writing; some degree of abnormal articulation; behaviour problems; restlessness; and a marked discrepancy between Verbal and Performance scores on the Wechsler Intelligence Scale for Children. In fact, Gubbay, et al concluded that this discrepancy on the WISC was the single most useful test in identifying clumsy children.

Gubbay continued his research, devised an eight item test battery which he subsequently administered to 992 children between 8 and 12 years old and by 1975 had decided that the clumsy child was one "whose ability to perform skilled movement was impaired, despite normal intelligence and normal findings on conventional neurological examination" (1975a, p. 233). It is interesting to note however that on the follow up study of 52 identified clumsy children, a significant number had reading quotients and intelligence quotients below 80 as compared with their controls, and there were significantly more abnormal EEG tracings in the clumsy sample (1978). These findings may be somewhat difficult to place in perspective, considering Gubbay's definition.

Concurrent with Gubbay's work in Australia, Stott (1966) began research in Scotland on the revision of the Oseretzky Test of Motor Ability. The purpose of this work was to devise a method of measuring motor impairment which was of a functional, or presumed neurological origin. Stott made an effort to minimize the effects of stature, muscular strength, spatial ability, mental level, temperament, previous learning, and culture although he realized their inevitable contribution to motor performance. This approach to an operational definition of clumsiness was much different than the discovery method used by previous researchers. Stott and his coworkers (Moyes and Henderson) made the assumption that clumsiness was a type of learning disability due to neurological defect which manifested itself in five specific areas: control and balance of the body while immobile; control and coordination of the upper limbs; control and coordination of the body while in motion; manual dexterity with emphasis on speed; and simultaneous movement and precision. Although Henderson and Stott recognized the heterogeneous nature of clumsiness, they stated that from results of their work, children who evidenced impairment were generally impaired in all five functions (1977). They tended to agree with Gubbay that clumsy children were equally distributed between the sexes. They approached the question of incidence by designing a test which would mirror the 10-15 percent impairment rate reported by Pringle et al (1966) in a study of 11,000 births in the British National Child Development Study.

The initial work of Brenner and the continuing work of Gubbay and Henderson have had a major impact on research into awkward children. The most obvious contribution has been the development of standardized tests of impairment. Two frequent criticisms of the deficit model approach are; one, that limitations are placed on the improvement that can be expected through remediation; and two, that although the tests tell us that a child is impaired, they do little for our understanding of the processes underlying movement skill development (Keogh, 1977).

The Developmental Lag Model

Those proponents of the developmental delay theory felt that this model held a much more favorable prognosis for the clumsy child. It had been fairly well established that mental retardation frequently was a causal factor in some types of clumsiness (Malpass, 1963; Francis and Rarick, 1959; Keogh, 1968). This was not the developmental clumsiness which interested developmental lag theorists, however. Ingram's clinical classification of chronic brain syndromes other than cerebral palsy, epilepsy and mental defect, categorized specific clumsiness as a "clinical syndrome with inconstant evidence of brain abnormality" (1963, p. 13). He emphasized that there was a natural wide distribution of ability in children, which was in turn affected by environmental opportunity and a genetic predisposition to developmental difficulties. Ingram credited the concept of minimal brain injury with directing attention to disorders which had previously been ignored, but he cautioned "it may be shown that brain damage is a contributory factor in a large variety of different behaviour abnormalities, but in many of these it seems likely that brain injury is a cause of psychological distress, but does not have a direct effect on the child's behaviour patterns (p. 16)."

Accepting the theory that delayed motor development was a common cause of clumsiness, Illingworth (1968) described the clumsy child as a "generic term to describe the older child who is awkward in his movements, like a much younger child" (p. 577). He provided a detailed protocol for pediatricians to follow on the route to a diagnosis of delayed maturation.

Further impetus was given to this theory in the now classic paper on developmental clumsiness by Reuben and Bakwin (1968). The authors discredited the term minimal cerebral damage syndrome as had been done in 1962 in the comprehensive monograph by Bax and McKeith (1963). Instead, they outlined a process of management for the developmentally clumsy child which they felt would relieve the pressure of a cerebral damage label. In describing the syndrome the authors stated that the children were awkward in the performance of everyday activities requiring ordinary manual dexterity and lacked the physical skills needed in school and athletics. They frequently had difficulties with handwriting and speech. They had low self esteem and performed poorly in school. Frequently they scored much lower on the performance than on the verbal portion of the Wechsler Intelligence Scale for Children. Notwithstanding the theoretical commitments of various researchers, the clumsy child syndrome was beginning to take shape.

Two important contributions to the theory were made by Dare and Gordon in 1970. In studying 35 physically awkward children referred to the Children's Hospitals in Manchester they developed three etiological classifications; specific developmental disorder; general development retarded; and minimal cerebral palsy. The first category contained the majority of their cases. The authors reiterated many of the characteristics previously mentioned, but in addition, they recognized the components of skilled motor function which had previously been ignored. Dare and Gordon realized that difficulties in performing for the physically awkward child could be manifested in either receptive or expressive components of a skill, or both. They were the first to emphasize the need for additional practice for the awkward child in learning a skill. They also suggested the essentially positive approach of developing those skills which were desirable and possible, and of avoiding those which were frustrating and non-essential.

This emphasis on effective management as the key to a healthy prognosis for the clumsy child was continued in a recent book by Gordon and McKinlay (1980). They express their adherence to the developmental delay theory in this manner.

> Clumsy children show difficulties in motor coordination out of proportion to their general abilities. They commonly, but not invariably, have co-existing learning difficulties. Their disabilities may lead to secondary emotional problems including frustration or social isolation. Thus, a child of whatever chronological age whose general abilities are those of an eight-year-old but whose coordination skills are typical of a five-or six year old will be regarded as 'clumsy'. (p.1)

The authors stress however, that there is no single cause and indeed that there is no typically clumsy child. Both gross and fine motor coordination may be affected, or either symptom may exist in isolation. They do feel that more boys are affected than girls. In lending support for early identification and management, Gordon and McKinlay suggest that detailed descriptions of the child's specific difficulties will be much more helpful than labelling him/her as brain damaged.

The impact of these, and other developmental delay theorists on research into physical awkwardness has been long lasting. The work of Reuben and Bakwin (1968) in particular was elemental in establishing the concept of developmental clumsiness. Dare and Gordon (1970), offered excellent advice for parent, teacher and child. However, those who have followed the work of Welford (1968), Elliott and Connolly (1974) and Schmidt (1975) on the nature and acquisition of skilled behaviour find developmental lag proponents to be preoccupied with identification of samples, to the detriment of the understanding of process components (Keogh, 1978). A brief review of five of the major contributors with a process approach to physical awkwardness follows.

The Information Processing Model

When Dare and Gordon (1970) wrote about clumsiness as a disorder of perception and motor organization, they alluded to the necessity of efficient sensory receptors and effectors, accurate memory, sufficient practice, selective attention, body awareness and concept formation, in addition to a cerebrally intact organism for accurate skill performance. They stopped short of saying that comprehension of motor skill performance theory was necessary to understand the phenomenon of physical awkwardness. Morris and Whiting (1971) on the other hand, made a strong case for what they called the perceptual motor performance model.

The main concepts which were developed originally by Welford (1968) have been revised and rewritten many times (Adams, 1971; Schmidt, 1975; Glencross, 1978; Singer, 1979). Very simply, the model describes a process in which the organism receives and perceives input stimuli, stores this information in an organised manner, generates appropriate decisions based on suitable strategic plans and then modifies this behaviour as a result of the feedback received from the resulting performance outcome. By indicating the many problems which motor impaired children could have within these processes, the authors tend to underscore the relative simplicity of the structural approach (i.e., deficit and developmental delay) to physical awkwardness. After convincing the reader that an information processing model is essential, the authors go on to suggest that the application of the model is extremely difficult. Although

> it serves the purpose of focusing attention on the diverse subsystems involved in any skilled performance, it also makes explicit the numerous disturbances which can affect the functioning of such subsystems or prevent the building up of mediating processes vital to adaptive behaviour. (p. 32)

Perhaps part of the value of Morris and Whiting's work lay with their ability to objectively evaluate the state of the art. They defined motor impairment as "the inability of an individual to perform simple everyday tasks effectively in a controlled and coordinated manner" (p. 15). They particularly commented on the arbitrariness of a cut-off score in designating physical awkwardness, since the term really was relative to what was expected of the child at a specific age, in his/her environment, by parents, teachers and peers. The authors indicated that the true magnitude of the problem of physical awkwardness could not be determined until a universal test existed which could accurately identify the sample. However, since those motor skills deemed essential or culturally desirable varied with the population being screened, construction of a suitable test remained a challenge.

Keogh accepted this challenge and made an effort to link motor performance theory to practice in his research. Earlier efforts (1966; 1968b), had dealt with the identification of awkward boys by administering a motor performance test. He later concluded that "performance data are limited in value when searching for underlying mechanisms and their functioning" (1977, p. 65). More value could be gained Keogh thought by observing the use of strategies, the types of errors made, the degree of confidence shown, the speed of learning evidenced, and the degree of right-left confusion displayed in a performance than in the raw score attained. He put forward an interesting concept of movement consistency and movement constancy as necessary and interrelated processes in the acquisition of motor skill. Movement consistency resulted with the acquisition of refined and reliable movement skills for solving everyday living problems. Movement constancy was the flexible use of these movement consistencies in solving novel movement skill problems (p. 80). The value in his treatise on movement skill development was in relating information processing theory to development. Both Bruner (1973) and Hogan and Hogan (1975) had made progress in describing the features of the development of skilled action. The more sophisticated models however, frequently omitted the development of skilled behaviour, and chose to deal with the learning mechanisms of an already skilled organism (Glencross, 1978).

In a later paper Keogh (1978) described movement consistency as movement for self; and movement constancy as movement for others. This concept related directly to the degree of difficulty that spatial and temporal constraints place on the acquisition of, and performance of a motor skill as explained by Higgins (1978) and elaborated upon by Wall (1982). Another aspect of Keogh's work which had considerable impact on the field was his isolation of particular psychological aspects of movement behaviour which had previously been mentioned only as outcomes of movement (Gordon, 1969; Gubbay, 1975). Thus he saw movement confidence and participation confidence not only as outcomes of adequate movement control, but also as attributes necessary in acquiring this control. This concept has considerable importance for the management of physically awkward children.

In more recent attempts to identify clumsy children, Keogh et al (1979) have made use of a multiple measurement process rather than relying on motor performance tests alone. They tried to isolate a sample of physically awkward children by applying a motor performance test, a teacher checklist of performance skills and movement behaviour and an observation checklist of performance skills and movement behaviours. In effect, the three processes identified three different groups of children. It may be that the relative ineffectiveness of this procedure is more a function of the complexity of the components of movement skill than of the failure of these measures to identify the same children.

Just as Keogh has tried to provide a conceptual link between developmental lag theorists and motor skill performance devoutees, Roy (1978) made an excellent effort at integrating the deficit model with information processing theory. The essence of his very technical paper is a reclassification of apraxia into three distinct forms, based on the anatomical site of lesion, the primary and the secondary symptoms. By viewing apraxia as a disturbance of a cognitive, information-processing system in which one or more of several basic functions may be in disarray, Roy develops these three classes: planning apraxia - or inability to properly plan motor behaviour; executive apraxia - or inability to execute planned behaviour; and unit apraxia - or inability to carry out isolated movements. Roy makes an excellent case for the study of apraxia as an important contributor not only in model building, and treatment of apraxic patients, but also in the training of skill acquisition in intact individuals. It appears that the question is not the superiority or inferiority of one model over another, but the contributions that each can make in an integrated attempt at defining physical awkwardness.

A final word on an integrated approach to physical awkwardness is afforded in the recent work of Wall (1982). Although Wall illustrates the role of genetic predisposition and an experiential play environment in developing the movement consistency first mentioned by Keogh, he emphasizes that physical awkwardness is not readily apparent until the child enters the school system. He defines physically awkward children as those children without known neuromuscular problems who fail to perform culturally-normative motor skills with acceptable proficiency. Wall points out the developmental aspect of skill acquisition by

explaining the increasing complexity of task demands to which a child is expected to respond, that is, the growth from "reaching for a rattle to hitting a curve ball." The child meets these demands by applying increasingly more successful strategies in consistent, long term practice sessions.

Wall feels that the cognitive aspect of successful skill acquisition is demonstrated through the work of Glencross (1978) on levels of planning. Through practice, the more skilled performer, is able to relegate more and more of his skilled behaviour from an attention consuming, executive system level to a routinized, motor program level. As the performer succeeds in this process he can free more and more of his capacity to deal with the novel or more difficult situations posed by his sport environment. The child who cannot cope with increasing task demands and is always performing at the executive level, quickly finds himself in a frustrating, information overload situation. Thus, those school time sports and recreation activities which are supposed to be enjoyable, rewarding experiences for a child, become for the physically awkward, a time of humiliation and unhappiness.

Superimposed on the demands of classmates and peers are the performance expectations of the family. Wall illustrates in his description of one attempt to remediate the problems of the physically awkward how the expectations of the family can be an effective tool in developing a positive prognosis for the child.

The evolution of a definition of physical awkwardness is not complete. It has been influenced by at least the three models mentioned, and by varying methods of practical application. It is hoped

that further theorizing and application will continue and eventually realize this goal.

Before turning to a discussion of the relationship between physical awkwardness and learning disability, some of the problems concerning physical awkwardness and its measurement will be briefly presented.

Measurement

In view of the differing theoretical models which have just been outlined, it is interesting to note that on one aspect of measurement, consensus has been reached. Researchers are convinced not only of the utility but also of the necessity of a reliable test that can be used in schools as a screening device for the initial identification of children who have difficulty in learning and performing simple everyday tasks (Morris and Whiting, 1971; Gubbay, 1975; Keogh, 1979; Wall, 1982). Despite the many tests which exist, and the recent attempts to devise new measurement techniques, the literature is replete with criticism on their lack of effectiveness. In addition to the structural, administrative, and theoretical difficulties of the tests themselves (Wall, Terry and Taylor, 1981), weaknesses in research design have restricted interpretation of the results of otherwise promising research (Gubbay, 1975b; Henderson and Hall, 1981).

An extensive review of over 256 tests used in assessing the motor behavior of disabled children (Lewko, 197[illegible] indicated that the tests were frequently used with populations for which they were not intended by untrained personnel, who knew little about test standardization and norming procedures. The two most popular measurement devices cited in the survey, The Purdue Perceptual Motor Survey and The Denver

Developmental Screening Test, were criticized by frequent users as being too subjective in scoring and generally ineffective in assessing quality of performance. Additional evaluative work (Pyfer, 1976; Herkowitz, 1978; Haubenstricker, 1977) on these two tests, as well as the Lincoln-Oseretsky Motor Development Scale and the Bayley Scales of Infant Development, has emphasized the problems of insufficient standardization, weak reliability and questionable validity. According to Cronbach (1970), acceptability of any test demands that these three elements be beyond suspicion. At the very least, cautionary notes should be placed in the manual warning the administrator of the weaknesses of the particular test.

In addition to the structural and administrative problems which are common not only to tests of motor impairment but also to measures of academic achievement and intelligence, there are some theoretical problems which are specific to motor impairment itself. Since users of the screening devices are interested in the ability of a child to perform culturally normative physical skills, the tasks need to reflect skills which are generally found in the performance repertoire of a normal child (Lewko, 1977; Wall, 1982). These tasks must also attempt to tap the motor behavior domain by including both fine and gross motor items with a range of task demands which mirrors the increasing demands put on a developing child in a school environment. As Wade (1977) so aptly puts it, tests need to explore the inappropriateness of a subject's response strategy if they are to satisfy the requirements of prescription and diagnosis. In short, effective measurement techniques must be accurate monitors of development.

Fortunately, those who have commented on the inadequacies of present techniques are not without suggestions for their improvement. Lewko (1977), who draws attention to the inherent weaknesses of screening tests, believes that as a single measure of a child's behavior, they have limited value as a measure of potential. In addition, because of all of the confounding variables present in a testing situation (Lewko, 1977) and the necessary restrictions which are placed on the opportunity for practice (Newell, 1977), he feels the chance of a screening test accurately monitoring culturally normative skilled behavior is rather remote. Instead, he recommends the use of a profile analysis in which both functional and normative skills are monitored. In addition, since it is known that behavior is a contributing factor (McKinlay, 1978), the motivation level and performance expectancies of the child and his/her parents should be measured. Pyfer (1976) believes this analysis of psychological and environmental influences makes the difference between assessing and evaluating.

More recently attention has been drawn to the observation of the process rather than the product components of physical performance (Kieffer, 1977; Loovis, 1977; Herkowitz, 1978). Although the instruments may differ somewhat, they generally involve the application of a specific task analysis model in which the child's performance is rated on a skill continuum rather than a pass/fail criterion. In addition to acquiring data on a child's performance in relation to that of his/her peers, his/her place on the continuum can be used as a starting point for remediation.

Many of these suggestions have been implemented in a clinic program for physically awkward children which is described by Wall (1982). However, the feasibility of using such extensive measures in a screening process, at least for the present, seems limited. As previously mentioned, Gubbay (1978) and Keogh et al (1979) have developed a multi-measurement process in trying to circumvent the problems presented by administering a single screening test. Recent work completed by Henderson and Hall (1981) in England, has made some additional progress, however, none of the studies is without methodological problems.

Both the Australian and American studies suffer from reliability problems. Gubbay avoided computing any reliability measures for his screening test or his parent/teacher questionnaire procedure. In addition, he attributed reliability to the screening test on the basis of the poor performances of the clumsy children, even though the low scores were the basis for their selection to the clumsy group. Keogh, on the other hand, realized the value of reliability measures, but was unable to acquire them for the teacher checklist and some performance test items. His inter-observer agreement scores ranged from 0.59 to 0.87, indicating some weakness in the particular measure. It is possible that the combination of these weaknesses thwarted the attempt to identify a single sample of physically awkward children just as much as the difficult nature of identification itself.

At first glance, the English study (Henderson and Hall, 1981) seems to be on better footing. Teachers made the initial selection of 16 six year old children from a population of 400 school children. A control group of 16 children matched on sex was chosen and the following measures were given to both groups: a motor performance test, a neurodevelopmental examination, the Schonell Reading Test and the Wechsler Intelligence Scale for Children. The purpose of the study was to compare the accuracy of the teacher's judgments with subjective judgments of a pediatric neurologist and a psychologist. Although no correlations were reported the neurologist's subjective evaluations had an 89 percent agreement with the teacher's judgments. In addition, the teacher's judgment was confirmed in 26 cases by the neurologist's evaluation, the motor performance test and the neurodevelopmental examination results.

Unequivocal interpretation of these results is made difficult, however, by the following: the initial selection of subjects by the teachers was made after a year of discussion with Henderson on what constitutes handicapping clumsiness; the neurologist made his subjective evaluation after administering his neurodevelopmental test; many items on the performance test and the neurological test were identical; in short, contamination of the 'different' selection methods is apparent. The value in the study lies instead with the ability of Henderson to instruct the teachers to recognize handicapping clumsiness in the first place. In addition, her description of the group characteristics is invaluable.

In spite of the limitations outlined the three studies mentioned represent the culmination of twenty years of research on three different continents. Not surprisingly, they were a major impetus for the present study and are lasting contributions to our increasing knowledge of the nature of physical awkwardness and the difficulties encountered in attempts to measure it.

Physical Awkwardness and Learning Disability

When one reflects upon the problems of definition and measurement encountered by researchers in the field of physical awkwardness, it is interesting to note the existence of similar difficulties in the research on learning disabilities (LD). Since the announcement of the proposed definition in 1967 by the National Advisory Committee on Handicapped Children to the adoption of the definition in the Education for all Handicapped Children Act of 1975, researchers have been wrestling with the concept of specific learning disability (Keogh, 1982). Before one could even consider the many methodological questions which develop in attempts to study children with learning problems, the question of definition must be dealt with. In general, the difficulty lies in a definition of exclusion. The proposal put forward in Public Law 94-142, was designed to provide specific funding for the education of a specific group. However, when this specific group is comprised of children with normal intelligence who have learning problems in one or more of the basic psychological processes, which are not due to visual, hearing or motor handicaps, mental retardation, emotional disturbance, and cultural or economic disadvantage, the question still remains. Who are these children?

Complications are added to the problem of definition when one considers the number of different disciplines doing investigative research on learning disabilities. The theoretical leanings of a pediatric neurologist, an educational psychologist, and an opthamologist will tend to dictate the particular children which each includes in his/her study of children with learning disabilities. Barbara Keogh has emphasized this problem in a recent review of 408 studies on learning disabilities (Keogh, Major, Omori, Gandara and Reid, 1980). She catalogued the use of over 1,400 diagnostic techniques in these studies. In addition, of some 40 measures of IQ used in the selection of subjects, only three IQ tests were used more than eight times. Both Torgeson (1975; 1978; 1982) and Keogh (1982) are in agreement. The questions of who and what to study remain paramount, despite the attention each has received in the literature.

In addition to the problems of accurately defining the research sample once it is decided who should be included, Torgeson has emphasized that the heterogeneous nature of children experiencing learning problems necessitates dogged attention to the identification of rationally defined subgroups if any meaningful conclusions are to be drawn from LD research (1982). In selecting these subgroups one must take into consideration: the use of clinical or non-clinical samples; the age group to which these descriptors are specific; the construct validity of the dependent variables; and the need for manipulation of psychological processes. Most important is the development of a planned series of studies which involves the systematic manipulation of dependent variables based on sound hypotheses developed from previous research.

In a recent study on attention and the disabled reader, Lupart (1981) contended that in addition to providing a detailed definition of the sample, researchers in learning disabilities should: define the nature of the processes they are investigating, ie., either structural or control; and develop research paradigms which are ecologically valid. She points out that those who are interested in the structural features of an organism are concerned with the labeling or identification of special groups, whereas those who concentrate on control processes are more interested in the remediation of the groups' problems. Although one would not argue with her interest in developing a fruitful liaison between laboratory and classroom for the purpose of remediation, concentration on control processes does not guarantee successful or even better remedial programs than presently exist (Torgeson, 1982). Perhaps, as was evident in reviewing the research on physical awkwardness, there is some merit to an eclectic approach in LD research.

Keogh (1982) may be alluding to such an approach in her plea for more multivariate research. As she points out, researchers are trying to solve the problems of a multivariate world with a univariate approach. Her particular concern is for work on the motivational or affective component of learning difficulties. Even when sample characteristics are carefully defined, it is obvious that no two children exist in exactly the same environment of motivation and performance expectation. Information on these aspects of a child's behaviour could be just as important to remediation programs as knowledge of the processing difficulty. Another aspect of the current research which bothers Keogh is the inference of sex linked differences in performance with little data based proof. In her review of the literature (Keogh et al, 1980) 50 of 408 studies used all male subjects, two used all females, and in the remainder the male to female ratio ranged from 4:1 to 20:1. Hence her conclusion, "we know a good deal about learning disabled boys; we know very little about learning disabled girls; and, our generalizations about learning disabled children are tenuous" (p. 40).

Not only do researchers in the two fields share similar definitional, theoretical and methodological problems, they also share a common research sample. As previously demonstrated in clinical descriptions (Orton, 1937; Spillane, 1942; Gesell and Amatruda, 1947; Prechtl and Stemmer, 1962) there is evidence for the concomitance of impairment in academic achievement (in this case, reading) and physical skill performance. Indeed, according to Mellor (1980), clumsy children are more often referred to the psychologist under three common guises: learning difficulties, behaviour problems and psychosomatic aches and pains. The most extensive study which illustrates this concomitance of learning difficulties was carried out by Rutter, Tizard and Whitmore (1970) on the Isle of Wight. The aim of the study was to give a comprehensive picture of handicap in a total population of children who lived in a defined geographical area and who were in the middle years of their schooling. The authors defined handicap as "any disability which impedes the child in some way in his daily life" (p. 6). Working in this broad framework, they concluded that one child in six had a chronic handicap (present for more than a year) of moderate or severe intensity.

The Isle of Wight study is particularly applicable to the present study because of the similarity of screening techniques and subject ages. From a total sample of 3,468 children aged 9 to 12, they were able to isolate 86 children or 3.7 percent with specific reading retardation. As a group they exhibited a mean Wechsler IQ of 102 (SD=15), but performed considerably below their expected reading rate. Other notable characteristics included a more than 2:1 male to female ratio, a significant degree of clumsiness as measured by the Lincoln-Oseretsky Test, three times the incidence of children with poor motor control and short attention span as the control group, and problems with right-left differentiation of body parts. These results led the authors to conclude that reading difficulties were associated with abnormalities of motor function. They also offered the hypothesis that clumsiness may be less evident than language defects in older children with reading retardation merely because motor development proceeds faster than language development.

In addition to the evidence of reading and motor problems in the general population, a certain proportion of clinical subjects also experience these difficulties (Gubbay et al, 1965). The authors reported that six of the 21 children referred with apraxic disorders displayed a concomitting problem in reading. A similar finding resulted from Gubbay's screening of 992 normal school children (1975b). Of the 56 children designated as clumsy, 12 had reading quotients below 80. The picture is clouded in both studies however by a lack of control on sub 80 IQ scores within the clumsy sample.

Perhaps Henderson's (1981) study sheds more light on the problem of heterogeneity which plagues both these disciplines. She found that eight of 16 children in her clumsy sample displayed poor reading ability as measured by the Schonell Reading Test. In attempting to create rationally derived subgroups out of the results of her screening procedures, Henderson arrived at three different groups. Group one consisted of children with above average intelligence who did well academically but displayed isolated and relatively severe motor impairment. Group two contained five of the poor readers. They had IQ's at the lower end of the normal range, had poor academic attainment and numerous other problems. Group three represented the remaining subjects who were not readily categorized because of a mixture of abilities and a wide range of scores. Three of the disabled readers were in this group.

In examining the question of concomitance from the viewpoint of learning disorders, Boshes and Myklebust (1964) found that of 85 children referred because of poor comprehension, reading and writing skills, there were frequent complaints of awkwardness and a lack of proficiency in learning to play. The children who ranged in age from 7 to 18 had few emotional problems and were within the normal IQ range. The authors were unsuccessful in attributing any of the performance problems to suspected neurological damage, although they did find some differences in strategic behaviour between groups displaying signs of brain damage, and groups without these positive signs.

Critchley (1970), on the other hand, preferred to think that disabled readers who also displayed clumsiness were victims of a developmental disorder or positive family history, rather than a minimal brain damage syndrome. He acknowledged "inordinate clumsiness" in 34 of 125 children examined in his clinic, but suggested that it occurred in very young dyslexics who would eventually grow out of the problem. In cases where dyslexia could be unequivocally explained by brain damage, Critchley conceded, awkwardness, especially of the fine motor type, was very common.

Bradley (1980) takes exception to this view and suggests that often clumsy children are referred so late that they have already developed some reading competency. Because they can read, their clumsiness is ignored or simply not noticed. From her clinical work, Bradley concludes that "the clumsy child is likely to have problems with organising his movements, attention, concentration, what he wants to do and what he wants to say" (p. 139). She views awkwardness as a problem which affects not only reading, but also speech and writing. In an analysis of the clumsy child's difficulties in spelling, Bradley indicates that without the benefit of an automatic motor memory, the clumsy child approaches each task as a new one. S/he is always performing at the executive level (Glencross, 1978). By providing a structure in these situations, which the child is unable to develop on his/her own, Bradley has succeeded in routinising for the child some of the steps required in learning to spell, read and write.

In addition to the above research which has looked at the problem from either a motor or a reading perspective, four recent studies have directly considered the question of motor proficiency and learning disability (Bruininks and Bruininks, [illegible] Maloy and Sattler, 1979; Steinberg and Rendle-Short, 1980; Kendrick and Hanten, 1980). Results from each study indicated that the learning disabled group performed more poorly than controls on a variety of motor tasks. Unfortunately, problems of sample description and construct validity make acceptance of the findings difficult. Three of the studies did not report IQ's and gave little information on the control group other than age; one made no mention of sex ratios or the criteria for determining learning disability; one in testing children aged 8 to 11 recorded no relationship between performance and chronological age. It is apparent from these studies that some guidance in developing useful research in this area is needed.

With regard to sample selection and definition, Keogh's UCLA Marker Variable Project (1980) provides a straight forward and yet detailed list of descriptors which need to be accounted for before research can either be evaluated or embarked upon. If one then superimposes Torgeson's model for research in learning disabilities upon this guide to defining a sample, a resulting increase in utility of findings seems almost assured. Briefly, Torgeson has developed five steps to effective research. Step one involves deciding which children to study. Step two, requires the specification of an operational definition by which subjects will actually be selected. Torgeson emphasizes that an operational definition should involve reliable assessment by replicable procedures and be sufficiently broad as to exclude unwanted sources of variation (eg. low IQ's). Step three of his model requires experimentation to identify the nature of the processing deficits which characterize the target group. Included in this step is the description of group homogeneity with regard to reasons for failure on the criterion task. If, in addition, the variables which affect performance on this task can be identified, then systematic manipulation of these variables would lead to a discovery of ways to improve performance.

The major purpose of step four is to establish a relationship between troublesome academic tasks and failure on the experimental task. Step four necessitates the pairing of LD children who have a particular problem (eg. physical awkwardness) with both normal children and LD children who do not have this problem. The ultimate goal in step four is to gain a more complete understanding of how the basic processing deficiencies of the target group affect their performance on academic tasks. Once these processing deficiencies can be categorized, step five directs research to develop remedial programs that are responsive to these dificiencies.

In summary, it is evident that investigative efforts concerning the learning disabled and the physically awkward could be much more effective if they emulated the guidelines of Keogh and Torgeson. It is the goal of the present study therefore, to: systematically define a research sample of reading disabled and control subjects; apply an operational definition of physical awkwardness by the use of reliable and replicable measurement techniques; and identify one or more sub groups who have common problems in motor skill performance. When one realizes that this goal stops short of step three, the immediate reaction is to apologize for the purely descriptive nature of this study. Additional justification may be afforded the study by the following remarks of Torgeson, "the greatest usefulness of research may not be in the construction of specific remedial techniques, but in the contribution which it makes to the cataloguing and proper description of the variety of human abilities" (1975, p. 433).

CHAPTER 3

METHOD

Sample

The sample under study was chosen from all children in grades three, five and seven in the Edmonton Catholic School System. The control group was selected from nine city schools, three each representing a high, middle and low socio-economic status as determined by the school system. All children were first selected on the basis of age, that is, if their birth dates fell between February 1973 and March 1974; February 1971 and March 1972; or February 1969 and March 1970, they were included in the pool of 8, 10 and 12 year old subjects.

Following this initial selection, children were retained for the sample if their full scale IQ scores, as measured by the Primary Mental Abilities Test (grade three) and the Canadian Lorge-Thorndike Test (grade four and seven), were within the normal range (85-115). In a few instances it was necessary to include children with IQ scores which exceeded 115 in order to complete the sample. A recent study done in the Edmonton Catholic School System (Tomko, 1981) gives support for the comparability of the Primary Mental Abilities Test and the Canadian Lorge-Thorndike. The successful use of the Lorge-Thorndike as a screening device for learning disabled children has also been reported by Baker and Kauffman (1978).

In addition to the age and IQ constraints placed on the control group, subjects were eliminated from the study if they had any obvious physical or neuromuscular handicap; gross behavioural problem; predominant second language; or detected reading difficulty.

The reading disabled sample was chosen from 40 of the 52 schools in the school system in accordance with the above criteria, with the one exception of reading level. The subjects were screened for reading difficulties by use of the Tinker-Bond formula (Brosseau, Fox and Romaniuk, 1977) which employs IQ scores and the number of years in school to determine an expected reading rate. This expected rate is then compared to the actual score achieved on the Canadian Test of Basic Skills. Children are automatically identified as reading disabled if they score one third below their expected reading rate. For this study, all children with an additional negative .5 rating or higher were chosen in an effort to secure a truly representative reading disabled group. In actual reading age, they were approximately two years or more below their expected reading level (see Table 8). As a final check, the resource room teachers were asked to verify the reading difficulties of all potential subjects.

Once parental permission was obtained for all of the participants, distribution of the subjects was equated by sex. The resulting research sample is described in Table I. The mean ages were calculated as of the test date for each individual because of the three month break in test administration between groups.

Rationale for Test Battery Selection

It was the intent of this study to apply a test of motor impairment which could satisfy the requirements of reliability and validity mentioned by Lewko (1977) and Cronbach (1970) while still measuring tasks which could be considered culturally normative (Morris and Whiting, 1971; Wall, 1982). As previously mentioned, Torgeson (1975)

TABLE I

Sample Characteristics

Group	Total n m	Total n f	Mean Chronological Age Years-Months (S.D. in months)	n[a] m	n[a] f	Mean IQ[b] Fullscale Score (S.D.)
Grade 3						
Control	22	21	8-4 (3.7)	19	17	111.1 (7.2)
Reading Disabled	25	20	8-5 (4.0)	25	20	105.1 (8.9)
Grade 5						
Control	22	21	10-4 (3.2)	20	19	110.4 (11.5)
Reading Disabled	20	19	10-6 (3.5)	20	19	95.23 (7.9)
Grade 7						
Control	21	21	12-2 (3.1)	15	18	110.4 (10.9)
Reading Disabled	13	15	12-6 (4.0)	7	6	98.7 (7.7)

[a]Numbers represent sample for which IQ scores were available.

[b]Grade 3 means were computed from the Primary Mental Abilities test. Grade 5 and 7 means were computed from Fullscale scores of the Canadian Lorge-Thorndike.

has recommended the employment of widely used, well known tests over the administration of unique measurement techniques. With the above considerations in mind, the Stott Test of Motor Impairment (1972) was selected for this study.

In reviewing the tests presently available, it became readily apparent that none of them completely satisfied the identified requirements. The Stott Test however, had a well organized manual with detailed descriptions of the 5 revisions which had been made, and the rationale employed for making these changes. In addition, the test had undergone several reliability checks (Keogh, 1968a; Moyes, 1969) and during its revision and norming was administered to 657 children aged 5 to 11, and 854 children aged 6 to 15 (Stott, Moyes and Henderson, 1972). The test-retest reliability coefficients varied from .71 in Keogh's study to .93 in Moyes' study.

Whiting, Clarke and Morris (1969) failed in two validation attempts to gain significant agreement between test scores and pediatric diagnosis, or test scores and identification by teachers, parents or psychologists. Moyes, on the other hand, reported a tetrachoric correlation of .85 between test scores and teachers' detailed assessments. Stott provided additional support for the validity of the test in his study of the concomitance of behaviour disturbance and motor impairment (Stott and Marston, 1971). In view of these findings it seemed advisable to investigate the test further in a pilot study.

Pilot Study

The pilot study was performed on one hundred and fifty, 8, 10 and 12 year old children in three elementary schools in the Edmonton Public

School System. The sample was equated for sex, with 25 males and 25 females at each age group. Children were administered the Stott Test of Motor Impairment with some modifications and a dodge run task used in a previous pilot study (Taylor, 1980). The study was conducted in order to: develop a uniform training and testing procedure; verify the suitability of the test items for assessing motor impairment; indicate the time necessary to adequately test children in a school environment; and measure the test-retest reliability over a one week interval.

In an effort to develop tester consistency, six graduate students underwent a training procedure which involved reading the manual, writing a multiple choice test, administering the test to peers, and then assessing normal children. It became obvious during this procedure that practice in administering the test was the most valuable aspect of the training procedure and should be given more consideration.

The Stott manual was supplemented by verbal instructions for each task. All tests were standardized at three trials and testing was discontinued after a successful attempt. Performance score means were therefore calculated on best scores rather than average scores. The shortened version of the test was employed so that only those items which a child failed were retested at a lower age level. Except for minor additions and clarifications, the changes to the manual were considered desirable.

Suitability of the test items was determined in several ways. The ability of a test to differentiate between subjects was of prime consideration. Using the cut-off scores outlined by Stott, 10.6 percent and 10 percent of the sample were identified as physically awkward by the first and second administrations of the test. These incidence figures compare favourably with the literature (Stott, Moyes and Henderson, 1972; Keogh, Sugden, Reynard and Calkins, 1979). However some problems were evident with the fine motor simultaneous and successive tasks at age 12. The successive task failed to identify any physically awkward children. The simultaneous task suffered from questionable reliability since testers experienced difficulty in assessing simultaneity. In addition both tasks were highly susceptible to practice effects. The suitability of these tasks was therefore strongly questioned.

A particular concern arose over the hierarchical arrangement of the ball skill tests, and the possibility of differences in performance occurring due to sex. Specifically, it was felt that the throw and catch test (8 year level) contained a higher degree of uncertainty than the one hand catch (10 year level) and would therefore be more difficult for 8 year olds to perform. These hypotheses were tested by administering the three ball tasks; throw and catch, one hand catch, and target throw to all children.

Comparison of the mean scores for each age group supports the contention that boys perform better than girls on these tasks (Table 2). Similarly, the throw and catch test proved to be more difficult for the 8 year olds than the one hand catch. Testers also indicated that success on the one hand catch varied markedly with the accuracy of the tester's throw. It was decided therefore, to discard the one hand catch test and to consider the sexes as separate groups when doing further analysis of ball skills.

TABLE 2

Mean Performance Scores on Ball Skill Tests

Group[A]		Throw and Catch	One Hand Catch(R)	One Hand Catch(L)	Target Throw
Age 8					
Females	Pre	2.8 (2.5)	4.9 (2.8)	5.1 (2.9)	2.3 (1.3)
	Post	3.9 (3.0)	6.9 (2.4)	6.3 (2.2)	3.1 (1.4)
Males	Pre	4.8 (3.3)	6.3 (3.3)	6.1 (3.2)	4.5 (2.1)
	Post	6.2 (3.0)	7.1 (2.4)	7.3 (2.3)	4.2 (1.9)
Age 10					
Females	Pre	6.8 (2.4)	7.2 (2.3)	7.3 (2.4)	4.0 (1.9)
	Post	7.6 (2.4)	8.7 (1.4)	8.1 (1.8)	3.8 (2.5)
Males	Pre	9.1 (1.3)	8.6 (1.8)	7.9 (2.2)	6.1 (1.8)
	Post	9.3 (1.2)	9.0 (1.3)	8.2 (2.5)	6.2 (1.8)
Age 12					
Females	Pre	9.1 (1.4)	9.3 (1.2)	8.9 (.97)	5.8 (1.9)
	Post	9.0 (1.6)	9.4 (.64)	9.3 (.73)	5.7 (1.5)
Males	Pre	9.6 (.96)	9.6 (.71)	9.6 (.71)	6.8 (1.6)
	Post	9.7 (.62)	9.5 (.77)	9.5 (.71)	6.3 (2.2)

[A]N= 25 for each group

Even though the testers' expertise improved as the study continued, the time to administer the Stott Test with the modifications mentioned and the additional dodge run task, varied from 20 to 45 minutes for each individual. The test time increased with the increasing awkwardness of the subject. It was considered advisable to selectively limit the number of tasks so that the test time could be reduced without substantially affecting the quality and quantity of the information gained from the assessment.

Results of the test-retest reliability procedure were mixed. Correlation coefficients for those tasks which were retained in the battery are reported in Appendix A. Since the correlations varied from .10 to .83 it was necessary to make some compromises with respect to reliability. The best discriminators of awkward behaviour were the balance tasks, the ball skills tests and the fine motor tasks (at the 8 year level). Similar findings were reported by Morris and Whiting (1971). They also found a .95 correlation between results on these three tasks and the total score. It was therefore decided to retain these tests as the basis of the test battery.

In addition, the dodge run was included because it offered an opportunity to observe strategic behaviour, had good reliability and was of a culturally normative nature. The controlled jump was retained because it allowed observation of the reaction to risk and of the ability to discriminate right from left. Since the one hand catch task had been previously eliminated a throw, clap and catch task by Gubbay (1975) was introduced in its place. This task eliminated the problem of tester accuracy since the child threw the ball up him/herself. Gubbay also reported that this task was highly related to the severity of impairment.

The test battery which emerged from this pilot study consists of ten items. Although these ten tasks do not exhaust the motor performance domain, they appear to be the most suitable and quick screening tests available for the identification of physically awkward children.

Motor Performance Test Battery

A brief description of the test items follows. Detailed information on each task is found in Appendix B.

Area of Measurement	Task Description
Upper Limb Coordination	1. Throw and Catch The child executes an underarm throw of a tennis ball to a wall 8 feet distant. The ball is thrown with the preferred hand and caught with both hands.
	2. Target Throw The child throws a tennis ball at a circular 12 inch wall target from a distance of 10 feet. The ball is thrown with the dominant hand in a manner preferred by the subject.

3. <u>Throw, Clap and Catch</u>

The child throws a tennis ball in the air with the preferred hand and catches it with both hands. If successful s/he 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

4. <u>Board Lacing</u>

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

5. <u>Peg Board Right and Left</u>

The child places ten plast[illegible]s in a 12-holed board as quickly as possible. The task is performed with preferred and non preferred hands.

Lower Limb Coordination

6. <u>Stork Balance Right and Left</u>

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. This task is performed on right and left feet.

7. <u>Wide Board Balance Right and Left</u>

The child balances on a 4 inch wide board for 10 seconds. The task is performed on preferred and non preferred feet.

8. <u>Narrow Board Balance Right and Left</u>

The child balances on a 1 inch wide keel of a balance board with the preferred foot for 14 seconds. S/he then performs the task on the non-preferred foot.

9. <u>Controlled Jump Right and Left</u>

The child jumps over a knee high cord. S/he takes off from two feet and lands on the preferred foot. The task is repeated with landing on the non-preferred foot.

10. <u>Dodge Run</u>

The child runs a zig-zag course around four traffic cones placed at 8 foot intervals, as quickly as possible.

Training Procedure

In an effort to assure a uniform assessment procedure, 12 graduate and senior undergraduate students underwent four training sessions as outlined in the Test Manual (Appendix B). The students were required to read the manual and watch a demonstration of the test administration. During the demonstration they were encouraged to ask questions concerning any procedures which they found unclear. After achieving an

80 percent or better score on the multiple choice test in the manual they administered the test to a peer as many times as possible.

The third session involved a more detailed instruction of the measurements required for the dodge run course and the procedure for testing ball skills. Immediately following this instruction, the trainees were required to administer each part of the test battery to a peer while four graduate trainees rated their testing ability (Appendix B). The comments and concerns of the trainers were discussed with each student after s/he completed the test.

On the final training day the students administered the test battery to three normal children who were not involved in the study. During the testing, obvious errors in procedure were verbally corrected and the students repeated parts of the test with which they experienced difficulty. From these observations and the ratings provided by the trainers, the students were assigned either to administer the dodge run and ball skills, or the balance and fine motor items, depending on the expertise they displayed.

Testing Procedure

The control group was assessed during a three week period in November of 1981. The reading disabled group was assessed during a five week period in February and March of 1982. All of the subjects in the study were tested in their own school gymnasium on an individual basis. No attempt was made to alternate the order of the test presentation as in most situations where more than one subject was assessed, a natural alternation occurred between gross motor, fine motor and balance items. Where only one subject was assessed s/he was administered the fine motor tasks first. The total testing time for each individual subject was 20-25 minutes.

The scores were recorded as the number of seconds to the nearest tenth of a second on all timed tasks. The ball skills were measured by the number of successful catches or target hits. On the throw, clap and catch task the attempts were rated for success on a scale from 1 to 7. In addition to the numerical scores, the testers were encouraged to make a note of any unusual strategies, task difficulties, or specific errors which they observed in the course of administering the test. A more detailed description of verbal testing instructions and administration procedure is provided in Appendix B.

As part of the interdisciplinary nature of the study, a common sample of children were administered the Schonell Graded Reading Test (see Appendix C). The results of these tests were included in this study as confirmation of the reading difficulties experienced by the RD sample.

CHAPTER 4

RESULTS AND DISCUSSION

The means and standard deviations which resulted from performances by each group on the test battery are given in Table 3. Examination of the group performance on each task reveals a general trend. On every task except the dodge run the performance of the reading disabled (RD) group was poorer than that of the control group. In addition, these differences reached significance on 11 out of 15 tasks. For ease of understanding, results from each group of tasks, upper limb coordination; fine motor coordination; and lower limb coordination, will be considered separately.

Upper Limb Coordination: Results

Group performance differences were examined using a 2 (groups) X 2 (sexes) X 3 (grades) analysis of variance with the sum of successful trials on the throw and catch, target throw, and throw, clap and catch as dependent variables. The results of this analysis are presented in Appendix D. The significant main effects are illustrated in Table 4.

Throw and Catch

A significant main effect for sex, $\underline{F}$ (1,228) = 26.643, $\underline{p} < .000$, was obtained as well as a significant sex by grade ordinal interaction, $\underline{F}$ (2,228) = 6.683, $\underline{p} < .002$. Simple effects tests (Winer, 1971, p. 449) determined that the interaction was due to the significantly lower scores obtained by the grade three girls when compared to the grade

TABLE 3

Mean Performance Scores on Test Battery
For Reading Disabled and Control Groups

Dependent Variable[a]	Control Group[b] (SD)	Reading Disabled Group[c] (SD)
Throw and Catch	11.2 (4.20)	10.0 (4.47)
Target Throw	7.3 (3.10)	6.9 (3.07)
Throw, Clap and Catch	6.0 (1.32)	5.3 (1.50)
Board Lacing	16.54 (2.27)	17.48 (2.55)
Peg Board Right	16.13 (1.25)	17.06 (1.37)
Peg Board Left	18.41 (1.72)	19.42 (1.56)
Stork Balance Right	17.16 (1.28)	16.15 (1.79)
Stork Balance Left	17.22 (1.49)	15.84 (1.99)
Wide Board Balance Right	7.72 (.53)	6.88 (1.27)
Wide Board Balance Left	7.39 (.71)	6.45 (1.01)
Narrow Board Balance Right	10.17 (.67)	9.42 (1.38)
Narrow Board Balance Left	10.39 (.91)	8.78 (1.84)
Controlled Jump Right	3.31 (.55)	2.46 (.74)
Controlled Jump Left	3.32 (.52)	2.40 (1.01)
Dodge Run	6.54 (.38)	6.33 (.39)

[a]The first three variables are scored as number of correct catches, or target hits. The remaining scores are recorded in seconds.

[b]$\underline{n}$ = 128.

[c]$\underline{n}$ = 112.

TABLE 4

Significant Main Effects

Derived from Anova for

Upper Limb Coordination Tasks

Dependent Variable	Independent Variable		
	Group	Sex	Grade
Throw and Catch	.051*	.000****	.000****
Target Throw	.734	.000****	.000****
Throw, Clap and Catch	.000****	.054*	.000****

*$p \leq .05$

**$p \leq .01$

***$p \leq .001$

****$p \leq .000$

three boys, $\underline{t}$ (228) = 5.931, $\underline{p}$ <.0005. The spread in scores between sexes decreased to marginal significance, $\underline{t}$ (228) = 1.613, $\underline{p}$, <.10, at grade five and was not significant at grade seven.

Groups main effects, similarly yielded a significant $\underline{F}$ ratio, $\underline{F}$ (1,228) = 3.854, $\underline{p}$ <.051. Group by grade comparisons are presented in Figure 1. T-tests on group by grade mean differences indicated a significantly poorer performance by RD children compared to controls at grade three only, $\underline{t}$ (228) = 2.42, $\underline{p}$ <.01.

A highly significant main effect for grade, $\underline{F}$ (2,228) = 101.880, $\underline{p}$ <.000, was evident whereas no significant interaction occurred. Multiple comparisons of grade means using the Neuman-Keuls procedure revealed a significant increase in performance from grade three to grade seven, $\underline{Q}$ (228) = 19.76, $\underline{p}$ <.01, from grade three to grade five, $\underline{Q}$ (228) = 13.95, $\underline{p}$ <.01, and from grade five to grade seven, $\underline{Q}$ (228) = 5.81, $\underline{p}$ <.01 (see Appendix D).

The interpretation of the results in Table 4 must take into account that the sex main effects were due to a significantly poorer performance by the grade three girls, and the group differences were a result of the poor performance of the grade three RD children. However, the grade main effects show that the throw and catch test clearly tapped performance differences at each grade level.

<u>Target Throw</u>

Results of the analysis of target throw scores can be found in Appendix D. A significant main effect for sex was obtained, $\underline{F}$ (1,228) = 31.778, $\underline{p}$ <.000. Post-hoc t-tests on sex by grade comparisons indicated significant differences betwee performances of girls and boys at grade

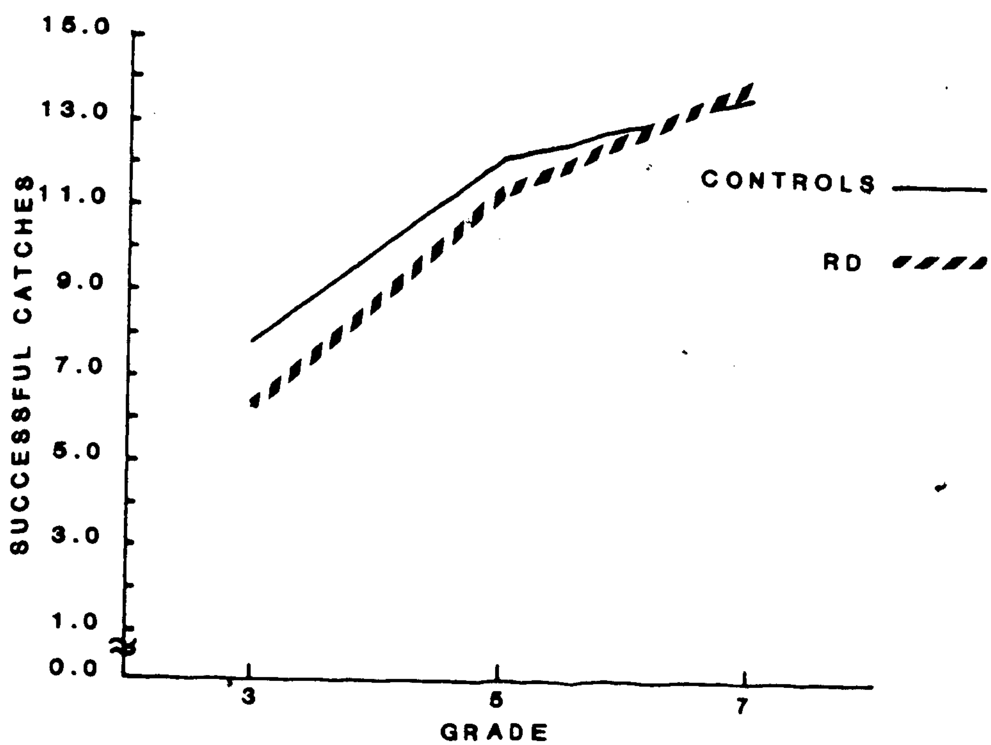

Figure 1. Groups by Grade on Throw and Catch

three, t (228) = 4.56, $p < .0005$, grade five, t (228) = 3.245, $p < .005$, and grade seven, t (228) = 1.81, $p < .05$.

The main effect for group was not significant. Group by grade comparisons presented in Figure 2 reveal an essentially similar performance by RD and control children on the target throw task.

A highly significant main effect for grade, F (2,228) = 66.985, $p < .000$, was evident whereas no significant interactions occurred. Multiple comparisons of grade means using the Neuman-Keuls procedure revealed a significant increase in performance from grade three to grade seven, Q (228) = 15.67, $p < .01$, from grade three to grade five, Q (228) = 11.28, $p < .01$, and from grade five to grade seven, Q (228) = 4.39, $p < .01$ (see Appendix D).

In summary, although no group differences resulted from analysis of target throw performances, the boys performed significantly better than the girls at every grade. In addition, performance means increased significantly with age.

Throw, Clap and Catch

Analysis of throw, clap and catch scores yielded significant main effects for all independent variables (see Table 4). The main effect for sex, F (1,228) = 3.744, $p < .054$, was investigated further using a one-tailed interpretation of t-tests on the mean performances of girls and boys at each grade level. These tests indicated that grade three boys performed significantly better than the girls, t (228) = 1.71, $p < .05$. This difference in performance reached marginal significance at grade five, t (228) = 1.53, $p < .10$, and became non significant at grade seven.

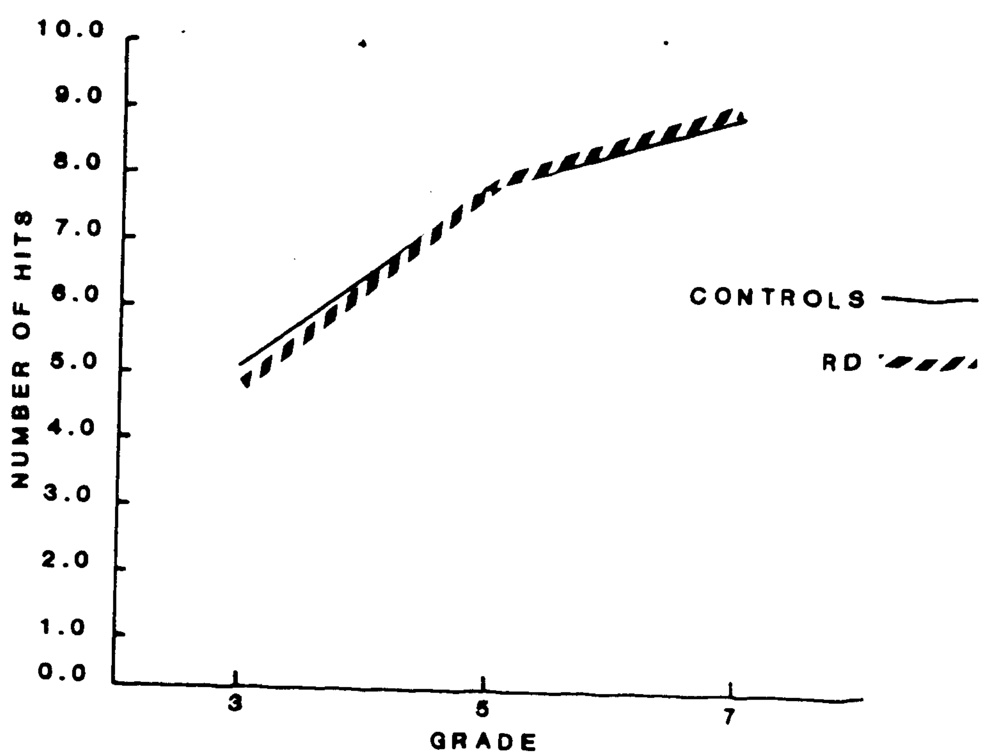

Figure 2. Groups by Grade on Target Throw

The significant main effect for group, $\underline{F}(1,228) = 14.571$, $\underline{p} < .000$, was supported by post-hoc t-tests on the group by grade results graphed in Figure 3. The RD children were significantly less proficient in the throw, clap and catch test than their control counterparts at grade three, $\underline{t}(228) = 2.90$, $\underline{p} < .005$, grade five, $\underline{t}(228) = 1.69$, $\underline{p} < .05$, and grade seven, $\underline{t}(228) = 1.97$, $\underline{p} < .025$.

In order to determine the specific nature of the highly significant main effect for grade, $\underline{F}(2,228) = 59.615$, $\underline{p} < .000$, the Neuman-Keuls procedure was utilized (see Appendix D). Significant performance differences occurred between grade three and grade seven, $\underline{Q}(228) = 15.234$, $\underline{p} < .01$, grade three and grade five, $\underline{Q}(228) = 11.406$, $\underline{p} < .01$, and grade five and grade seven, $\underline{Q}(228) = 3.828$, $\underline{p} < .01$.

A clear interpretation of both group and grade differences is therefore afforded by results of the post-hoc tests. The superior performance of the boys on the throw, clap and catch test was significant at grade three only.

Upper Limb Coordination: Discussion

In general, the results of performances on these three tasks lend support to the predictions made concerning sex and group differences. As postulated in Hypothesis 1-2, the boys' scores for both throwing and catching tasks significantly exceeded those of the girls. Although Stott, Moyes and Henderson (1972) did not confirm these findings in their norming of the original test items, the pilot study results presented in Table 2 indicated that such differences could be expected. Specifically, the 8 year old boys excelled on all three tasks, and these significant performance differences were maintained at age 10 and 12 on

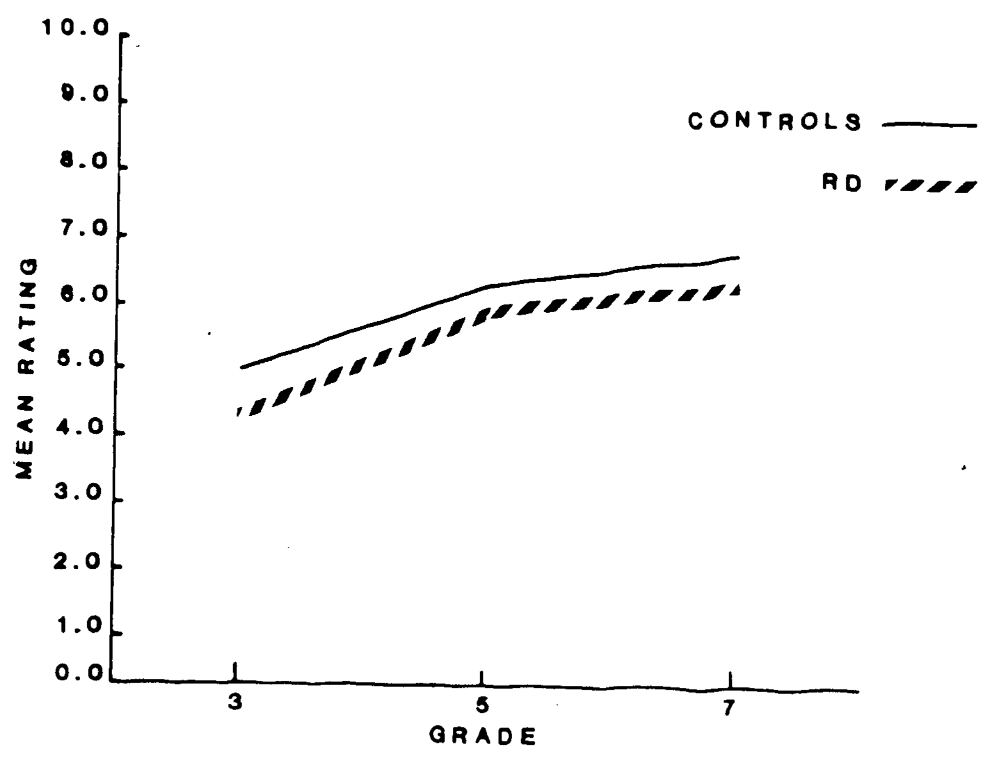

Figure 3. Groups by Grade on Throw, Clap and Catch

the target throw. This finding is also comparable to the results of the pilot study, as 12 year old girls equalled the boys on the throw and catch task, but could not close the gap so convincingly on the target throw.

As illustrated in Figure 4 there was a definite superiority in the boys performances across grades on the target throw. Notwithstanding the physiological differences which are well documented (Tanner, 1970), replication of these results would tend also to indicate, that because precise throwing is a constantly practised and highly valued skill in a boy's skill repertoire and because opportunity to pursue this skill is afforded more easily in Canadian culture to boys, that sex differences on this particular task are well established. It is interesting to note, that Henderson and Stott (1977) had some reservations about retaining the ball tasks for the very obvious influences of culture and practice on skill development. They concluded, however, that the tasks were so revealing of motor dysfunction, that they should be retained in the test battery.

Group performance differences, which were predicted in Hypothesis 2 and 2-1, were well documented on the two catching tasks. As expected, the reading disabled children did not perform as well as the control group on the throw and catch. These results are comparable to the findings of Rutter, Tizard and Whitmore (1970) in the Isle of Wight study. The group performance differences were most noticeable at age 8. Results of the throw, clap and catch task support the contention that learning disabled children as a group, tend to acquire a lower level of proficiency in motor skills than their control group peers (Gesell and Amatruda, 1947; Gordon and McKinlay, 1980). This phenomenon would tend

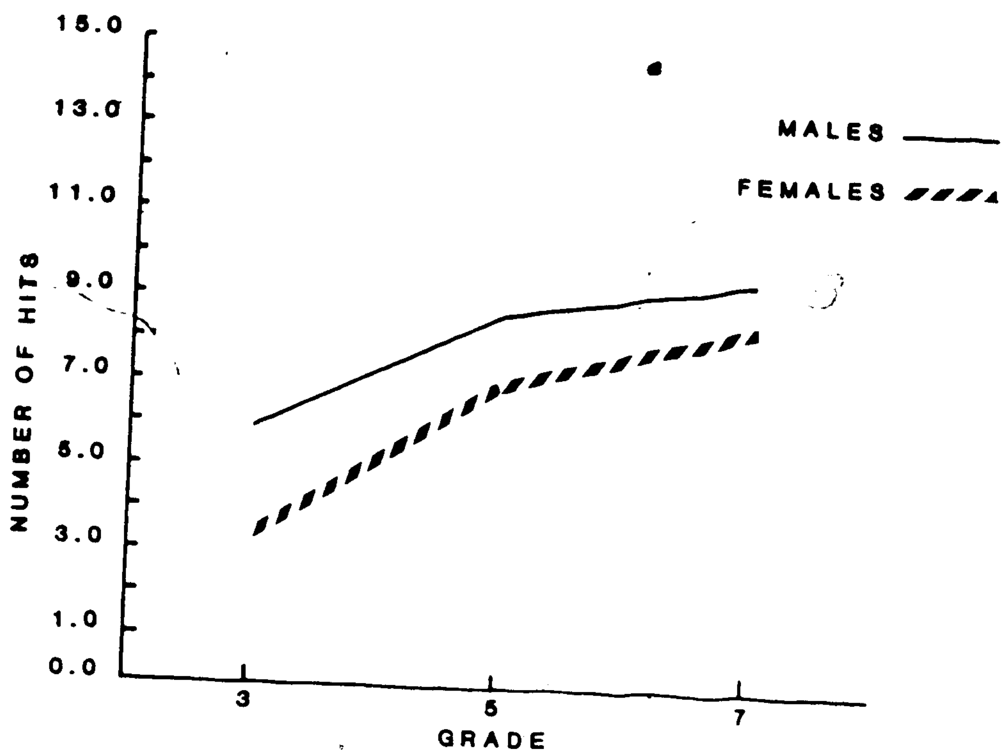

Figure 4. Sex by Grade on Target Throw

to compliment similar findings with respect to acquisition of reading (Vellutino, 1979; Lupart, 1981).

In contrast to the above results, group differences were significant at each grade level on the throw, clap and catch test. The trend to greater between group differences at age 8 than age 12 was still evident, but this task does not appear to be as greatly affected as other tasks in the battery by the developmental increases in the skill of the reading disabled child. Gubbay (1978) reported that it was one of four tests in his battery that was a good guide to the severity of the motor impairment. Perusal of the percentile scores for severely awkward children (Appendix E) would tend to verify his point. Seventeen of the children designated as severely awkward by the test battery results had scores below the 10th percentile on the throw, clap and catch. Hopefully, replication of these results in the remaining years of this study will afford better analysis of the specific relationship of this test to physical awkwardness.

Group differences were not evident on the target throw. One explanation of these results is that boys performances were so superior that they cancelled out any group differences that might exist. It is obvious, in any case, that the target throw did not discriminate between groups.

As illustrated in Figures 5, 6 and 7 all three upper limb coordination tasks were good measures of developmental differences. The utility of these tasks as screening instruments is thus enhanced because they allow for the placement of children on a developmental continuum. In summary, one cannot deny the sensitivity of the target throw to sex differences in throwing achievement. The catching tasks, however,

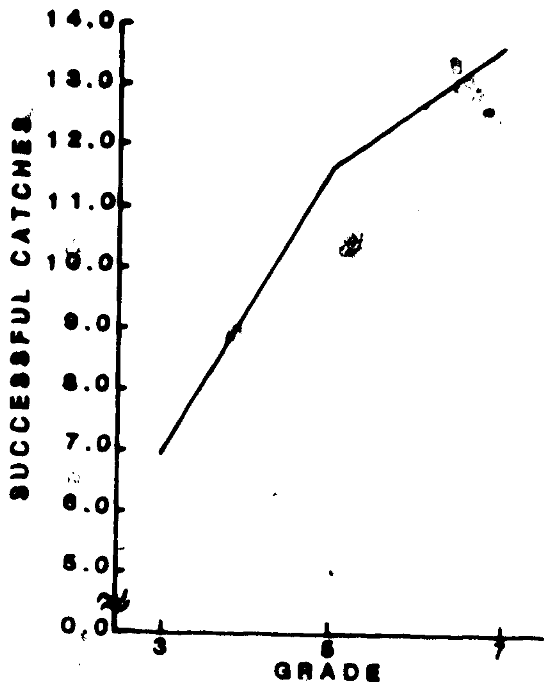

Figure 5. Throw and Catch

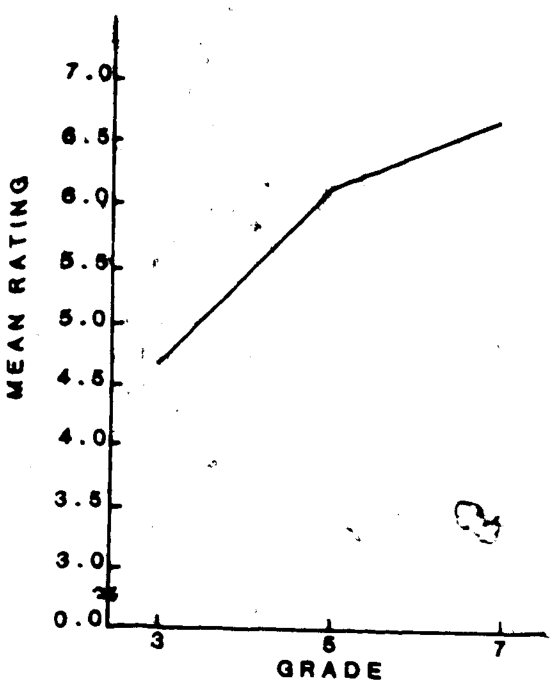

Figure 7. Throw, Clap and Catch

Developmental Trends

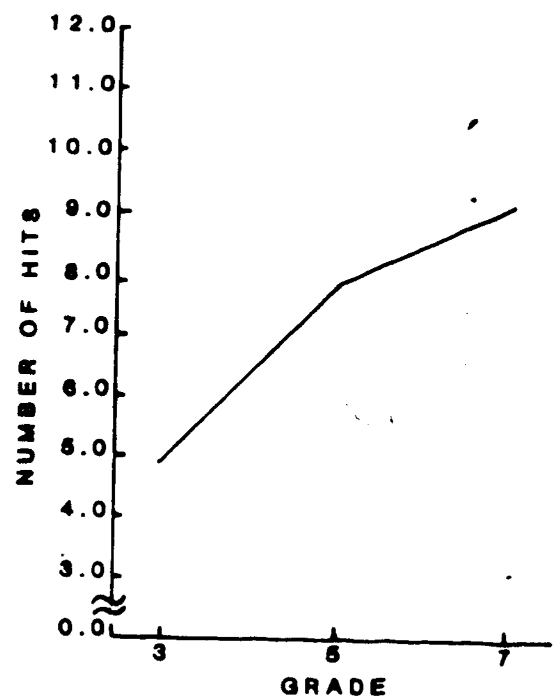

Figure 6. Target Throw

illustrate the group differences which were expected. It can be concluded that reading disabled children do not perform as well as a group on catching tasks, particularly at age 8 and that boys are superior to girls in throwing skills.

Fine Motor Coordination: Results

Performance scores for fine motor coordination were calculated as the mean score of three trials rather than the best scores. According to Bardo and Garney (1979) mean scores are better estimates of true performance than maximum scores. Group performance differences were examined using a 2 (groups) X 2 (sexes) X 3 (grades) X 3 (trials) analysis of variance with repeated measures on the last factor, and the mean scores in board lacing, peg board right and peg board left as the dependent variables. The results of this analysis are presented in Appendix D. The significant main effects are illustrated in Table 5.

Board Lacing

There were no significant main effects for sex or group which resulted from the analysis of board lacing scores. In addition group by grade comparisons, graphed in Figure 8 depict an essentially similar performance by RD and control children. However, a significant group by grade by trials ordinal interaction, F (4,456) = 2.447, p <.046, did occur. To investigate the nature of the grade by trials interaction with each group, separate t-tests were utilized. For the RD group there were significant differences in performance between grade three and grade five at trial one, t (228) = 4.505, p <.0005, trial two, t (228) = 7.020, p <.0005, and trial three, t (228) = 5.692, p <.0005. In

TABLE 5

Significant Main Effects

Derived from Anova for

Fine Motor Tasks

	Independent Variable			
Dependent Variable	Group	Sex	Grade	Trials
Board Lacing	.175	.124	.001***	.001***
Peg Board Right	.011**	.387	.001***	.001***
Peg Board Left	.025*	.012*	.001***	.001***

*p ≤ .05

**p ≤ .01

***p ≤ .001

****p ≤ .000

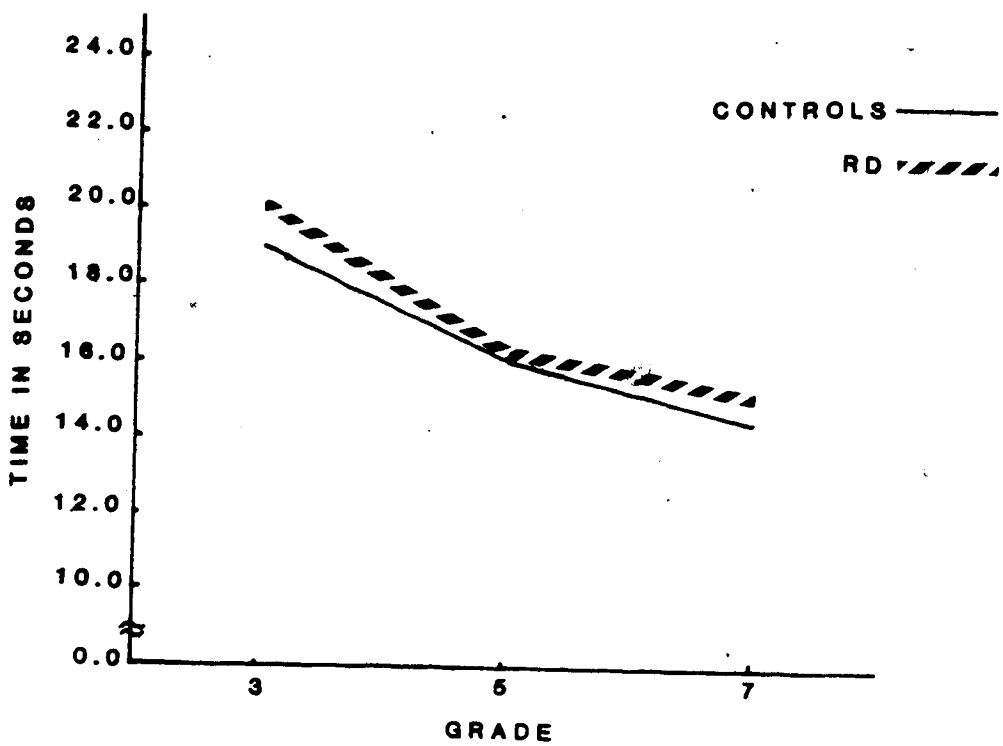

Figure 8. Groups by Grade on Board Lacing

contrast, differences between grade five and seven were significant only on trial one, $\underline{t}$ (228) = 1.941, $\underline{p}$ <.01.

Similarly, performances of grade three and five control children were significantly different at trial one, $\underline{t}$ (228) = 6.58, $\underline{p}$ <.0005, trial two, $\underline{t}$ (228) = 2.83, $\underline{p}$ <.005, and trial three, $\underline{t}$ (228) = 3.90, $\underline{p}$ <.0005. The differences in scores between grade five and seven however were significant at trial two, $\underline{t}$ (228) = 2.92, $\underline{p}$ <.005, and trial three, $\underline{t}$ (228) = 2.52, $\underline{p}$ <.01.

A significant main effect for trials, $\underline{F}$ (2,456) = 34.260, $\underline{p}$ <.001, was also evident. Use of the Neuman-Keuls procedure on the mean scores across trials indicated a significant decrease in the time required to lace the board between trials one and three, $\underline{Q}$ (456) = 6.89, $\underline{p}$ <.01, and trials two and three, $\underline{Q}$ (456) = 4.28, $\underline{p}$ <.01.

The main effect for grade, $\underline{F}$ (2,28) = 40.519, $\underline{p}$ <.001, was subjected to further analysis using the Neuman-Keuls procedure (see Appendix D). The results indicated a significant increase in performance between grade three and grade seven, $\underline{Q}$ (228) = 7.47, $\underline{p}$ <.01, and grade three and grade five, $\underline{Q}$ (228) = 5.51, $\underline{p}$ <.01.

In summary, although no sex or group differences resulted, the performances across trials increased differentially by groups. In addition the performance increases across grade, indicated by Table 5, were not significant between grade five and seven.

<u>Peg Board Right</u>

No significant main effects or interactions for sex resulted from the analysis of mean scores on the peg board right. The main effect for group, $\underline{F}$ (1,228) = 6.631, $\underline{p}$ <.011, is illustrated in Table 5. Post-hoc t-tests of the group by grade scores (Figure 9) resulted in marginally significant differences at grade three only, t (228) = 1.38, $p < .10$.

The specific nature of the significant main effect for trials, F (2,456) = 8.054, $p < .001$, was investigated using the Neuman-Keuls procedure (see Appendix D). The main effect for trials was a result of a significant increase in scores from trial one to trial three, Q (456) = 3.42, $p < .05$. The significant main effect for grade, F (2,228) = 31.519, $p < .001$, followed a similar pattern to the results for board lacing. The newman-Keuls analysis indicated a significant improvement in performance from grade three to grade seven, Q (228) = 6.69, $p < .01$, and grade three to grade five, Q (228) = 4.545, $p < .01$.

In effect performance differences on the peg board right were limited to between trials (one and three) and between grade (three and five, and three and seven) improvements. There was some support for group differences at grade three only.

Peg Board Left

As indicated in Table 5, analysis of mean performances on the peg board left yielded significant main effects for all independent variables. The nature of the main effect for sex, F (1,228) = 6.391, $p < .012$, was explored by post-hoc t-tests on sex by grade scores. Grade five girls were somewhat less efficient than the boys, t (228) = 1.343, $p < .10$. Further application of t-tests to group by grade by sex mean performance scores indicated an unexpected poor performance from grade five RD girls, t (228) = 1.957, $p < .025$.

Although a significant main effect for group, F (1,228) = 5.087, $p < .025$, occurred, when group by grade comparisons (see Figure 10) were

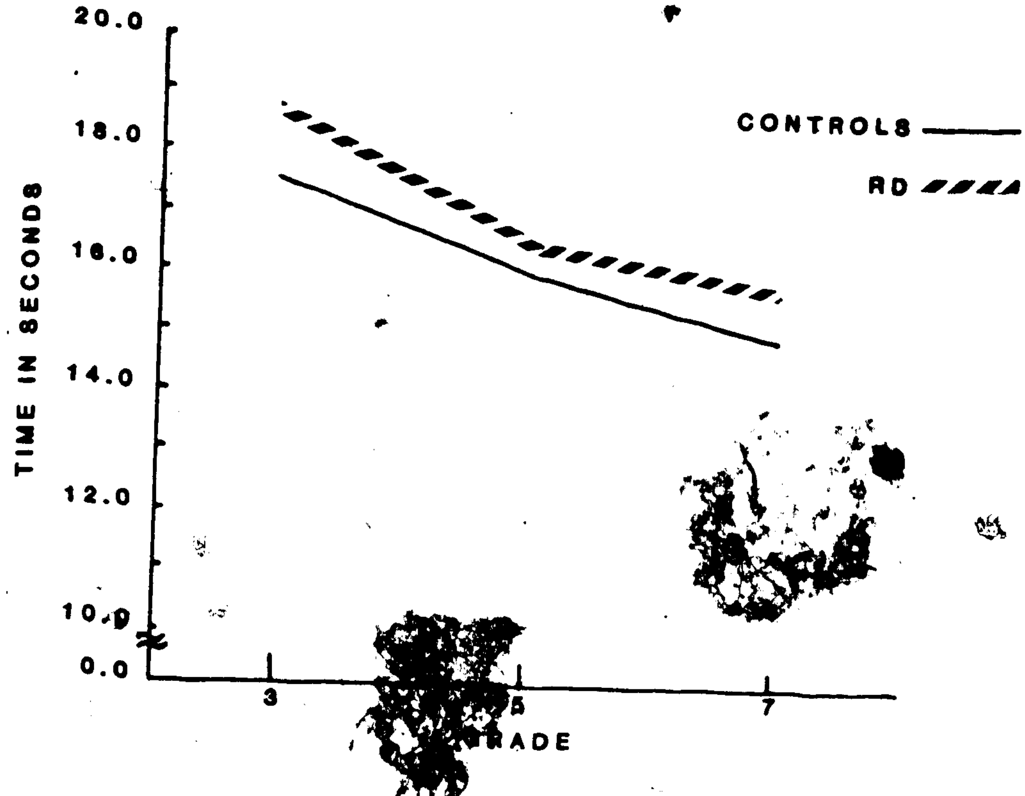

Figure 9. Groups by Grade on Peg Board Right

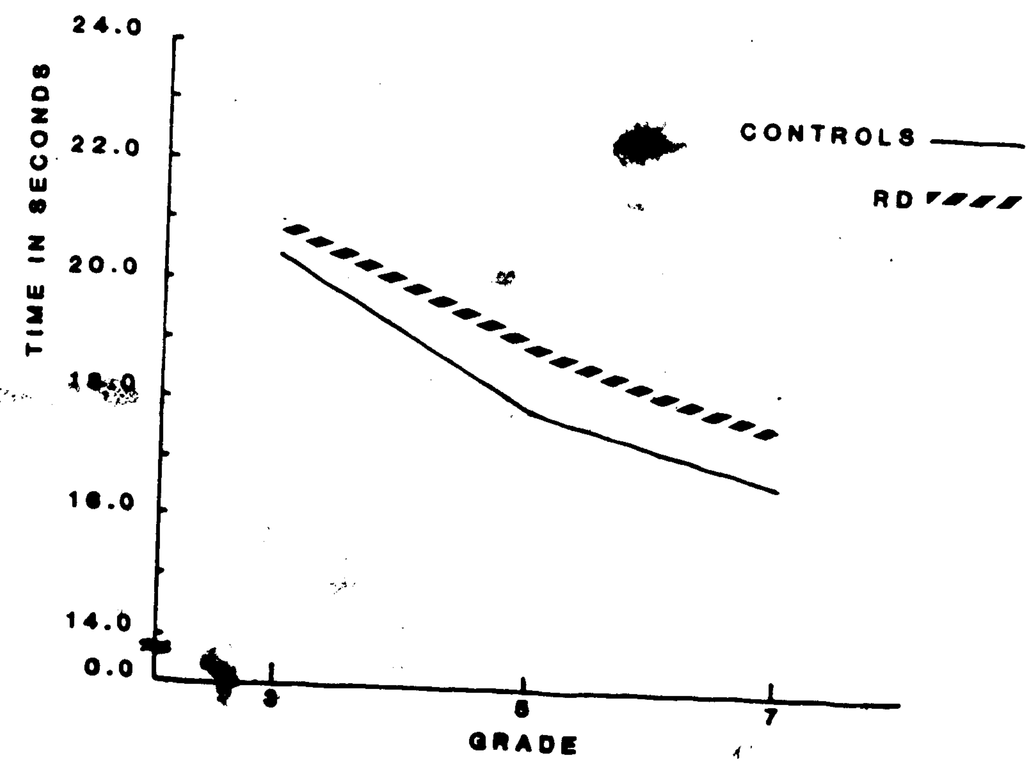

Figure 10. Groups by Grade on Peg Board Left

made using a one-tailed interpretation of t-tests, none of the differences reached significance.

The main effect for trials, F (2,456) = 7.039, p <.001, was analyzed using the Neumans-Keuls procedure. A significant improvement in performance occurred between trials one and three, Q (456) = 3.32, p <.05. Analysis of the main effect for grade, F (2,228) = 29.082, p <.001, with the Neuman-Keuls test gave identical results to the other fine motor tasks. Improvements in performance with age were significant between grade three and seven, Q (228) = 6.386, p <.01, and grade three and five, Q (228) = 4.10, p <.01.

As was evident with results of the peg board right analysis, performance differences on the peg board left were significant between trials (one and three) and between grades (three and seven and three and five). There was also some evidence of a poor performance by grade five RD girls.

Fine Motor Coordination: Discussion

Results of the performances on the fine motor tasks were mixed. There was some support for all of the predictions concerning sex and group differences, but the strength of the support was not great, nor was it maintained on all tasks. Hypothesis 1 indicated that the performance of boys and girls would be essentially similar. This prediction was verified on the board lacing and peg board right tasks. Boys, however, outperformed girls on the peg board left. The differences were greatest at grade five due to an unexpectedly poor performance from the reading disabled girls.

Evidence of between group differences was provided by the superior performances of the control group on the peg board tasks. There was weak support for Hypothesis 2-2 on these tasks, however. The inverse relationship predicted between age and group performance differences held for the peg board right, but was actually reversed for the peg board left.

In contrast, the board lacing task failed to indicate any between group differences. There was some indication of different group learning patterns across trials, but no trend could be deciphered from this interaction. Whiting, Clarke and Morris (1969) had indicated that the fine motor task results compared well to results on the test as a whole. In view of the lacing board results, that conclusion would be tenuous. It is also interesting to note that both 8 year old control and reading disabled children had equal difficulty with this task and their mean scores were considerably higher than those suggested by Stott, Moyes and Henderson (1972).

Consistency was reached on all tasks with respect to developmental trends. There was a definite improvement in performance with age. The magnitude of the improvement decreased between the 10 and 12 year olds on each task. Stott, Moyes and Henderson (1972) indicated in the norming work on their test, that differences between 11 and 12 year olds were generally insignificant. It is plausible therefore that these tasks are accurately monitoring the rapid increase in manual skill from age 8 to 10 and subsequent less significant improvement from age 10 to 12.

Mention should be made of the significant improvement across trials that occurred on all three tasks. Although the tasks allow for observation of strategic behaviour and comparison of learning rates, the magnitude of learning that occurs with both groups suggests that these tasks may be somewhat unstable as measures of fine motor skill. The inference here is that if the tasks were administered over six trials or at a later date, that more performance improvements would be expected.

In summary, results of the fine motor tests do not give a clear indication of group differences and it appears that test inconsistency may make them unreliable tools for assessing awkward behaviour.

Lower Limb Coordination: Results

Performance on the lower limb coordination tasks was measured as the mean score of three trials. The results were analyzed with a 2 (groups) by 2 (sexes) by 3 (grades) by 3 (trials) analysis of variance with repeated measures on the last factor, and mean performance scores on the stork balance right and left, wide board balance right and left, narrow board balance right and left, controlled jump right and left and dodge run as the dependent variables. Appendix D presents the results of this analyis. The significant main effects and interactions are given in Table 6 and 7.

Stork Balance Right

No significant main effects resulted from the analysis of mean performance scores on the stork balance right. However, a disordinal group by grade interaction, F (2,228) = 5.991, p <.003, did occur (see Figure 11). Further analysis of this interaction using a one-tailed interpretation of t-tests indicated a significantly poorer performance from grade three RD children, t (228) = 2.073, p <.025, compared to the

TABLE 6

Significant Main Effects Derived From Anova

for

Lower Limb Coordination Tasks

Dependent Variable	Group	Sex	Grade	Trials
Stork Balance Right	.077	.092	.187	.104
Stork Balance Left	.013**	.05*	.001***	.224
Wide Board Balance Right	.013**	.782	.001***	.332
Wide Board Balance Left	.004**	.469	.009***	.263
Narrow Board Balance Right	.101	.571	.039***	.316
Narrow Board Balance Left	.001***	.681	.044*	.880
Controlled Jump Right	.001***	.183	.059	.001***
Controlled Jump Left	.001***	.779	.001***	.014***
Dodge Run	.001***	.001***	.001***	.001***

* $p < .05$

** $p < .01$

*** $p < .001$

TABLE 7

Significant Two and Three-Way Interactions

Derived from Analysis of Variance Tests

Dependent Variable	Group By Grade	Group By Sex	Group By Trials	Sex By Grade	Sex By Trials	Sex By Trials
	Two Way Interactions					
Throw and Catch				.002**		
Stork Balance Right	.003**		.054*			
Stork Balance Left		.039*				.004**
Wide Board Balance Right.	.001**	.023*				
Narrow Board Balance Left	.025*	.007**				
Controlled Jump Right			.005**		.010**	

	Group By Grade By Trials
	Three Way Interactions
Board Lacing	.046

* p <.05
** p <.01
*** p <.001

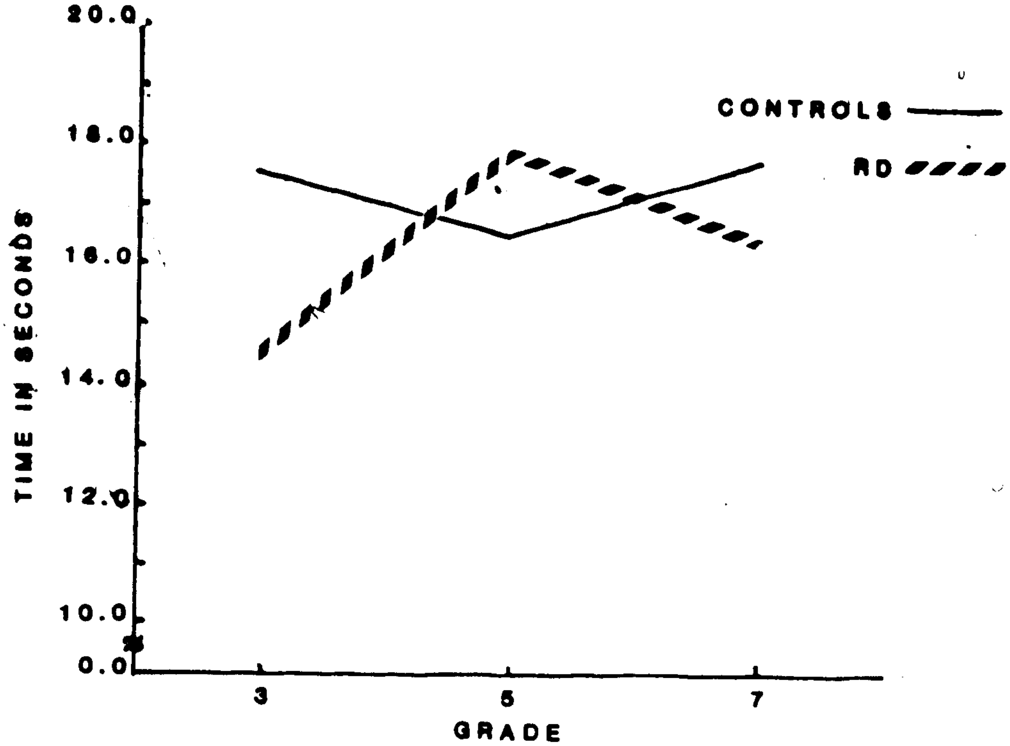

Figure 11. Groups by Grade on Stork Balance Right

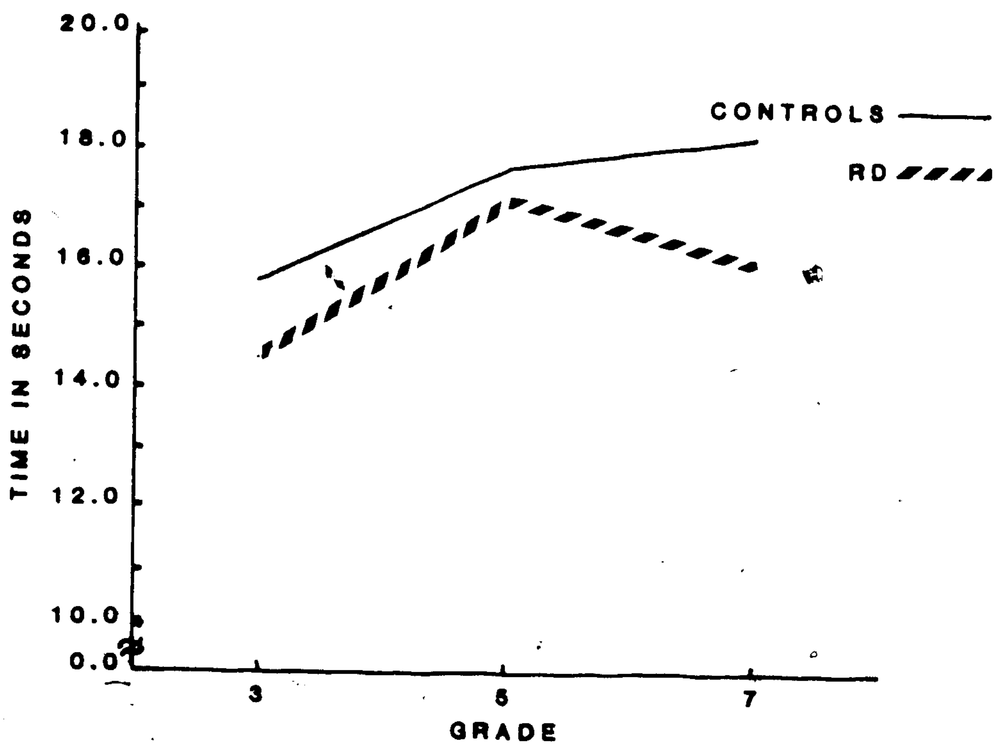

Figure 12. Groups by Grade on Stork Balance Left

grade three control group. In contrast, the grade five RD children achieved higher mean performance scores than any other group. This improvement over their grade three RD peers was significant, $\underline{t}$ (228) = 2.239, $\underline{p}$ <.025. No other within or between group differences were significant.

In addition, an ordinal group by trials interaction, $\underline{F}$ (2,456) = 2.929, $\underline{p}$ <.054, was evident. Results of post-hoc t-tests indicated a significant decrease in performance by the RD group at trial three compared to the control group, $\underline{t}$ (456) = 3.437 $\underline{p}$ <.0005 and compared to their own performance on trial two, $\underline{t}$ (456) = 2.886, $\underline{p}$ <.0005. These analyses give some evidence of group differences across trials and at grade three on the stork balance right.

Stork Balance Left

A significant main effect for sex, $\underline{F}$ (1,228) = 3.870, $\underline{p}$ <.050, was obtained as well as an ordinal group by sex interaction, $\underline{F}$ (1,288) = 4.293, $\underline{p}$ <.039. Post-hoc t-tests revealed that the male RD children performed significantly worse than both the control group males, $\underline{t}$ (228) = 2.17, $\underline{p}$ <.025, and the RD females, $\underline{t}$ (228) = 1.65, $\underline{p}$ <.05.

The main effect for group, $\underline{F}$ (1,228) = 6.238, $\underline{p}$ <.013, was examined more closely by using a one tailed interpretation of t-tests on group by grade performance scores (see Figure 12). The group differences were marginally significant at grade seven only, $\underline{t}$ (228) = 1.29, $\underline{p}$ <.10.

In addition to the significant main effect for grade, $\underline{F}$ (2,228) = 6.817, $\underline{p}$ <.001, which occurred a disordinal grade by trials interaction, $\underline{F}$ (4,456) = 3.839, $\underline{p}$ <.004, was evident. This interaction revealed an unexpected trend across trials. Both the grade three and grade five subjects showed a net decrement in performance across trials. The decrease in scores for grade three children was significant between trials one and three, t (456) = 1.923, p < .05. At grade five the differences were marginally significant between trials one and three, t (456) = 1.409, p < .10, and trials two and three, t (456) = 1.367, p < .10. In contrast, the grade seven subjects displayed essentially similar scores on trials one and two but increased their balance time dramatically after trial two, t (456) = 2.10, p < .025. Evidence of a linear increase in scores with age was not evident on the stork balance right or left.

<u>Wide Board Balance Right</u>

As indicated by Table 6 there was a significant main effect for group, F (1,228) = 6.248, p < .013, and a group by sex ordinal interaction, F (1,228) = 5.239, p < .023. Post-hoc t-tests indicated a significantly poorer performance from the RD boys, compared to the control group boys, t (228) = 2.246, p < .025.

A disordinal group by grade interaction, F (2,228) = 8.020, p < .001, also occurred (see Figure 13). Simple effects tests indicated that the interaction was the result of an extremely depressed performance by the grade three RD group, t (228) = 2.934, p < .005, in contrast to a relatively constant performance from all other subjects.

A significant main effect for grade, F (2,228) = 7.360, p < .001, was evident, but Neuman-Keuls tests on the grade means yielded no significant differences.

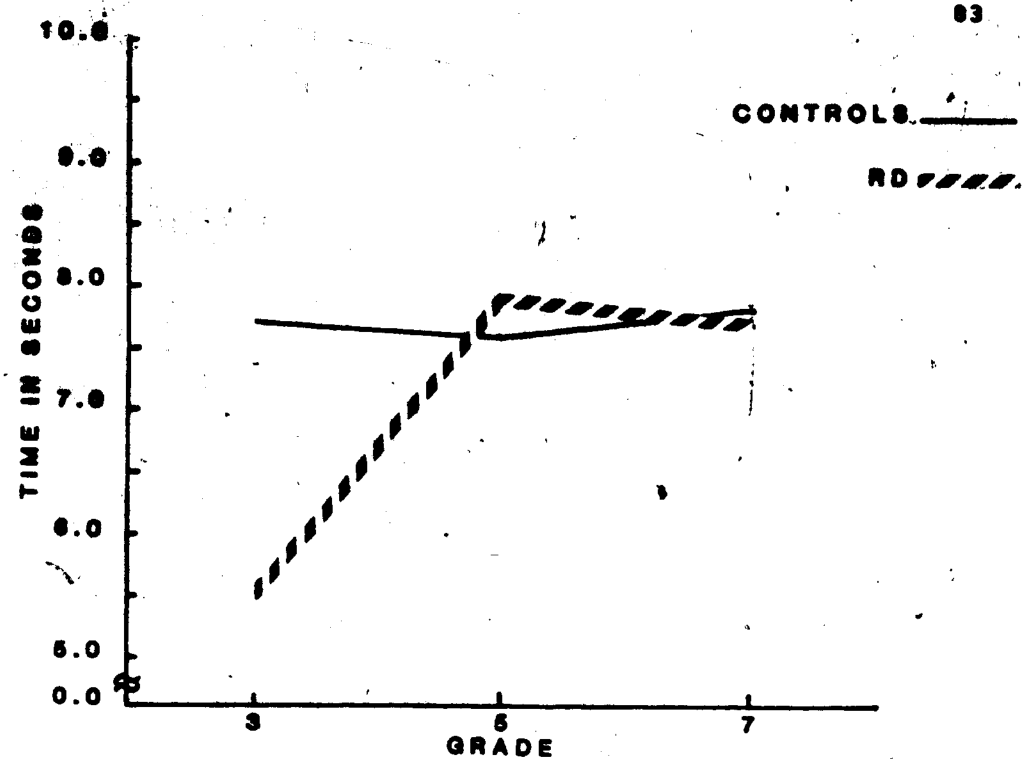

Figure 13. Groups by Grade on Wide Board Balance Right

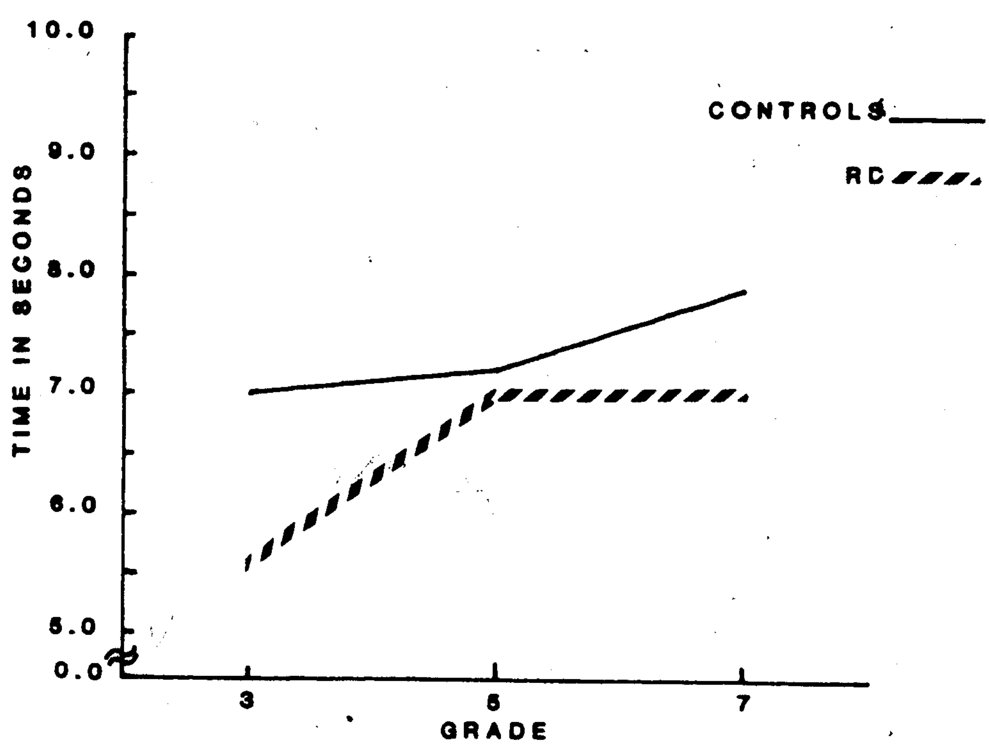

Figure 14. Groups by Grade on Wide Board Balance Left

Wide Board Balance Left

Analysis of mean performance scores on the wide board balance left resulted in a significant main effect for group, F (1,228) = 8.594, p <.004. Post-hoc t-tests on the group by grade means graphed in Figure 14, indicated that grade three RD children balanced for significantly less time than their control counterparts, t (228) = 1.73, p <.05.

Although a grade main effect was evident, F (2,228) = 4.865, p <.009, suggesting a definite increase in performance with age, Neuman-Keuls tests on the mean differences between grades did not reach significance. Results of both wide board balance right and left indicated group differences at grade three only, and minimal support for an increase in scores with age.

Narrow Board Balance Right

No significant main effects for sex or group emerged from the analysis of these mean balance scores. The group by grade mean performance scores are graphed in Figure 15. Post-hoc t-tests on the group by grade means yielded marginally significant differences between the grade three RD children and their control group, t (228) = 1.39, p <.10, and significant differences between grade three and grade five RD children. Although a main effect for grade, F (2,228) = 3.298, p <.039, occurred, no differences were large enough to reach significance on a Neuman-Keuls test.

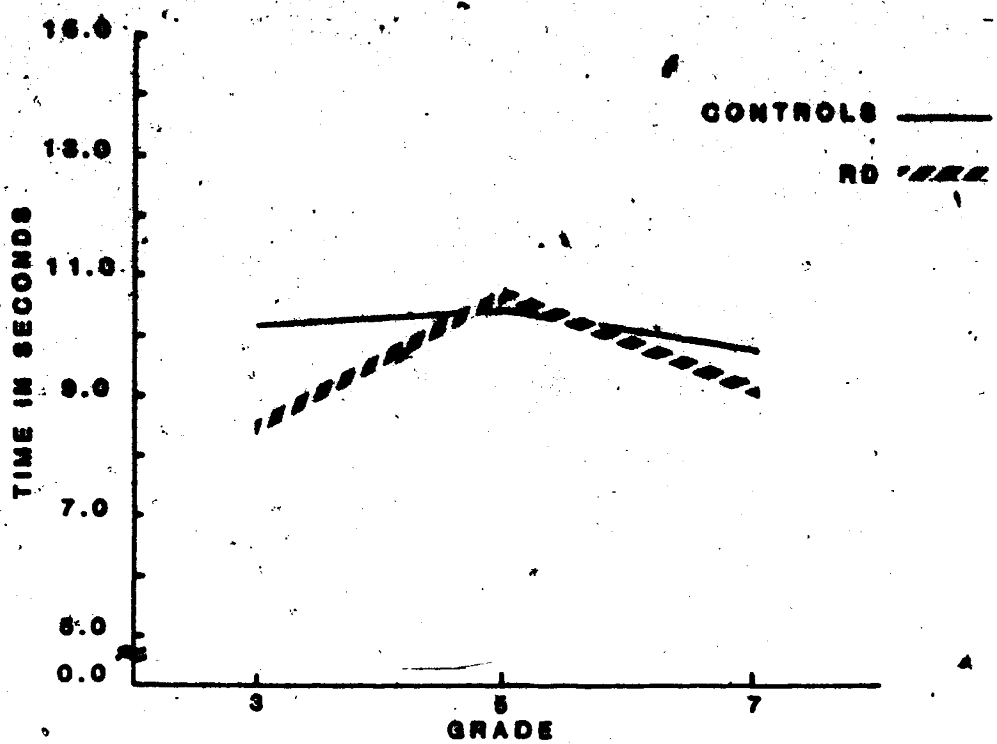

Figure 15. Groups by Grade on Narrow Board Balance Right

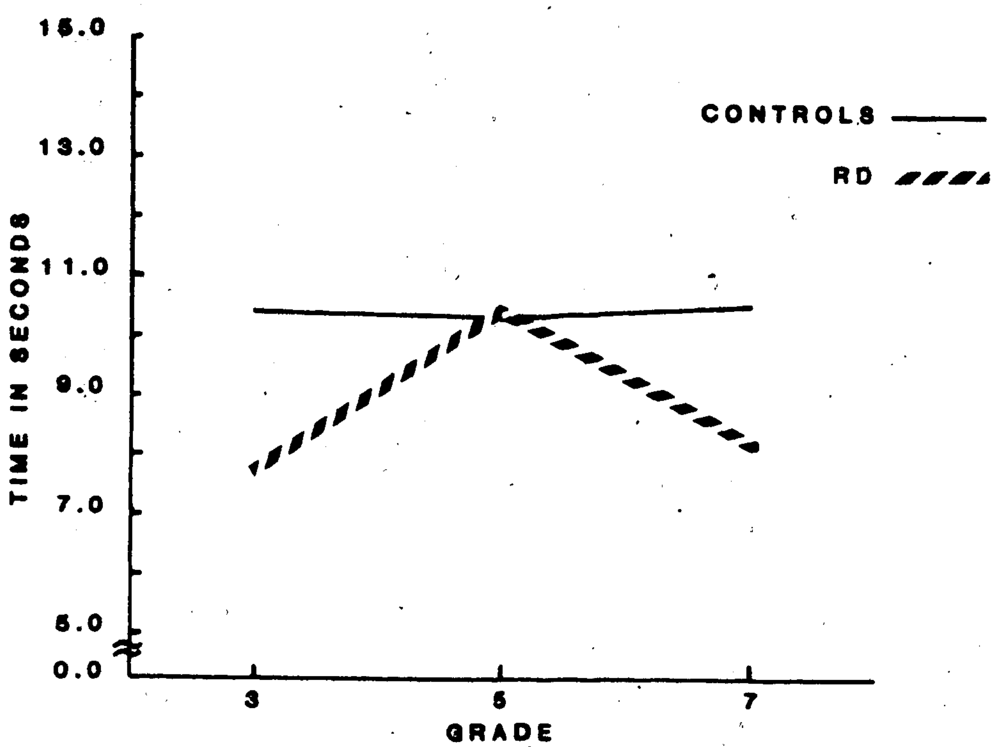

Figure 16. Groups by Grade on Narrow Board Balance Left

Narrow Board Balance Left

A significant main effect for group, $\underline{F}$ (1,228) = 1[illegible].496, $\underline{p}$ <.001, resulted from the analysis of these mean balance scores. In addition, an ordinal group by sex interaction, $\underline{F}$ (1,228) = 7.468, $\underline{p}$ <.007, occurred. Post-hoc t-tests on the group means indicated a significantly poorer performance from the RD boys, compared to their control group counterparts, $\underline{t}$ (228) = 2.62, $\underline{p}$ <.005.

The significant disordinal group by grade interaction, $\underline{F}$ (2,228) = 3.765, $\underline{p}$ <.025, which resulted is illustrated in Figure 16. Simple effects tests indicated that the interaction was due to a relatively similar performance across grades by the control group, in contrast to a significantly low performance by the grade three RD group, $\underline{t}$ (228) = 2.169, $\underline{p}$ <.025, and the grade seven RD subjects, $\underline{t}$ (228) = 1.594, $\underline{p}$ <.10.

Although the analysis also yielded a significant main effect for grade, $\underline{F}$ (2,228) = 3.176, $\underline{p}$ <.044, no between grade differences were large enough to reach significance on the Neuman-Keuls tests (see Appendix D). In summary, group differences were evident on both narrow board balance tasks at grade three only. There was some evidence of additional group differences provided by the significantly poor performance of the RD boys on the left foot balance. Neither task showed a significant difference in performance scores with age.

Controlled Jump Right

The analysis of mean performance scores on this task yielded a significant main effect for group, $\underline{F}$ (1,228) = 12.938, $\underline{p}$ <.001. Group by grade mean performance scores are illustrated in Figure 17. Simple

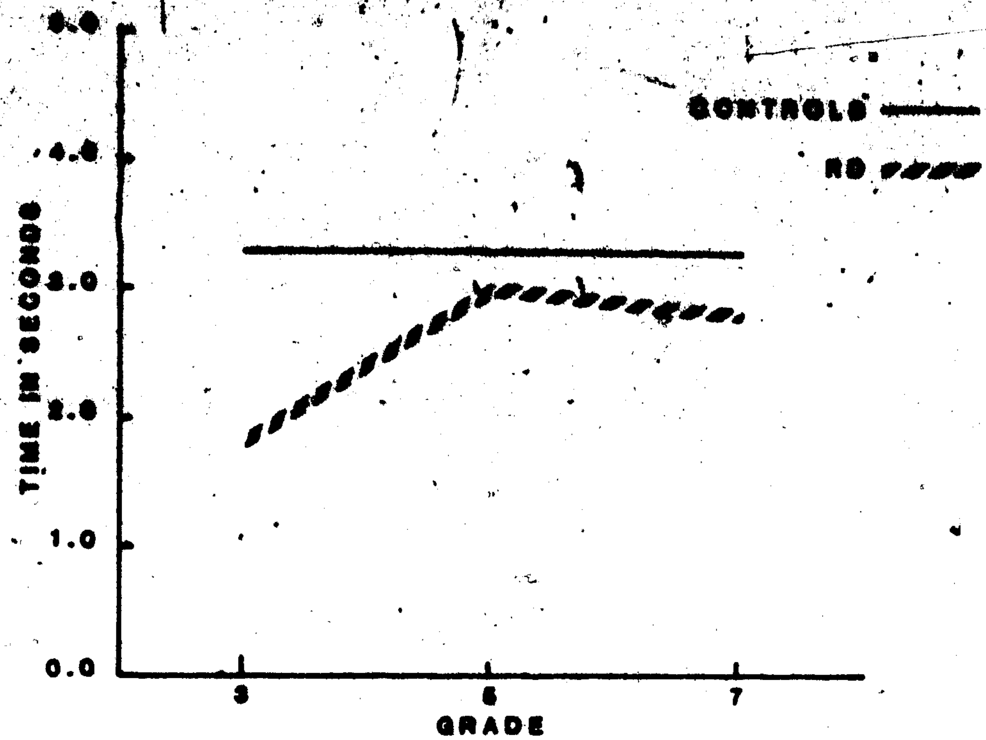

Figure 17. Groups by Grade on Controlled Jump Right

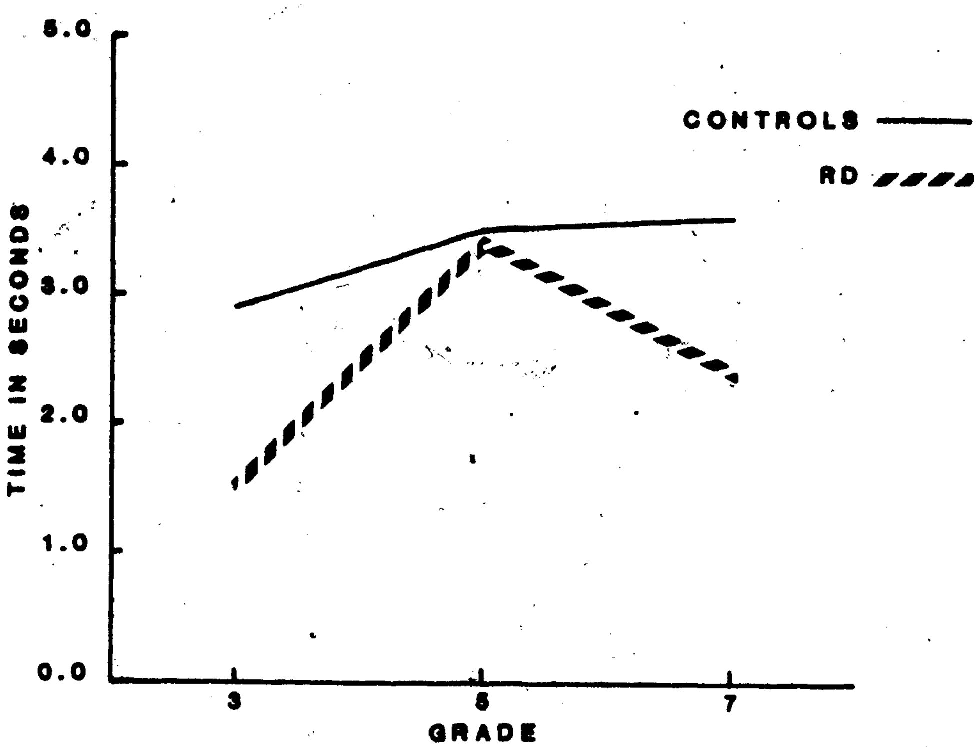

Figure 18. Groups by Grade on Controlled Jump Left

[illegible] tests on the [illegible] differences indicated a significantly less skilful [illegible] from grade three RD children, compared to the grade three [illegible] group, $\underline{t}$ (228) = 2.46, $\underline{p}$ <.01.

The significant main effect for trials, $\underline{F}$ (2,456) = 6.669, $\underline{p}$ <.001, was investigated further with the Neuman-Keuls procedure. None of the differences across trials were significant. In contrast, the disordinal sex by trials interaction, $\underline{F}$ (2,456) = 4.636, $\underline{p}$ <.010, which occurred was the result of a relatively constant performance over trials by the boys and a contrasting dramatic improvement in performance by the girls at trial two, $\underline{t}$ (456) = 2.257, $\underline{p}$ <.025. This difference increased in significance at trial three, $\underline{t}$ (456) = 2.69, $\underline{p}$ <.005.

The significant ordinal group by trials interaction, $\underline{F}$ (2,456) = 5.372, $\underline{p}$ <.005, resulted from an interesting pattern of performance differences from the control and RD children. Generally the RD children performed less skilfully across trials, with the greatest difference being at trial two, $\underline{t}$ (456) = 6.219, $\underline{p}$ <.0005 and the smallest difference at trial three, $\underline{t}$ (456) = 1.705, $\underline{p}$ <.05.

Controlled Jump Left

As indicated in Table 6, analysis of the mean scores for controlled jump left yielded a significant main effect for group, $\underline{F}$ (1,228) = 11.688, $\underline{p}$ <.001. Post-hoc t-tests on group by grade mean differences, illustrated in Figure 18, indicated significantly poorer performances from grade three RD children, $\underline{t}$ (228) = 1.913, $\underline{p}$ <.05 and some evidence of poorer performances from grade seven RD children, $\underline{t}$ (228) = 1.45, $\underline{p}$ <.10.

The specific nature of the significant main effect for grade, $\underline{F}$ (2,228) = 8.008, $\underline{p}$ <.001, was investigated by the Neuman-Keuls procedure. Significant differences resulted between grade three and five only, $\underline{Q}$ (228) = 3.42, $\underline{p}$ <.05. In co[illegible], the main effect for trials which was evident, $\underline{F}$ (2,456) [illegible]14, did not reach significance on any between trial[illegible] the Neuman-Keuls procedure.

In effect, group differences were maintained at grade three only, for both right and left controlled jump tasks. A significant improvement in performance with age was supported on the jump left between grades three and five only.

Dodge Run

As illustrated in Table 3, the mean performance scores for the dodge run task tended to reverse the trend in group differences in favour of the reading disabled group. The significant main effect for sex, $\underline{F}$ (1,228) = 10.487, $\underline{p}$ <.001, which resulted, indicated a superior performance by male subjects. Similarly, a main effect for group, $\underline{F}$ (1,228) = 14.914, $\underline{p}$ <.001, occurred. Group by grade mean performances are illustrated in Figure 19. Comparisons of the mean differences using post-hoc t-tests indicated a significantly better performance by the grade five RD children only, $\underline{t}$ (228) = 2.17, $\underline{p}$ <.025.

In addition, the main effect for trials, $\underline{F}$ (2,456) = 11.997, $\underline{p}$ <.001, was significant. Between trial comparisons using the Neuman-Keuls tests resulted in significant differences between trials one and three, $\underline{Q}$ (456) = 4.08, $\underline{p}$ <.01, and between trials one and two, $\underline{Q}$ (456) = 3.12, $\underline{p}$ <.01.

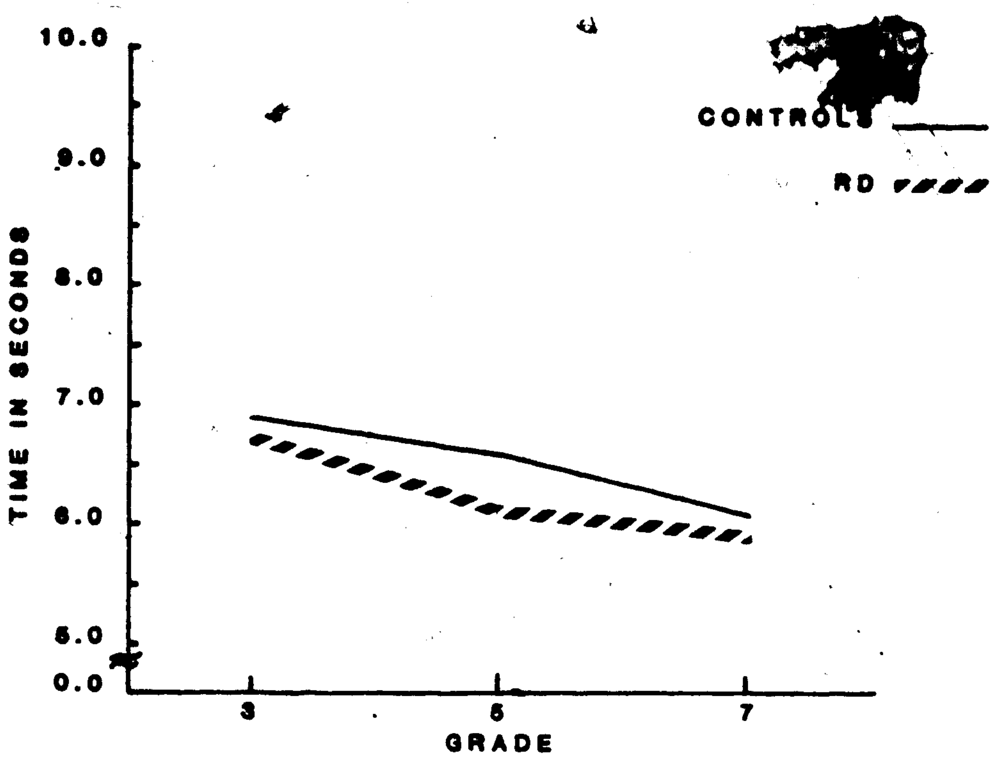

Figure 19. Groups by Grade on Dodge Run

A highly significant main effect for grade, F (2,228) = 49.550, p <.001, also resulted from the analysis of dodge run performances. Use of the Neuman-Keuls procedure for comparing between grade performance indicated significant differences in performance with each increase in age (see Appendix D). It is apparent that the superiority of the RD children on this task was significant only at grade five. In contrast, there is clear evidence of an increase in performance with age.

Lower Limb Coordination: Discussion

With the exception of the dodge run, which will be discussed separately, the results of the lower limb coordination tests were supportive of the research hypotheses. In general, boys and girls performed equally well on the balance and jumping tasks. However, the group by sex interactions indicated in Table 7, revealed that reading disabled boys in particular, had more trouble with balance tasks than the other groups. It is possible that these problems which appear to be quite specific to this group are evidence of the sex differences which have been documented in clinical populations (Dare and Gordon, 1970; Reuben and Bakwin, 1968), however, they do not seem to indicate any overall performance differences due to sex.

As predicted by Hypothesis 2, the control group performances exceeded those of the reading disabled group on six of the eight tests. In addition, group by trials interactions were indicative of poorer performances across trials by the reading disabled children on the stork balance right and controlled jump right. In the first case, it is speculated that the three 20 second trials taxed their ability to maintain concentration on the task, and consequently their performance decreased noticeably by trial three (Ferguson, 1977). On the jumping task performance improvements were negligible until two trials had been executed. It is postulated that this evidence of a slower rate of learning by the reading disabled group may be a result of their right-left discrimination difficulties on this particular task.

As indicated in the group by grade illustrations (Figures 11 to 18), group differences were most significant at grade three on all but the stork balance left. There is definite support for the contention that young reading disabled children are very different performers from their control group peers. The predicted gradual improvement in performance across grades did not materialize, however. Instead, the pattern of improvement for RD children involved a large increment in scores from grade three to grade five but some difficulty in maintaining these scores at grade seven. Scores in fact decreased significantly on the stork balance, narrow board balance and controlled jump with the left foot. Although there may be some phenomenon at work within the reading disabled sample which is causing this unusual trend, but further interpretation at this stage is not possible.

An increase in performance scores across grades was evident with each task, however, as indicated above, there were no constant increases between grade five and grade seven. Since this trend was fairly evident on all tasks, there is the possibility that the tasks themselves limit performance ranges significantly. In addition, as was pointed out earlier, Stott, Moyes and Henderson (1972) had found negligible performance differences on balance tasks between ages 11 and 12. It is

[illegible]

hoped that results from the continuation of this study may help to identify more clearly the shape of this trend in performance.

In contrast to all other lower limb coordination tasks, significantly different performance results were evident on the dodge run. There was no support for the predictions made in Chapter 1 for sex and group differences. In fact boys outpaced the girls on this task, and grade five reading disabled children were significantly better at running the course than their peers. Conversely, the task was a good indicator of developmental increases as can be seen in Figure 20. It was one of the four tasks in the battery to register a significant increase in performance at each grade level.

In searching the literature for a plausible explanation of this reversal in group performance trends, a number of possibilities have surfaced. Although the face validity of the task itself would suggest that it was indeed a measure of whole body coordination and speed, it has been illustrated in a number of factor analytic studies that agility run tasks tend to load on a factor described as explosive strength (Rarick, 1968; Fleishman, 1972; Liehmohn and Knapczyk, 1974). This factor structure tends to hold with average, mentally retarded and learning disabled children. If one accepts the premise that the dodge run is in fact a measure of explosive strength, then its relationship to physical awkwardness and the other tasks in the test battery is tenuous.

In considering the accommodations that were made for learning disabled children in the design of this particular task the factor structure explanation becomes more salient. RD children were not penalized for knocking over traffic cones. If they fell, they were

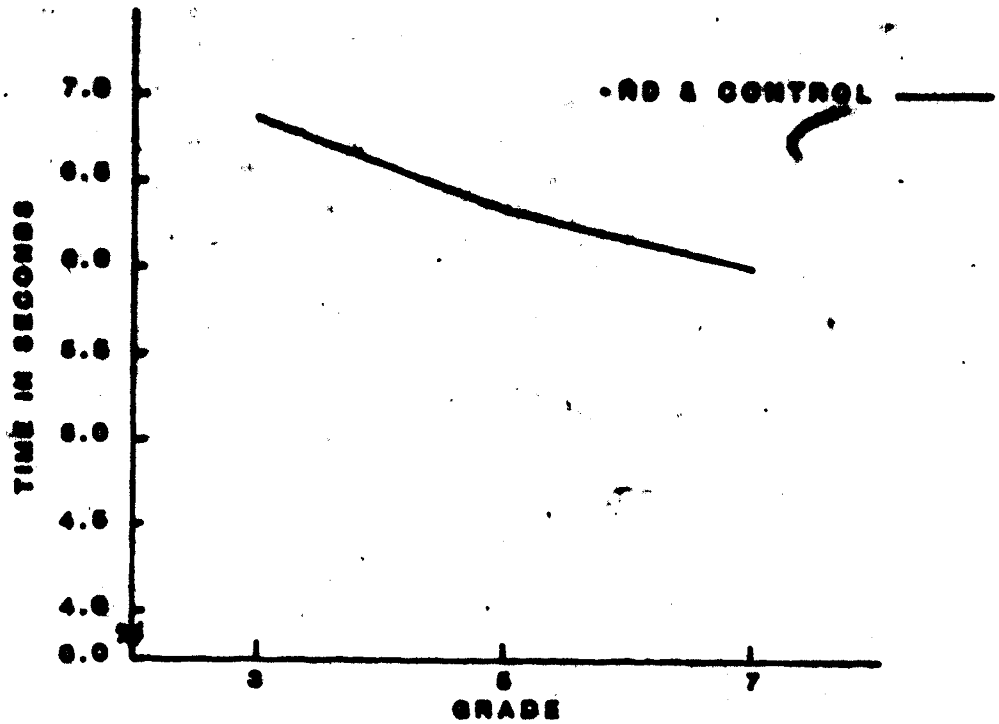

Figure 20. Developmental Trend on Dodge Run

[illegible]. [illegible] to [illegible] that were evident in their [illegible].

[illegible] culturally [illegible] tasks as well as has [illegible] reliability (Appendix B) it is difficult to account for the [illegible] results. [illegible] work with the severely awkward [illegible] that they do not perform well on this task. In view of this discussion it seems possible that in attempting to devise a highly reliable test, the very qualities which allow for the measurement of subtle differences in performance have been eliminated from its structure.

Subjective Observations of Strategic Behaviour

Results and Discussions

No attempt was made to objectively score the behaviour of subjects during the test situation. The information presented here was gathered from the written comments of the testers and/or their verbal communication with the writer following the test sessions. It is included as clinical observation which, in the descriptive vein of this thesis, may shed light on the problems of some physically awkward learning disabled children.

Since the reading disabled children were tested three months later than the control group, there was no opportunity for 'blind' testing. Despite the problems which this flaw in design entails, the delay did allow an obvious comparison of test behaviour to take place. The comments which follow therefore represent a consensus that performance behaviours of the RD children differed in three respects to those of the controls.

Movement Confidence

Testers frequently commented that reading disabled children lacked the movement confidence which Keogh suggested is necessary for acquiring movement control (1978). It was often necessary to encourage them, particularly in the balance and controlled jump tasks. In general one could say that they were unable, without encouragement, to summon up as much effort as the control children to successfully complete the task.

Inappropriate Strategic Behaviour

Torgeson (1977), Bradley (1980) and Wall (1982) have commented on the difficulty that learning disabled children have in using active and efficient task strategies. Performance of RD children on both the peg board and the throw, clap and catch task supported this theory. Children who were successful on the peg board task frequently altered their strategy in order to improve their time on the task. In contrast, a number of observations were made concerning the on task behaviour of RD children: they found performance with the non preferred hand taxing and would try to 'help' with the preferred hand; they would change their strategy, but the result would be poorer performance; they would concentrate on making patterns with the pegs rather than placing them as quickly as possible.

In the throw, clap and catch task there was a noticeable number of RD 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.

Specific Errors and Difficulties

The one problem which was noticed more frequently with the RD children than controls was their difficulty in discriminating right and left. This problem was most obvious in the controlled jump task, in which children had to land on a specific foot. The difficulty ranged from actually being unable to tell which foot to land on and therefore varying the response in the hopes that one might be correct; to knowing which foot to land on, but being unable to successfully execute the act; or being confused about right and left, but able to learn the task across three trials.

In other tasks, the errors seemed to be similar to those made by the control subjects. There was one rather important exception. Some children would make errors but be unaware of them. Although they were cautioned on the characteristics of an unacceptable performance before hand, some children would make the error described and not recognize it. For example, on the board lacing task some children would not 'see' the error in lacing around the edges of the board, instead of in and out - straight stitch fashion. When the benefit of feedback as a factor in improving skill and subsequent strategies (Glencross, 1978) is considered in light of this observation the inappropriate behaviour of the RD child becomes even more salient.

The above observations must be considered in light of their subjective nature. Perhaps they may serve to focus attention on the need for more investigation of the strategic and affective problems which inhibit physically awkward children in a learning situation.

Schonell Graded Reading Test: Results and Discussion

Although some care was taken in defining the characteristics of the reading disabled sample to be used in this study, it was decided to include the results of the Schonell Graded Reading Test as verification of the group differences. Mean test results presented in Table 8 lend support to the initial description of the sample. Not only did the reading ages increase uniformly across grades, but the discrepancy between the reading disabled and control group was also maintained at each grade level. It should be noted that the grade 7 control group scores are artificially low because of the 12.6 ceiling of the 1970 norms.

As the Schonell Graded Reading Test is a measure of word identification it is apparent from Table 8 that the RD children in this study actually did display the type of reading difficulty frequently associated with this group (Vellutino, 1979). In addition, not only did the grade seven mean score indicate that the discrepancy between groups was maintained across grades, but also their ability to overcome the perceptual difficulties common to reading disabled children in younger grades (Lupart, 1982).

The Physically Awkward: Results and Discussions

Selection of the Sample

The identification of a sample of physically awkward children proceeded in the following manner. A decile distribution of the

TABLE 8

Mean Schonell Reading Scores

Group	Total N[a] M	F	Mean Reading Age Years (S.D. in Years)
Grade 3			
Control	18	21	9.21 (1.05)
Reading Disabled	25	19	7.67 (.45)
Grade 5			
Control	22	21	11.16 (1.21)
Reading Disabled	20	19	9.39 (.84)
Grade 7			
Control	19	16	11.99 (.85)
Reading Disabled	11	13	11.18 (1.25)

[a]Represents sample for whom scores were available.

individual mean performances on all tasks was computed. In order to rate the mean performance of each child against that of his/her age and sex matched peers, his/her score on each task was given a percentile rating. From these ratings it was possible to select a sample of children whose test results were at the low extreme of the distribution. This method has been used successfully by Stott, Moyes and Henderson (1972), Gubbay (1975b) and Keogh et al (1979).

The sample comprised two parts, a severely awkward group and a generally awkward group. Children were identified as severely awkward if their mean test scores were at or below the 10th percentile on at least three of the following tasks: throw and catch; throw, clap and catch; the dodge run; the balance task appropriate for their age group; and the controlled jump. In order to take into account the natural developmental trend in performance scores, 10 year olds were also rated on the stork balance, and 12 year olds were rated on all three balance tasks. Tasks performed with both preferred and non preferred limbs were regarded as one variable for the purpose of assessing awkwardness, that is, a child was only penalized once for poor performance with both limbs. Children were identified as generally awkward performers if they had a large number of scores at or below the 20th percentile and two scores at or below the 10th percentile. The results of this analysis are presented in Appendix E.

Sample Characteristics

The total sample of awkward children which resulted from the above selection processes is described in Table 9. This sample represents 20 percent of the 240 subjects in the study. A chi square analysis was

TABLE 9

Characteristics of the Awkward Sample

Grade	Sex	Reading Disabled	Control	Significance
3	M	7	2	
	F	4	3	
5	M	5	3	
	F	5	5	
7	M	5	2	
	F	5	2	
Total		31	17	$p < .01$[a]

[a] $\chi^2 = 7.737$, df = 1

used to determine if the number of physically awkward children who were also reading disabled was significantly greater than the number of physically awkward control children. Results of this analysis were significant, χ^2 (1) = 7.737, p <.01. As predicted by Hypotheses 3, there were almost twice as many children identified as physically awkward who had concomitant reading problems. That is, 27.7 percent of the RD children compared to only 13.3 percent of the control children were physically awkward. One other feature of the group was particularly noticeable. As illustrated in Table 10, a significantly greater number of RD males was identified compared to control males, χ^2 (11) = 6.701, p <.01.

A search of the literature for similar studies allows some interesting comparisons to be made. It should be noted first, that none of the studies cited equated the size of the reading disabled and control groups before they identified a physically awkward sample. Consequently, the interaction of sex and reading difficulty which is frequently cited cannot be easily interpreted. For example, Henderson and Hall (1981) had a 13:3 male to female ratio in their sample of referred physically awkward children. The eight children who had concomitant reading difficulties were all males. In contrast, Gubbay (1975) found no significant interaction of sex and awkwardness in a sample that was initially equated for sex. He did report that 12 of the 56 clumsy children identified had reading quotients below 80, but no indication of the sex of these children was given.

The Isle of Wight (1970) study provides a third perspective for viewing this problem. In looking at what was essentially a total population, Rutter, Tizard and Whitmore uncovered more than a 2:1 male

TABLE 10

Frequency Table of Physically Awkward

RD Males and Control Males

	Reading Disabled	Control	Significance
Awkward	17	7	$p < .01^a$
Others	41	58	
Total	58	65	

$^a\chi^2 = 6.701$, df = 1

TABLE 11

Frequency Table of Severely Awkward

RD Children and Control Children

	Reading Disabled	Control	Significance
Severely Awkward	19	7	$p < .01^a$
Others	93	121	
Total	112	128	

$^a\chi^2 = 8.177$, df = 1

to female ratio in the group identified with reading retardation. In addition, there was a significant increase in the frequency of clumsiness in this group compared to the controls. It is not clear, however, what relationship existed between clumsy reading retarded males and clumsy reading retarded females.

Since the present study sample was generally equated for sex and reading difficulty, it is interesting to note that more RD children were physically awkward, and that more RD males were awkward compared to control males. However, the distribution of awkwardness by sex was remarkable for its similarity, that is, 24 males and 24 females. In addition the distribution of awkward children by grade was relatively stable. There were two exceptions. The number of 8 year old RD males and 10 year old control females were slightly higher than the trend in Table 9 would indicate.

Comparison of Severe and Less Severe Groups

Once the sample was divided into its two components, severe and less severe, further analysis was conducted. The characteristics of each subject are recorded in Appendix E. As was evident in the total sample analysis, the ratio of males to females in both severe and less severe groups was essentially similar. The 26 children in the severe group represented 10.8 percent of the 240 children in the study, whereas 9.2 percent or 22 children were identified in the less severe group.

Although the number of reading disabled and control children in the less severe group was essentially similar (11:10), as predicted in Hypothesis 3-1, a significantly greater number of RD children compared to controls was identified as severely awkward χ^2 (1) = 8.177, $p < .01$

(See Table 11). One other very noticeable difference between the severe and less severe groups involved the 8 year old children. Without exception every severely awkward 8 year old child was also reading disabled, whereas in the less severe group, the distribution of control and RD children was equal.

This concept of identifying awkward children with respect to severity has been employed in several studies by Keogh (1968b; 1979). Similarities are limited, however, because of his sample characteristics. In his early work Keogh designated the severe group as those with scores below the 10th percentile and the less awkward group as those with scores between the 10th and 30th percentile. He found that the experimental group of 40 mentally retarded boys (IQ range 51 to 77) had three times as many low marks as the control boys. The 1979 study also used all male subjects, but no measures of IQ or academic achievement were reported for the movement problem sample or the control group. It is difficult therefore, to make any further comparison to the present study.

As Torgeson has advised (1982), attempts were made to isolate rationally devised subgroups within the severe and less severe groups. It was hoped that a number of children might share some common characteristics. To this end, children were identified whose IQ scores or Schonell Reading Ages were one standard deviation or more below the mean for their group (see Appendix E). None of the children displayed both a deviant IQ and reading score. In addition, none of the IQ scores were out of the normal range. In fact, when mean IQ scores were computed for both severe and less severe groups, they differed by only four points (98, 102). With the one exception of the 8 year old severely awkward RD children, attempts to isolate further subgroups within the two samples have been unsuccessful.

It appears that the identification of the severely awkward group as a result of this study, is an invitation for further analysis as recommended by Torgeson's step three. Having accounted for age, IQ, socio economic status, predominant second language, and physical and neuromuscular problems, there remains a group of 8 year old, severely awkward reading disabled children who may exhibit further homogeneity in strategic behaviours and specific task failure. It is hoped that the follow-up study of these children may provide more information on the specific relationship of physical awkwardness and reading disability.

CHAPTER 5

CONCLUSIONS AND RECOMMENDATIONS

Conclusions

As a result of the findings of this study, a number of descriptive statements may be put forward concerning the nature of physical awkwardness in general, and its relationship to the reading disabled, in particular. With respect to sex differences, despite previous conclusions to the contrary (Rutter, Tizard and Whitmore, 1970), it can be said that with few exceptions the performances of boys and girls are not significantly different on fine motor and lower limb coordination tasks. Boys do out perform girls significantly at all ages in throwing skills, and have superior catching ability at age eight. These results compare favourably with Gubbay's contention that there are no sex differences with respect to the incidence of awkwardness.

Although there are some exceptions, the reading disabled children do perform more poorly as a group on the test battery. The differences are most noticeable in the upper and lower limb coordination tasks, or generally what are termed gross motor skills. It is also apparent that group differences are largest at age eight. These results tend to support the developmental delay theory and suggest that, if one assumes that the study is sampling the same children at each age group, reading disabled children do manage to acquire an adequate skill level as they grow older. There is some evidence that reading disabled boys have more difficulty than girls with balance tasks. Replication of these results is needed to strengthen this contention.

The characteristics of the awkward children identified in this study illustrate that the sexes are equally involved, both in less and more severe levels of awkwardness. There is evidence however, that a much larger number of reading disabled boys are involved than average boys. With respect to the relationship of physical awkwardness and reading disability, in particular, it can be said that according to the measurement techniques used in this study, there is a definite subgroup of severely awkward reading disabled children. In addition, there is a specific group within these children of 8 year old severely awkward reading disabled children.

It is apparent from the investigation of developmental trends and this test battery, that further investigation with these tasks may help to clarify the pattern of performances which would be expected from 10 and 12 year old children. In general, the tasks do monitor changes in performance due to developmental differences. It might be difficult, however to place a 12 year old on a continuum in the narrow board balance left, for example. In addition, the relationship between the three balance tasks as comparable measures of balance at different developmental levels needs to be clarified by further study.

Despite the qualifications which have been made for particular parts of the battery, the study has been successful in illustrating performance differences between reading disabled and average children. It has also provided strong evidence for the concomitance of physical awkwardness and reading disability. The following recommendations are made for further study of this problem.

Recommendations

Gross Performance Test Battery and Procedure

It would be most beneficial to continue work with the test battery both as a screening instrument and as a clinical technique. Particular emphasis should be placed on the specific nature of the behaviours which are being tapped by the battery and how each relates to the concept of physical awkwardness. The utility of another data set for this purpose is evident.

It is also recommended that efforts be directed at improving the fine motor tasks in this battery, so that they may be included as criteria for identifying physically awkward children. Research could then be directed at investigating the concomitance of fine and gross motor problems and perhaps allow the identification of further sub groups in the sample of physically awkward children.

Efforts to verify the construct validity of this test battery should be continued. It is hoped that some support for its validity may be provided by a concurrent study which is comparing teacher ratings to test battery performances (Umansky, 1982). In addition if a replication of the present findings can be made in the second year of this study using cohort comparisons, then additonal support for the test battery would result.

Follow-Up Study

An investigation of the specific processing difficulties experienced by the identified sub group of severely awkward children, would be particularly valuable. Simple re-test scores would provide some information on the progress of 8 year old severely awkward reading disabled children, but utilization of Torgeson's model in Step four would provide a better opportunity to analyze processing skills (1982).

To this end, a method of coding the performance errors of the sample as a whole might provide some suggestions for the type of questions which could be studied with the smaller groups. A catalogue of the task strategies of successful and unsuccessful performers would provide additional information for the descriptors used in defining physical awkwardness. Also the utility of such a measure in providing clues for remediation cannot be understated. The following factors should be considered in the development of a coding scheme of strategic behaviours.

Classification of Errors

1. Lack of motor control.
2. Inability to follow a pattern.
3. Inability to recognize errors.
4. Deficiencies related to specific skills acquisition.
5. Inability to take advantage of strategic advice.

The next step would be to design the comparative experiment using the following three groups: 8 year old reading disabled children; 8 year old control children; and 8 year old physically awkward reading disabled children. It would be advisable at this point, to try and acquire a better record of the interaction of the non-specific factors affecting performance which Torgeson (1977) and Barbara Keogh (1982) believe are particularly applicable in the research of the learning disabled. More specific guidelines may be provided by the recent work of Wall, McClements, Bouffard and Findlay (1982) in which they attempt to define the cognitive interaction of genetic and environmental effects on skill development. The following is suggested, therefore, as a rough framework in which to encompass the study of non specific factors.

Ability to Actively Engage the Task - Some Considerations

1. Lack of Understanding of the task.

2. Frequent use of non-goal related behaviour.

3. Tendency to act on a limited amount of pertinent task information.

Affective Behaviour

1. General level of motivation.

2. Level of performance confidence.

3. Level of movement confidence.

To aid the observer, specific examples of the interaction of these factors with each task in the battery could be written and used in a checklist format. In conclusion, although this study has emphasized the specificity required in subject selection, definition of measurement techniques and identification of sub groups, it is hoped that the call for multivariate research will not go unheeded.

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APPENDIX A

TEST BATTERY RELIABILITY COEFFICIENTS

Test-Retest Correlation Coefficients

for

Motor Performance Test Battery

Task	8 year olds M	8 year olds F	10 year olds M	10 year olds F	12 year olds M	12 year olds F
Upper Limb Coordination						
Throw and Catch	.75**	.64**	.50**	.53**	.24	.78**
Target Throw	.10	.32	.48**	.35*	.60**	.49**
Fine Motor Coordination						
Board Lacing	.29	.47**				
Lower Limb Coordination						
Stork Balance R.	.51**	.51**				
Stork Balance L.	.50**	.40*				
Wide Board Balance R.			.69**	.37*		
Wide Board Balance L.			.42*	.64**		
Narrow Board Balance R.					.18	.36*
Narrow Board Balance L.					.15	.43*
Controlled Jump R.			.36*	.27		
Controlled Jump L.			.34*	.43*		
Dodge Run	.69**	.70**	.77**	.83**	.80**	.71**
Total Score	.55**	.63**	.16	.61**	.18	.70**

* p <.05

** p <.01

APPENDIX B

MOTOR PERFORMANCE TEST MANUAL

INTRODUCTION

This manual contains a test battery designed to screen 8, 10 and 12 year old children for motor impairment. The tasks have been adapted from the Stott Test of Motor Impairment and Gubbay's screening test. The items in the battery measure the following areas of function:

1. Control and balance of the body while immobile

2. Control and coordination of the upper limbs

3. Control and coordination of the body while in motion

4. Manual dexterity with the emphasis on speed

5. Leg speed and agility.

(For further details see the Stott Test of Motor Impairment, 1972, and the Adapted Manual, 1981, Taylor).

The manual is designed to:

1. Provide a detailed description of the tasks

2. Give verbal instructions for administration

3. Provide a training process for testers.

Following is a training procedure designed to ensure understanding and standardized administration.

Task 1

Notes on general testing technique and specific instructions are provided. Read them through. It is not necessary to memorize the words, but they should be in front of the tester for referral during administration. There is a danger that after frequent administrations, testers will adopt their own mode of instruction which even though effective, will significantly alter the standard administration of a test. During your reading pay particular attention to the following.

1. A comfortable and efficient arrangement of equipment and scoring forms should be adopted prior to testing.

2. Note the manner for assessing handedness.

3. Note accommodations recommended for the learning disabled.

4. Learn the administration and scoring procedure required for each task.

5. Before testing ensures it is important that the tester establish a rapport with the subject, and attempt to ensure a relaxed atmosphere while still promoting the subject's best effort.

6. Shoes should be worn for all balance tests. Note the position of the tester during balance subtests. Timing should not begin until the balance position is attained.

7. Note the equipment set up and preparation needed for each task.

8. Note the number of trials required for particular subtests.

9. Note the conditions of failure, especially for balance items.

10. If it is apparent that the subject does not understand the instructions the first time, repeat them. If a second demonstration is needed, provide it. If no response is forthcoming or difficulty is still apparent, ask the child what part he does not understand. In severe cases, ask the child if he would prefer to go on to another item and return to the troublesome task later.

GENERAL TESTING INSTRUCTIONS

Test Room The test room should be at least 40' x 16' to accommodate throwing items, running distance, etc. It must have one blank wall suitable for ball throwing. At least part of the floor should be a hard solid surface for ball bouncing, jumping, etc. (carpeting is unsuitable). All floor and wall markings should be made prior to testing as these require careful measurement. If a permanent testing room is available it would be ideal to have these painted on the floor.

A table and three chairs are required. The height of the table and the one chair may have to be adjusted to suit the size of the child being tested. A school desk and chair may be suitable.

Equipment The equipment needed for each age level is listed before the description of the test items. A stop watch and scoring forms are required at all levels. The manual should be at hand.

A rubber mat is provided and should always be used when the subject has to pick up small objects such as pegs.

Recording Techniques (i) Since counting a number of catches or throws can be a source of error, the tester should use the small grids on the Test Record to mark the result of each trial as made.

(ii) As the tester must observe the subject carefully during the timed tests, he may allow the subject to complete the task before checking the stop watch and recording the time.

(iii) The tester should choose a suitable place to stand for balance or coordination items so that he can see the subject's feet.

(iv) When an item is difficult to complete or is failed because of comprehension problems, this should be noted on the record form.

Establishing the Preferred Hand Place a pencil and the record sheet, printed side down, in front of the subject. Ask him/her to write or print his/her name. The hand used to hold the pencil should be recorded in the scoring form and treated throughout the testing as "preferred hand". In addition, for ball skill tasks, the subject should be asked to perform the skill with the hand he prefers.

Checking Clothing Subjects are not required to change for the test but should wear a minimum of clothes so that observation of movement is easier. Rubber soled gym shoes must be worn. All tests should be done with the subject in gym shoes and not barefeet.

Demonstration and Encouragement The tester should normally demonstrate the task to the subject in order to overcome any difficulty in attending or understanding verbal instructions. The most important features of the task should be emphasized, e.g.; while demonstrating a timed task say, "See how many you can do while I time you." The cue words "Ready? Begin" or "Ready? Go", should be used in most cases where timing is necessary.

General Note It is important to remember that the test is intended to discover motor impairment and NOT inability to comprehend instructions, poor motivation, etc. Every effort should be made to get the best out of the child. As a modification to this manual verbal instructions are included. When difficulty of comprehension is suspected as a cause of failure, the tester should repeat demonstrations and simplify instructions.

Notes on the Test Categories

Category 1: Balance Items Subject should stand away from furniture, walls, etc. Demonstration helps convey to the child the balance position to be adopted. Tester should make sure that the position is correct and that the subject is balanced before starting the stop watch. If the tester is satisfied that a subject is definitely incapable of achieving the balance position he should record failure. Where necessary the tester should advise the performer to stand with the balancing foot on the middle of the balancing board and the weight over that foot.

Category 2: Upper Arm Coordination In the ball throwing or catching the ball must be in good condition as resilience is important especially in bouncing items. The scoring system is designed to accommodate varied experience in ball handling.

Category 3: Whole Body Coordination For the purpose of the test, knee height is taken as the distance from the floor up to the beginning of the knee cap. Some children are apprehensive in the jumping items. The tester should encourage and help the child where necessary.

Category 4: Manual Tasks A plastic mat is provided as a standard surface for all tasks requiring the picking up of small objects.

Testing of Learning Disabled Children

Learning disabled children tend to have related problems such as timidity, lack of attention, inability to persevere with a task, and difficulty with imitation. As the test is designed as one of motor impairment it is permissible to modify the procedure in order to minimize these extraneous handicaps. In doing so the tester may find the following observations helpful.

Fatigue — The larger amount of motor disability usually found among the learning disabled often necessitates time being spent on verbal encouragement and prompting. No effort should be made to rush the subject through the test.

Comprehension — The tester should use very simple words and repeat the instructions as often as is necessary. He should anticipate difficulties during the performance of the task and remind the subject just before the difficulty arises.

A task may be broken down into several parts to help the subject understand what is required, e.g.: in throwing and catching, each may be done separately, then combined. Attempts at parts of a test should not be scored as complete trials. If the tester is not satisfied with the subject's understanding of the instructions, the number of trials allowed should be increased.

Demonstration — Demonstrations may have to be repeated several times. To avoid difficulty in imitation the tester should stand alongside the subject. In manual dexterity tasks it may help to reach over the child from behind.

Notes on Test Categories (learning disabled children) — Balance Items (Category 1): Failure in concentration is particularly noticeable in balance work. Continuous verbal encouragement is necessary. Many of these children may be unable to assume the required balance position - this must be regarded as failure.

Whole Body Coordination (Category 3): Some subjects may be particularly timid when attempting tasks in this category. To overcome these fears the tester may give assistance in the first few trials, until confidence is gained.

SCORING PROCEDURE

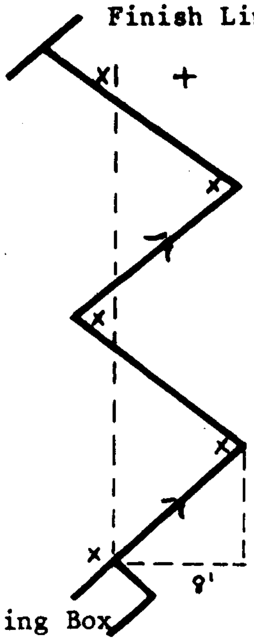
The battery consists of 10 tasks. All raw scores and comments are recorded on the record form. Performances are measured in seconds; number of catches; or success in jumping. It is important that a score be recorded for every trial, whether the child is successful or not.

Note:

In addition, it is important that the tester note any idiosyncracies in performance and any factors which he feels have affected the performance, for example, anxiety, comprehension, slow reaction time, or inattention.

DODGE RUN

EQUIPMENT	5 traffic cones masking tape 8' tape measure gym floor 40' x 16' stop watch scoring sheet
LAY OUT	Course consists of 5 traffic cones placed as per diagram, on corners of 8' square. Each cone is outlined on the floor with tape so that if it is knocked over accurate replacement is possible. In addition the path is marked on the floor with masking tape to avoid confusion.
STARTING POSITION	Student stands in starting box. Student must wear running shoes.
TASK	On signal ready, go, the subject runs a weaving pattern to the outside of each cone. Tester stops the watch as subject passes the last cone. If subject traces incorrect path, trial is repeated.
TRIALS	Three
SCORING	Best time of 3 trials.



DODGE RUN

EQUIPMENT	5 traffic cones masking tape 8' tape measure	gym floor 40' x 16' stop watch scoring sheet

PROCEDURE

Five traffic cones are placed on corners of 8' squares, as per diagram. The path is marked on the floor with masking tape.

Have subject in starting box at start cone.

a) Say "When I say ready? go, run as quickly as possible. Follow the tape lines on the floor and go to the outside of each cone. When you go by the last cone run to the finish line."

b) Say, "Now follow me and we will trace the path together."* Walk through the course once, with the student behind you. At the end of the course, the student hands the scoring sheet to the tester. Ask the subject to return to the start and begin with ready? go.

Tester stands on 4' restraining line facing subject. He begins watch on word "go". As subject approaches the last cone the tester pivots on the line and stops the watch as any part of the subject's body passes the cone. If an incorrect path is traced, or the subject falls, the trial is repeated. Record after each trial to the nearest 10th of a second.

TRIALS

Three

SCORING

Best time of three trials.

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

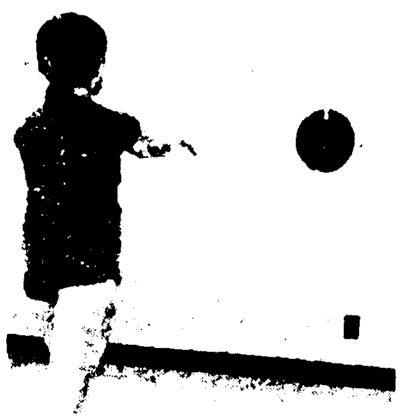
a) Say, "Now I want you to stand behind this line and throw the ball to the wall, underhand. When the ball returns, catch it with both hands. Try not to use your body to trap the ball."

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.



TARGET THROW

EQUIPMENT	Tennis ball 12" circular board Scoring grid on Record Sheet
LAY OUT	The target is hung on a wall at the height of the subject's chest with masking tape. The subject stands behind a chalked or taped line 10 feet away.
TASK	The subject throws the ball, either underarm or overarm, at the target with the preferred hand. The height of the target may be ajusted if the subject feels it is too high or too low. Only the preferred hand is tested. Success or failure should be entered on the grid after each attempt.
TRIALS	15. Do all of them. Give 2 practice trials.
SCORING	Record after each attempt. A throw is successful if any part of the target is hit. If any problems of style, or pattern of misses occurs, record on data sheet.

TARGET THROW

EQUIPMENT	Tennis ball 12" circular board Scoring grid on record sheet
PROCEDURE	Place target on wall at subject's chest height. Mark 10' distance on floor with tape. a) Say, "Throw the ball with your right (preferred) hand, in whatever manner you wish, and try to hit the target. You have 15 tries."
TRIALS	15. Do all of them. Mark after each attempt.

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 [illegible] in front of and to the side of the subject [illegible] 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.

WIDE BOARD BALANCE
Right and Left

EQUIPMENT	Stop watch One balance board Subject must wear running (gym) shoes.
PREPARATION	The balancing board should be placed with the keel on the underside, away from walls and furniture. Tester must stand in front of and to the side of the subject so that the feet can be clearly observed.
TASK	Subject balances on the board on one leg. Tester may advise the subject to place his foot firmly on the middle of the board then raise the other foot gently. Tester should ensure that the subject is in the correct position before starting the stop watch.
TRIALS	Three for each leg.
SCORING	Discontinue timing after 10 seconds. Record time for each trial. Stop Watch: If the standing leg is moved from the board. If the board tilts so that the sides of the board touch the floor. If the free leg touches the floor. If the subject cannot adopt the balancing position, assess score of 0.

WIDE BOARD BALANCE
Right and Left

EQUIPMENT	Stop watch One balance board
PROCEDURE	Place the balance board with the keel on the underside on the floor away from walls and furniture. a) Say, "Place one foot on the middle of the board. Now raise your other foot gently off the floor. Good" or "Like this. Now let's see how long you can do it. Good, Now, place your other foot on the board. Tester should ensure that the subject is in the correct position before starting the stop watch.
TRIALS	Give three for each leg.
FAILURE	Standing leg is moved from the board. Free leg touches the floor. Subject cannot adopt the balancing position. If the board tilts so that the sides of the board touch the floor.

PEG BOARD
Right and Left

EQUIPMENT

12-hole board

Ten plastic pegs

Plastic mat

Stop watch

LAY OUT

The plastic mat is laid on a table with the board of holes placed in front of the subject. On the side of the subject's preferred hand the ten plastic pegs are laid out in a single row one inch apart. The row should be about three inches from the board.

The pegs are subsequently laid out on the other side of the board for the non-preferred hand.

TASK

On a signal the subject, using one hand, places the pegs one at a time in the holes. He should be encouraged to steady the board with the other hand.

TRIALS

Three for each hand.

PEG BOARD
Right and Left

EQUIPMENT

12 hole board
10 plastic pegs
Plastic mat
Stop watch

PROCEDURE

With the plastic mat on the table, the board of holes is placed in front of the subject. The ten plastic pegs are placed in a single row, one inch apart and about three inches from the board on the side of the subject's preferred hand.

a) Say, "Now when I say go, I want you to pick up the pegs one at a time and put them in the holes. You can hold the board steady with your other hand. Ready? Go."

b) Then lay the pegs out on the other side of the board for the non preferred hand.

TRIALS

Give three trials for each hand. Allow child to place the pegs in any pattern they wish. Record time taken for each trial. Record comments.

NARROW BOARD BALANCE
Right and Left

EQUIPMENT	Stop watch One balance board
PREPARATION	Subject must wear running (gym) shoes. The balance board must be placed with the keel uppermost, away from walls or furniture. Tester should stand in front of and to the side of the subject so that the feet can be clearly observed.
TASK	Subject balances on the keel on one leg. Tester may advise the subject to centre his foot firmly on the keel then lift the other foot gently. Tester should ensure that the subject is in the correct position before starting the stop watch. The task is repeated with the other leg.
TRIALS	Three for each leg.
SCORING	Discontinue timing after 14 seconds. Record time for each trial. Stop watch: If the standing leg is moved from the board. If the free leg touches the floor. If the subject cannot adopt the balancing position, assess score of 0.

NARROW BOARD BALANCE
Right and Left

EQUIPMENT	Stop watch One balance board.
PROCEDURE	Place balance board on the floor away from walls or furniture with the keel on the upper side. a) Say, "Place one foot on the centre of the board and raise the other gently off the floor until you balance. Good. Let's see how long you can do it." Tester should stand in front of and to the side of the subject so that the feet can be clearly observed. Tester should ensure that the subject is in the correct position before starting the stop watch.
TRIALS	Give three for each leg.
FAILURE	Standing leg moved from the board. Free leg touches the floor. Subject cannot adopt balancing position.

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

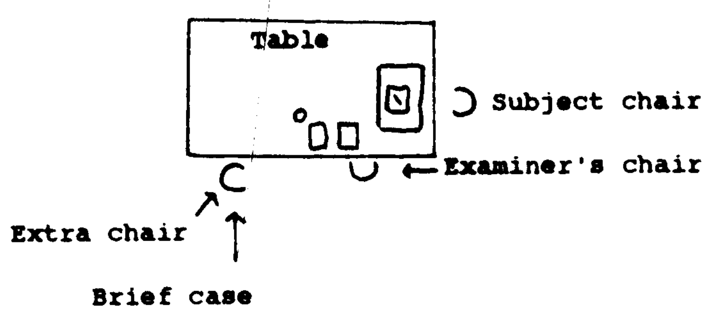
Indicate failure and assess time of 0:
If subject does not take off with two feet together.
If subject does not land on one foot and maintain the position for 5 seconds.
If subject displaces the cord.

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.

ARRANGEMENT OF TESTING EQUIPMENT

On table
Stop watch
Record form
Manual
Plastic mat
Paper
Pencil



Equipment
5 traffic cones
5 tennis balls
12" target
masking tape
lacing board
lace

12 holed board
10 plastic pegs
jumping standards 2 pegs
weighted string
balance board

Note:

Equipment for each task should be kept in the briefcase on the chair out of the subject's sight. Return equipment to the case as soon as you have completed the subtest.

Task 2

A true/false quiz is provided for self-evaluation. Do it without reference to the text. Check your answers and score the test. Re-read reference sections for any errors you may have made.

Quiz

Circle the most appropriate answer. Do not omit any questions.

T F 1. It is essential that all tests be done in barefeet, except for the balance subtests.

T F 2. The testing procedure involves administering all tests at each age level.

T F 3. One demonstration per subtest is recommended for slow learners.

T F 4. When timing a subject, observations should be made before the time is recorded.

T F 5. On the target throw, the ball must be thrown overhand.

T F 6. On most subtests it is not necessary to complete all trials if success occurs first.

T F 7. The lacing board task may be done with either hand.

T F 8. In all catching subtests the ball must be caught cleanly.

T F 9. All balance items have two trials.

T F 10. To measure knee height the distance is taken from the floor to the bottom of the knee cap.

T F 11. Instructions should never be modified since standard procedure would be violated.

T F 12. To determine the preferred hand, ask the student which is his writing hand.

T F 13. Reliability on the catching subtests can be improved by recording after each trial.

T F 14. In all balance subtests the stop watch is begun on the command "Ready? Go."

T F 15. If a subject is reluctant to attempt a subtest, a failure should be scored.

T F 16. If it is apparent that a child does not understand the instructions, every reasonable effort should be made to convey the desired outcome.

T F 17. It is important to have all of the testing equipment on the table in front of the subject.

T F 18. The stork stand is timed to a maximum of 16 seconds.

T F 19. The subject may place the 12 pegs in the board in any order.

T F 20. In the clap and catch task a total of 21 trials is given before failure is recorded.

Task 3

Watch a test demonstration.

Task 4

Learn the test and administer it to your partner. Comment on problems.

Task 5

Administer the test for evaluation of procedural technique.

COMMON EQUIPMENT AND CRITERIA PROBLEMS

Item	Problem	Solution
Jump with one foot landing	Subject lands with a slight hop.	Emphasize minor adjustments are permitted.

General Comments

1. Whenever there is doubt about marking a trial + or −, give an additional trial and point out the criteria to the subject so that he is aware of the desired performance.

2. Do not hesitate to demonstrate and repeat instructions if confusion or lack of understanding is evident.

LIST OF COMMON PROBLEMS

Following are some of the problems which I have observed since training began. Would you read this list and try to take each point into consideration when testing. Thanks.

1. When assessing handedness be sure to ask if the child does all tasks with the same hand. eg. (writing and throwing).

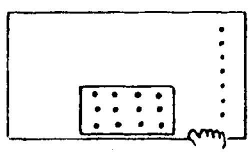
2. Take particular note of balance failure conditions. eg. (hands taken off hips, foot off knee.

3. There is a tendency for some examiners to start the stop watch at the initiation of balance rather than when the child has attained balance. Please let the child assume the balance. This procedure will decrease the failure rate considerably.

4. It may be helpful to encourage during balance tasks.

5. Be sure to tell the child he can use two hands for the lacing task if he wishes.

6. Check the placement of the pegboard on the plastic mat.



Pegboard

Hand

7. Have the child begin the peg task with the placing hand on the table edge.

8. Make sure subjects perform the dodge run in the same footwear for all three trials.

9. Check the distance of the dodge run after you have set up the course.

10. Ask child if the target is at the preferred height for him.

11. In Gubbay's test, give only 3 trials if the child is unsuccessful. After 3 trials on 1 task, discontinue testing. A perfect score would look like this.

–	0	1	2	3	4	4D
✓		✓	✓	✓	✓	✓

12. Make instructions slow enough to be understood.

13. Demonstrate the tasks.

14. Always record after each trial. (nearest 10th of a second on timed tasks).

15. Remember to note if child is anxious, inattentive, etc.

16. If you attribute failure to your inadequate instructions, give a re-trial.

17. Regarding the question of intervention and encouragement during a task; generally, do so between trials on the fine motor tasks. Remember you may be adding to anxiety by too much encouragement. Also, a primary consideration is offering the same degree of encouragement to each subject.

Evaluation of Testing Technique

	Satisfactory	Needs Work	Comments
1. General knowledge of format			
2. Method of presentation eg., method of gaining rapport, quality of voice and instructions (clear, pleasant, encouraging), relaxed manner.			
3. Attention to specific details eg., correct arrangement of equipment, method of demonstrating, knowledge of conditions of failure, flexibility in difficult situations.			
4. Can tester conduct test in a flowing manner, without paying constant attention to the manual?			
5. Does he record after every trial?			

General Comments

RECORD FORM

Name ______________________________

Sex ______________________________

Age ______________________________

Birthdate ______________________________

Preferred Hand ______________________________

School ______________________________

Grade ______________________________

Examiner ________________ Date __________

								Comments
Dodge Run								
Throw & Catch								
Target Throw								
Clap & Catch	–	0	1	2	3	4	4D	

Stork Balance (20)	1	R2	3	1	L2	3	Comments
Lacing							
Board Balance (10)	1	2	3	1	2	3	
Pegs	1	2	3	1	2	3	
Board Balance (14)	1	2	3	1	2	3	
Jump 1 Foot Landing (5)	1	2	3	1	2	3	

APPENDIX C

SCHONELL GRADED READING TEST

Schonell Graded Reading Test

FORM A

tree	little	milk	egg	book
school	sit	frog	playing	bun
flower	road	clock	train	light
picture	think	summer	people	something
dream	downstairs	biscuit	shepherd	thirsty
crowd	sandwich	beginning	postage	island
saucer	angel	ceiling	appeared	gnome
canary	attractive	imagine	nephew	gradually
smoulder	applaud	disposal	nourished	diseased
university	orchestra	knowledge	audience	situated
physics	campaign	choir	intercede	fascinate
forfeit	siege	recent	plausible	prophecy
colonel	soloist	systematic	slovenly	classification
genuine	institution	pivot	conscience	heroic
pneumonia	preliminary	antique	susceptible	enigma
oblivion	scintillate	satirical	sabre	beguile
terrestrial	belligerent	adamant	sepulchre	statistics
miscellaneous	procrastinate	tyrannical	evangelical	grotesque
ineradicable	judicature	preferential	homonym	fictitious
rescind	metamorphosis	somnambulist	bibliography	idiosyncrasy

Schonell's Graded Word Reading Test (1970)

Revised Norms

No. of words Read Correctly	R.A. Yrs Mths	No. of words Read Correctly	R.A. Yrs Mths	No. of words Read Correctly	R.A. Yrs Mths
0-1	6.0 minus	33	8.3	61	10.4
2	6.0	34	8.4	62	10.5
3	6.2	35	8.5	63	10.6
4	6.4	36-37	8.6	64	10.7
5	6.5	38	8.7	65	10.8
6	6.6	39	8.8	66	10.9
7-8	6.7	40	8.9	67	10.10
9	6.8	41	8.10	68	11.0
10	6.9	42	8.11	69	11.1
11-12	6.10	43	9.0	70	11.3
13-14	6.11	44	9.1	71	11.4
15	7.0	45	9.2	72	11.5
16	7.1	46	9.3	73	11.6
17-18	7.2	47	9.4	74	11.8*
19	7.3	48	9.5	75	11.10
20-21	7.4	49-50	9.6	76	12.0
22-23	7.5	51	9.7	77	12.1
24	7.6	52	9.8	78	12.2
25-26	7.7	53	9.9	79	12.3
27	7.8	54	9.10	80	12.4
28	7.9	55	9.11	81	12.5
29	7.10	56	10.0	82	12.6
30	8.0	57-58	10.1	83+	12.6+
31	8.1	59	10.2		
32	8.2	60	10.3		

*Revised reading ages beyond 11.6 have been extrapolated from the 7-11 1/2 year age population.

APPENDIX D

ANOVA TABLES AND NEUMAN KEULS CALCULATIONS

ANOVA for Throw and Catch

SOURCE		df	MS	F	p
Between					
A	Group	1	36.057	3.854	SIG
B	Sex	1	249.302	26.643	SIG
C	Grade	2	953.293	101.880	SIG
AB	Group X Sex	1	12.948	1.384	NS
AC	Group X Grade	2	20.080	2.146	NS
BC	Sex X Grade	2	62.530	6.683	SIG
ABC	Group X Sex X Grade	2	17.232	1.842	NS
	Error	228	9.357		

ANOVA for Target Throw

SOURCE		df	MS	F	p
Between					
A	Group	1	0.664	0.116	NS
B	Sex	1	182.448	31.778	SIG
C	Grade	2	384.582	66.985	SIG
AB	Group X Sex	1	0.005	0.001	NS
AC	Group X Grade	2	1.494	0.260	NS
BC	Sex X Grade	2	7.819	1.362	NS
ABC	Group X Sex X Grade	2	6.635	1.156	NS
	Error	228	5.741		

ANOVA for Throw, Clap and Catch

SOURCE		df	MS	F	p
Between					
A	Group	1	19.460	14.571	SIG
B	Sex	1	5.000	3.744	SIG
C	Grade	2	79.618	59.615	SIG
AB	Group X Sex	1	0.020	0.015	NS
AC	Group X Grade	2	0.477	0.357	NS
BC	Sex X Grade	2	1.184	0.887	NS
ABC	Group X Sex X Grade	2	0.214	0.160	NS
	Error	228	1.336		

ANOVA for Board Lacing

SOURCE		df	MS	F	p
Between					
A	Group	1	60.263	1.847	NS
B	Sex	1	77.871	2.387	NS
C	Grade	2	1322.026	40.519	SIG
AB	Group X Sex	1	0.152	0.005	NS
AC	Group X Grade	2	11.574	0.355	NS
BC	Sex X Grade	2	63.640	1.951	NS
ABC	Group X Sex X Grade	2	2.581	0.079	NS
	Error	228	32.627		
D	Trials	2	340.819	34.260	SIG
AD	Group X Trials	2	1.101	0.111	NS
BD	Sex X Trials	2	5.313	0.534	NS
CD	Grade X Trials	4	4.857	0.488	NS
ABD	Group X Sex X Trials	2	26.564	2.670	NS
ACD	Group X Grade X Trials	4	24.344	2.447	SIG
BCD	Sex X Grade X Trials	4	15.274	1.535	NS
ABCD	Group X Sex X Grade X Trials	4	12.941	1.301	NS
	Error	456	9.948		

ANOVA for Peg Board Right

SOURCE		df	MS	F	p
Between					
A	Group	1	95.100	6.631	SIG
B	Sex	1	10.777	0.752	NS
C	Grade	2	452.009	31.519	SIG
AB	Group X Sex	1	5.237	0.365	NS
AC	Group X Grade	2	8.842	0.617	NS
BC	Sex X Grade	2	4.554	0.318	NS
ABC	Group X Sex X Grade	2	10.550	0.736	NS
	Error	228	14.341		
D	Trials	2	34.154	8.054	SIG
AD	Group X Trials	2	5.313	1.253	SIG
BD	Sex X Trials	2	1.935	0.456	SIG
CD	Grade X Trials	4	5.332	1.257	SIG
ABD	Group X Sex X Trials	2	3.605	0.850	SIG
ACD	Group X Grade X Trials	4	7.210	1.700	SIG
BCD	Sex X Grade X Trials	4	4.212	0.993	SIG
ABCD	Group X Sex X Grade X Trials	4	1.916	0.452	SIG
	Error	456	4.241		

ANOVA for Peg Board Left

SOURCE		df	MS	F	p
Between					
A	Group	1	116.351	5.087	SIG
B	Sex	1	146.179	6.391	SIG
C	Grade	2	665.244	29.082	SIG
AB	Group X Sex	1	14.572	0.637	NS
AC	Group X Grade	2	4.668	0.204	NS
BC	Sex X Grade	2	17.381	0.760	NS
ABC	Group X Sex X Grade	2	4.820	0.211	NS
	Error	228	22.874		
D	Trials	2	50.927	7.039	SIG
AD	Group X Trials	2	14.914	2.061	NS
BD	Sex X Trials	2	0.114	0.016	NS
CD	Grade X Trials	4	4.402	0.608	NS
ABD	Group X Sex X Trials	2	0.531	0.073	NS
ACD	Group X Grade X Trials	4	5.485	0.758	NS
BCD	Sex X Grade X Trials	4	2.675	0.370	NS
ABCD	Group X Sex X Grade X Trials	4	11.499	1.589	NS
	Error	456	7.235		

ANOVA for Stork Balance Right

SOURCE		df	MS	F	p
Between					
A	Group	1	135.174	3.156	NS
B	Sex	1	122.879	2.869	NS
C	Grade	2	72.255	1.687	NS
AB	Group X Sex	1	1.290	0.030	NS
AC	Group X Grade	2	256.610	5.991	SIG
BC	Sex X Grade	2	12.713	0.297	NS
ABC	Group X Sex X Grade	2	65.310	1.525	NS
	Error	228	42.834		
D	Trials	2	49.941	2.277	NS
AD	Group X Trials	2	64.247	2.929	SIG
BD	Sex X Trials	2	40.567	1.849	NS
CD	Grade X Trials	4	1.252	0.057	NS
ABD	Group X Sex X Trials	2	18.633	0.849	NS
ACD	Group X Grade X Trials	4	34.799	1.586	NS
BCD	Sex X Grade X Trials	4	23.566	1.074	NS
ABCD	Group X Sex X Grade X Trials	4	17.760	0.810	NS
	Error	456	21.935		

ANOVA for Stork Balance Left

SOURCE		df	MS	F	p
Between					
A	Group	1	286.438	6.238	SIG
B	Sex	1	177.677	3.870	SIG
C	Grade	2	317.594	6.917	SIG
AB	Group X Sex	1	197.107	4.293	SIG
AC	Group X Grade	2	52.066	1.134	NS
BC	Sex X Grade	2	54.153	1.179	NS
ABC	Group X Sex X Grade	2	26.223	0.571	NS
	Error	228	45.916		
D	Trials	2	33.737	1.500	NS
AD	Group X Trials	2	5.806	0.258	NS
BD	Sex X Trials	2	24.932	1.109	NS
CD	Grade X Trials	4	86.334	3.839	SIG
ABD	Group X Sex X Trials	2	6.110	0.272	NS
ACD	Group X Grade X Trials	4	12.656	0.563	NS
BCD	Sex X Grade X Trials	4	39.676	1.764	NS
ABCD	Group X Sex X Grade X Trials	4	12.390	0.551	NS
	Error	456	22.489		

ANOVA for Wide Board Balance Right

SOURCE		df	MS	F	p
Between					
A	Group	1	[illegible]	[illegible].248	SIG
B	Sex	1	[illegible]	[illegible].077	NS
C	Grade	2	9[illegible]	7.350	SIG
AB	Group X Sex	1	69.741	5.239	SIG
AC	Group X Grade	2	106.769	8.020	SIG
BC	Sex X Grade	2	2.301	0.173	NS
ABC	Group X Sex X Grade	2	26.631	2.000	NS
	Error	228	13.313		
D	Trials	2	8.949	1.106	NS
AD	Group X Trials	2	2.146	0.265	NS
BD	Sex X Trials	2	1.577	0.195	NS
CD	Grade X Trials	4	2.067	0.256	NS
ABD	Group X Sex X Trials	2	0.849	0.105	NS
ACD	Group X Grade X Trials	4	3.635	0.449	NS
BCD	Sex X Grade X Trials	4	7.521	0.930	NS
ABCD	Group X Sex X Grade X Trials	4	2.520	0.312	NS
	Error	456	8.088		

ANOVA for Wide Board Balance Left

SOURCE		df	MS	F	p
Between					
A	Group	1	130.151	8.594	SIG
B	Sex	1	7.974	0.527	NS
C	Grade	2	73.668	4.865	SIG
AB	Group X Sex	1	24.278	1.603	NS
AC	Group X Grade	2	21.828	1.441	NS
BC	Sex X Grade	2	14.167	0.935	NS
ABC	Group X Sex X Grade	2	42.391	2.799	NS
	Error	228	15.144		
D	Trials	2	10.884	1.340	NS
AD	Group X Trials	2	3.489	0.430	NS
BD	Sex X Trials	2	3.226	0.397	NS
CD	Grade X Trials	4	13.675	1.684	NS
ABD	Group X Sex X Trials	2	3.669	0.4[illegible]	NS
ACD	Group X Grade X Trials	4	5.462	0.673	NS
BCD	Sex X Grade X Trials	4	9.621	1.185	NS
ABCD	Group X Sex X Grade X Trials	4	2.124	0.262	NS
	Error	456	8.120		

ANOVA for Narrow Board Balance Right

SOURCE		df	MS	F	p
Between					
A	Group	1	92.856	2.707	NS
B	Sex	1	11.043	0.322	NS
C	Grade	2	113.135	3.298	SIG
AB	Group X Sex	1	104.886	3.057	NS
AC	Group X Grade	2	49.127	1.432	NS
BC	Sex X Grade	2	6.259	0.182	NS
ABC	Group X Sex X Grade	2	15.832	0.461	NS
	Error	228	34.306		
D	Trials	2	15.557	1.153	NS
AD	Group X Trials	2	28.324	2.100	NS
BD	Sex X Trials	2	3.861	0.286	NS
CD	Grade X Trials	4	16.505	1.224	NS
ABD	Group X Sex X Trials	2	4.483	0.332	NS
ACD	Group X Grade X Trials	4	6.302	0.467	NS
BCD	Sex X Grade X Trials	4	10.228	0.758	NS
ABCD	Group X Sex X Grade X Trials	4	14.693	1.089	NS
	Error	456	13.487		

ANOVA for Narrow Board Balance Left

SOURCE		df	MS	F	p
Between					
A	Group	1	450.387	13.496	SIG
B	Sex	1	5.645	0.169	NS
C	Grade	2	105.979	3.176	SIG
AB	Group X Sex	1	249.244	7.468	SIG
AC	Group X Grade	2	125.654	3.765	SIG
BC	Sex X Grade	2	80.755	2.420	NS
ABC	Group X Sex X Grade	2	97.865	2.932	NS
	Error	228	33.373		
D	Trials	2	1.712	0.127	NS
AD	Group X Trials	2	2.021	0.150	NS
BD	Sex X Trials	2	21.828	1.625	NS
CD	Grade X Trials	4	23.556	1.753	NS
ABD	Group X Sex X Trials	2	7.009	0.522	NS
ACD	Group X Grade X Trials	4	5.999	0.447	NS
BCD	Sex X Grade X Trials	4	16.962	1.263	NS
ABCD	Group X Sex X Grade X Trials	4	15.142	1.127	NS
	Error	456	13.434		

ANOVA for Controlled Jump Right

SOURCE		df	MS	F	p
Between					
A	Group	1	110.597	12.938	SIG
B	Sex	1	15.227	1.781	NS
C	Grade	2	24.441	2.859	NS
AB	Group X Sex	1	1.807	0.211	NS
AC	Group X Grade	2	23.294	2.725	NS
BC	Sex X Grade	2	8.453	0.989	NS
ABC	Group X Sex X Grade	2	0.149	0.017	NS
	Error	228	8.548		
D	Trials	2	22.091	6.669	SIG
AD	Group X Trials	2	17.793	5.372	SIG
BD	Sex X Trials	2	15.357	4.636	SIG
CD	Grade X Trials	4	2.095	0.633	NS
ABD	Group X Sex X Trials	2	0.723	0.218	NS
ACD	Group X Grade X Trials	4	1.754	0.530	NS
BCD	Sex X Grade X Trials	4	3.656	1.104	NS
ABCD	Group X Sex X Grade X Trials	4	2.234	0.675	NS
	Error	456	3.312		

ANOVA for Controlled Jump Left

SOURCE		df	MS	F	p
Between					
A	Group	1	128.647	11.688	SIG
B	Sex	1	0.868	0.079	NS
C	Grade	2	88.136	8.008	SIG
AB	Group X Sex	1	2.448	0.222	NS
AC	Group X Grade	2	25.779	2.342	NS
BC	Sex X Grade	2	13.047	1.185	NS
ABC	Group X Sex X Grade	2	8.709	0.791	NS
	Error	228	11.00[illegible]		
D	Trials	2	29.259	4.288	SIG
AD	Group X Trials	2	1.931	0.283	NS
BD	Sex X Trials	2	4.625	0.678	NS
CD	Grade X Trials	4	4.850	0.711	NS
ABD	Group X Sex X Trials	2	3.024	0.443	NS
ACD	Group X Grade X Trials	4	3.253	0.477	NS
BCD	Sex X Grade X Trials	4	3.670	0.538	NS
ABCD	Group X Sex X Grade X Trials	4	5.837	0.855	NS
	Error	456	6.824		

ANOVA for Dodge Run

SOURCE		df	MS	F	P
Between					
A	Group	1	11.698	14.914	SIG
B	Sex	1	8.225	10.487	SIG
C	Grade	2	38.864	49.550	SIG
AB	Group X Sex	1	2.766	3.526	NS
AC	Group X Grade	2	1.428	1.820	NS
BC	Sex X Grade	2	1.039	1.324	NS
ABC	Group X Sex X Grade	2	1.255	1.600	NS
	Error	228	0.784		
D	Trials	2	0.607	11.997	SIG
AD	Group X Trials	2	0.126	2.484	NS
BD	Sex X Trials	2	0.062	1.218	NS
CD	Grade X Trials	4	0.049	0.961	NS
ABD	Group X Sex X Trials	2	0.069	1.359	NS
ACD	Group X Grade X Trials	4	0.044	0.867	NS
BCD	Sex X Grade X Trials	4	0.020	0.398	NS
ABCD	Group X Sex X Grade X Trials	4	0.007	0.141	NS
	Error	456	0.051		

Neuman-Keuls Test of Grade Main Effects

for

Throw and Catch

	Grade		
	3	5	7
$\bar{X}$ catches	7.03	11.76	13.73
$\bar{X}_i - \bar{X}_j$		4.73	6.71
			1.97
$Q = \frac{\bar{X}_i - \bar{X}_j}{\sqrt{MS_w/n}}$		13.95**	19.76**
			5.81**
* Q (.05) for df = 228		2.77	3.31
**(Q (.01) for df = 228)		(3.64)	(4.12)
			2.77
			(3.64)

Neuman-Keuls Test of Grade Main Effects

for

Target Throw

	Grade		
	3	5	7
$\bar{X}$ hits	4.90	7.90	9.07
$\bar{X}_i - \bar{X}_j$		3.00	4.17
			1.17
$Q = \frac{\bar{X}_i - \bar{X}_j}{\sqrt{MS_w/n}}$		11.28**	15.67**
			4.39**
* Q (.05) for df = 228		2.77	3.31
**(Q (.01) for df = 228)		(3.64)	(4.12)
			2.77
			(3.64)

Neuman-Keuls Test of Grade Main Effects

for

Throw, Clap and Catch

	Grade		
	3	5	7
$\bar{X}$ catches	4.64	6.10	6.59
$\bar{X}_i - \bar{X}_j$		1.46	1.95
			.49
$Q = \frac{\bar{X}_i - \bar{X}_j}{\sqrt{MS_w/n}}$		11.41**	15.23**
			3.82**
* Q (.05) for df = 228		2.77	3.31
**(Q (.01) for df = 228)		(3.64)	(4.12)
			2.77
			(3.64)

Neuman-Keuls Test of Trials Main Effects

for

Board Lacing

	Trials		
	1	2	3
$\bar{X}$ seconds	18.082	17.167	15.670
$\bar{X}_i - \bar{X}_j$		.915	2.412
			1.497
$Q = \frac{\bar{X}_i - \bar{X}_j}{\sqrt{MS_w/n}}$		2.614	6.89**
			4.28**
* Q (.05) for df = 456		2.77	3.31
**(Q (.01) for df = 456)		(3.64)	(4.12)
			2.77
			(3.64)

Neuman-Keuls Test of Grade Main Effects for Board Lacing

	Grade 3	Grade 5	Grade 7
$\bar{X}$ seconds	19.549	16.053	14.813
$\bar{X}_i - \bar{X}_j$		3.496	4.736
			1.246
$Q = \frac{\bar{X}_i - \bar{X}_j}{\sqrt{MS_w/n}}$		5.51**	7.47**
			1.97**
* Q (.05) for df = 228		2.77	3.31
**(Q (.01) for df = 228)		(3.64)	(4.12)
			2.77
			(3.64)

Newman-Keuls Test of Trials Main Effects for Peg Board Right

	Trials 1	2	3
$\bar{X}$ seconds	16.986	16.5	16.206
$\bar{X}_i - \bar{X}_j$		.486	.78
			.294
$Q = \frac{\bar{X}_i - \bar{X}_j}{\sqrt{MS_w / n}}$		2.13	3.42*
			2.21
* Q (.05) for df = 456		2.77	3.31
**(Q (.01) for df = 456)		(3.64)	(4.12)
			2.77
			(3.64)

Newman-Keuls Test of Grade Main Effects

for

Peg Board Right

	Grade		
	3	5	7
$\bar{X}$ seconds	18.036	16.127	15.225
$\bar{X}_i - \bar{X}_j$		1.909	2.811
			.902
$Q = \frac{\bar{X}_i - \bar{X}_j}{\sqrt{MS_w/n}}$		4.545**	6.692**
			2.148
* Q (.05) for df = 456		2.77	3.31
**(Q (.01) for df = 456)		(3.64)	(4.12)
			2.77
			(3.64)

Newman-Keuls Test of Trials Main Effects

for

Peg Board Left

	Trials		
	1	2	3
$\bar{X}$ seconds	19.416	18.801	18.426
$\bar{X}_i - \bar{X}_j$		.615	.99
			.375
$Q = \frac{\bar{X}_i - \bar{X}_j}{\sqrt{MS_w/n}}$		2.06	3.32*
			1.26
* Q (.05) for df = 456		2.77	3.31
**(Q (.01) for df = 456)		(3.64)	(4.12)
			2.77
			(3.64)

Newman-Keuls Test of Grade [illegible]
for
Peg Board Left

	Grade		
	3	5	7
$\bar{X}$ seconds	20.614	18.436	17.223
$\bar{X}_i - \bar{X}_j$		2.178	3.391
			1.213
$Q = \dfrac{\bar{X}_i - \bar{X}_j}{\sqrt{MS_w/n}}$		4.10**	6.386**
			2.284**
* Q (.05) for df = 228		2.77	3.31
**(Q (.01) for df = 228)		(3.64)	(4.12)
			2.77
			(3.64)

Neuman-Keuls Test of Grade Main Effects on Wide Board Balance Right

	Grade 3	Grade 5	Grade 7
$\bar{X}$ seconds	6.586	7.747	7.762
$\bar{X}_i - \bar{X}_j$		1.161	1.176
			.015
$Q = \frac{\bar{X}_i - \bar{X}_j}{\sqrt{MS_w/n}}$		2.86	2.90
			.037
* Q (.05) for df = 228		2.77	3.31
**(Q (.01) for df = 228)		(3.64)	(4.12)
			2.77
			(3.64)

Neuman-Keuls Test of Grade Main Effects on Wide Board Balance Left

	Grade 3	Grade 5	Grade 7
$\bar{X}$ seconds	6.312	7.106	7.575
$\bar{X}_i - \bar{X}_j$		.794	1.263
			.469
$Q = \dfrac{\bar{X}_i - \bar{X}_j}{\sqrt{MS_w / n}}$		1.837	2.92
			1.09
* Q (.05) for df = 228		2.77	3.31
** (Q (.01) for df = 228)		(3.64)	(4.12)
			2.77
			(3.64)

Newman-Keuls Test of Grade Main Effects on Narrow Board Balance Right

	Grade		
	3	7	5
$\bar{X}$ seconds	9.350	9.499	10.606
$\bar{X}_i - \bar{X}_j$		.149	1.256
			1.107
$Q = \frac{\bar{X}_i - \bar{X}_j}{\sqrt{MS_w/n}}$		.229	1.932
			1.703
*Q (.05) for df = 228		2.77	3.31
**(Q (.01) for df = 228)		(3.64)	(4.12)
			2.77
			(3.64)

[illegible] Test of Grade Main Effects

[illegible]

[illegible]

	Grade		
	3	7	8
$\bar{X}$ seconds	9.011	9.584	10.356
$\bar{X}_i - \bar{X}_j$		.573	1.348
			.772
$Q = \dfrac{\bar{X}_i - \bar{X}_j}{\sqrt{MS_w/n}}$		.893	2.098
			1.204
*Q (.05) for df = 228		2.77	3.31
**(Q (.01) for df = 228)		(3.64)	(4.12)
			2.77
			(3.64)

[illegible]

	[illegible]		
	1	2	3
$\bar{X}$ seconds	[illegible]	[illegible]	3.106
$\bar{X}_i - \bar{X}_j$		[illegible]	[illegible]
			[illegible]
$Q = \frac{\bar{X}_i - \bar{X}_j}{\sqrt{MS_e/n}}$		[illegible]	2.722
			.119
* $Q(.05)$ for df = [illegible]		2.77	3.31
** $(Q(.01)$ for df = 486$)$		(3.64)	(4.12)
			2.77
			(3.64)

[illegible]

	1	Totals 2	3
X [illegible]	[illegible].577	2.[illegible]	[illegible]
$X_i - X_j$		.[illegible]	.[illegible]
			.[illegible]
$Q = \frac{X_i - X_j}{\sqrt{[illegible]/n}}$		1.17[illegible]	2.[illegible]
			1.07[illegible]
* Q (.05) [illegible] df = [illegible]		2.77	[illegible]
**(Q (.01) [illegible] df = [illegible])		([illegible])	(4.12)
			[illegible].77
			(3.64)

Neuman-Keuls Test of Grade Main Effects

on

Controlled Jump Left

	Grade		
	3	7	5
$\bar{X}$ seconds	2.194	3.107	3.455
$\bar{X}_i - \bar{X}_j$		.913	1.261
			.348
$Q = \dfrac{\bar{X}_i - \bar{X}_j}{\sqrt{MS_w/n}}$		2.481	3.424*
			.945

* Q (.05) for df = 228		2.77	3.31
**(Q (.01) for df = 228)		(3.64)	(4.12)
			2.77
			(3.64)

Neuman-Keuls Test of Trials Main Effects

on

Dodge Run

	Trials		
	1	2	3
$\bar{X}$ seconds	6.502	6.424	6.400
$\bar{X}_i - \bar{X}_j$		.078	.102
			.024
$Q = \dfrac{\bar{X}_i - \bar{X}_j}{\sqrt{MS_w/n}}$		3.12*	4.08*
			.96
* Q (.05) for df = 456		2.77	3.31
**(Q (.01) for df = 456)		(3.64)	(4.12)
			2.77
			(3.64)

Neuman-Keuls Test of Grade Main Effects

on

Dodge Run

	Grade		
	3	5	7
$\bar{X}$ seconds	6.833	6.357	6.050
$\bar{X}_i - \bar{X}_j$		.476	.783
			.307
$Q = \frac{\bar{X}_i - \bar{X}_j}{\sqrt{MS_w/n}}$		4.85**	7.98**
			3.13*
* Q (.05) for df = 228		2.77	3.31
**(Q (.01) for df = 228)		(3.64)	(4.12)
			2.77
			(3.64)

APPENDIX E

PERCENTILE RATINGS AND CHARACTERISTICS OF SEVERE AND LESS SEVERE AWKWARD SAMPLES

Characteristics

of

Less Severely Awkward Sample[a]

ID	Age	Sex	RD	Control	IQ	Schonell
421	12	M		+	83*	
480	12	M	+			12.60
475	12	M	+		100	9.90*
418	12	F		+	98*	
147	10	F	+		92	8.10*
145	10	F	+		92	9.10
302	10	F	+		92	10.10
106	10	F		+	112	11.10
105	10	F		+		11.50
365	10	M	+		85*	9.30
276	10	M	+		86*	9.10
368	10	M	+		104	9.30
77	10	M		+	111	9.11*
54	8	F	+		112	7.40
177	8	F		+	113	9.30
135	8	F		+	117	9.70
331	8	F		+	115	10.80
284	8	M	+		106	7.70
36	8	M	+		105	7.80
1	8	M	+		100	7.40
181	8	M		+	110	9.00
137	8	M		+	118	8.50

[a]n = 22

* = One standard deviation or more below mean score for reading disabled or control group.

Characteristics

of

Severely Backward Sample[a]

ID	Age	Sex	RD	Control	IQ	Schonell
443	12	F	+			12.00
483	12	M	+		92	11.60
452	12	F	+			12.20
400	12	F		+	114*	
445	12	M	+		88	11.10
442	12	M	+			
440	12	M			110	[illegible]
465	12	F	+			11.10
457	12	F	+		104	8.11
461	12	F	+			12.40*
160	10	F	+		91	8.60
364	10	F	+		91	9.70
103	10	F		+		10.10
107	10	F		+	96*	10.00
193	10	F		+	100	12.60
57	10	M	+		89	8.90
353	10	M	+		88*	8.90
115	10	M		+	86*	10.90
237	10	M		+	96*	10.60
318	8	F	+		90	7.70
29	8	F	+		120	7.60
207	8	F	+		99	7.70
308	8	M	+		116	9.10*
14	8	M	+		100	6.10
2	8	M	+		102*	8.00
312	8	M	+		93	7.50

[a] n = 26

* = One standard deviation or more below mean score for reading disabled or control group.

8 Year Old Awkward Sample Percentile Scores

Less Severe

Subject ID	RD	Control	Sex	Throw and Catch	Throw Clap and Catch	Dodge Run	Stork Balance Right	Stork Balance Left	Controlled Jump Right	Controlled Jump Left
54	+		F	0	11.9	54.8	52.3	78.5	19.0	40.4
177		+	F	0	47.6	30.9	14.2	2.3	45.2	21.4
135		+	F	45.2	47.6	9.5	11.9	40.4	0	0
331		+	F	14.3	47.6	2.3	69.0	64.2	42.8	0
284	+		M	14.8	63.8	74.4	34.0	2.1	0	29.7
36	+		M	23.4	12.8	40.4	19.2	6.3	23.4	0
1	+		M	27.6	12.8	53.2	8.5	10.6	29.8	57.4
181		+	M	27.6	12.8	10.6	40.4	76.5	0	36.2
137		+	M	70.2	12.8	6.3	29.8	8.5	38.3	61.7

Severe

Subject ID	RD	Control	Sex	Throw and Catch	Throw Clap and Catch	Dodge Run	Stork Balance Right	Stork Balance Left	Controlled Jump Right	Controlled Jump Left
318	+		F	69.0	11.9	7.1	2.3	0	0	0
29	+		F	0	0	54.8	57.1	26.2	0	0
207	+		F	0	11.9	0	4.8	16.6	0	0
308	+		M	6.3	0	36.2	76.5	72.3	36.2	0
14	+		M	40.4	12.8	14.8	2.1	0	0	0
2	+		M	0	4.2	8.5	0	12.8	0	0
312	+		M	40.4	12.8	93.6	10.6	25.5	27.6	0

10 Year Old Awkward Sample Percentile Scores

Less Severe

Subject ID	RD	Control	Sex	Throw and Catch	Throw Clap and Catch	Dodge Run	Stork Balance Right	Stork Balance Left	Wide Board Balance Right	Wide Board Balance Left	Controlled Jump Right	Controlled Jump Left
147	+		F	2.5	12.5	57.5	17.5	37.5	72.5	15.0	10.0	10.0
145	+		F	5.0	32.5	40.0	30.0	12.5	22.5	7.5	40.0	12.5
302	+		F	22.5	60.0	22.5	45.0	52.5	10.0	20.0	10.0	0
106		+	F	40.0	12.5	20.0	0	0	12.5	17.5	0	52.5
105		+	F	57.5	12.5	25.0	12.5	97.5	2.5	0	10.0	12.5
365	+		M	41.5	14.6	56.0	4.9	0	65.9	51.2	12.2	0
276	+		M	31.7	14.6	34.1	41.5	39.0	7.3	2.4	26.8	12.2
368	+		M	7.3	14.6	34.1	48.8	21.9	34.1	17.1	0	19.5
77		+	M	17.1	12.1	31.7	9.7	7.3	70.7	73.1	58.5	31.7

Severe

Subject ID	RD	Control	Sex	Throw and Catch	Throw Clap and Catch	Dodge Run	Stork Balance Right	Stork Balance Left	Wide Board Balance Right	Wide Board Balance Left	Controlled Jump Right	Controlled Jump Left
160	+		F	10.0	2.5	67.5	2.5	17.5	5.0	57.5	0	12.5
364	+		F	12.5	12.5	30.0	7.5	52.5	27.5	10.0	10.5	22.5
103		+	F	0	2.5	0	15.0	7.5	72.5	62.5	7.5	0
107		+	F	7.5	32.5	15.0	60.0	52.5	7.5	5.0	32.5	0
193		+	F	32.5	0	10.0	60.0	20.0	60.0	40.0	10.0	57.5
57	+		M	2.4	0	24.4	46.3	12.2	58.5	24.4	0	60.9
353	+		M	12.2	0	4.8	60.9	9.8	75.6	58.5	17.0	0
115		+	M	0	0	0	0	2.4	0	9.8	0	24.4
237		+	M	70.7	0	9.8	60.9	43.9	17.1	0	0	0

12 Year Old Awkward Sample Percentile Scores

Less Severe

ubject ID	RD	Control	Sex	Throw and Catch	Throw Clap and Catch	Dodge Run	Stork Balance Right	Stork Balance Left	Wide Board Balance Right	Wide Board Balance Left	Narrow Board Balance Right	Narrow Board Balance Left	Controlled Jump Right	Controlled Jump Left
421		+	M	44.1	26.5	11.8	0	11.8	35.3	70.6	14.7	67.6	35.3	11.8
480	+		M	5.8	26.4	94.1	14.7	20.6	23.5	29.4	5.9	5.9	17.6	70.6
475	+		M	44.1	5.8	8.8	32.4	70.6	61.8	23.5	26.4	14.7	32.4	14.7
418		+	F	36.1	27.8	5.5	33.3	16.7	61.1	19.4	41.7	2.8	69.4	33.3

Severe

ubject ID	RD	Control	Sex	Throw and Catch	Throw Clap and Catch	Dodge Run	Stork Balance Right	Stork Balance Left	Wide Board Balance Right	Wide Board Balance Left	Narrow Board Balance Right	Narrow Board Balance Left	Controlled Jump Right	Controlled Jump Left
443	+		F	25.0	27.8	75.0	11.1	47.2	2.8	47.2	5.5	0	0	8.3
483	+		M	5.8	5.8	2.9	8.8	2.9	2.9	0	2.9	0	0	0
452	+		F	63.9	13.9	94.4	0	2.8	19.4	0	0	5.6	30.6	77.8
400		+	F	2.8	27.8	8.3	52.8	47.2	0	27.8	52.8	41.7	69.4	83.3
445	+		M	0	5.8	17.6	11.8	8.8	0	5.8	0	11.8	0	17.6
442	+		M	2.9	0	20.6	20.6	5.9	8.8	2.9	8.8	2.9	0	0
440		+	M	44.1	5.9	20.6	2.9	41.2	11.8	26.5	17.6	55.8	20.6	0
465	+		F	63.9	0	66.7	5.5	47.2	41.7	55.6	58.3	33.3	30.6	0
457	+		F	36.1	0	22.2	52.8	11.1	33.3	22.3	36.1	8.3	8.3	5.6
461	+		F	36.1	0	25.0	8.3	13.9	69.4	63.9	19.4	27.8	11.1	0