STUDENTS WITH SIGNIFICANT MOTOR SKILL IMPAIRMENT
- A LONGITUDINAL STUDY -

A thesis presented in partial fulfilment of the requirements for the degree of Master of Education, Department of Education

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Lynne Donaldson

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ABSTRACT

This is a four year follow-up study of a group of students who were originally tested in the 1982 South Auckland Perceptual Motor Dysfunction Survey in Hamilton. All those students identified at the primary school standard three level as having significantly impaired motor skills (clumsy), and a selected group of students who were just above the level of significant impairment, were traced for retesting in order to examine the motor skill development of these students.

In all 55 students were retested. Thirty-eight of the 62 students (61%) identified with significant impaired motor skills in 1982 were retraced in the Hamilton area in 1986. Seventeen of 23 students selected (74%) from the group of students whose motor skills were just above the level of impairment were also retraced. This retesting percentage result compares favourably with other related longitudinal studies.

The Bruininks-Oseretsky Test of Motor Proficiency was used to test students at both the standard three and form three levels. This is a comprehensive and reliable test of motor skills. Such an extensive motor skills testing programme has not to the writer's knowledge been undertaken in the context of a longitudinal study before.

Seventy-three percent (73%) of those students (two out of every three students) with significantly impaired motor skills in 1982 continued to have motor skill problems at the form three level in 1986. Gross motor skills (Balance, Bilateral Co-ordination, Strength, and Running Speed and Agility) were more impaired than fine motor skills with Balance subtest skills showing the greatest degree of impairment.

Thirty-five percent of those students (35%) whose motor skills just were just above the level of significant impairment at the standard three level showed a deterioration in their motor skills over the four years to be classified as having significantly impaired motor skills in 1986.

The above results and a calculation of the incidence of students with significantly impaired motor skills at both the standard three and form three levels do not support a maturational effect on motor skill development.

This study briefly explored whether student participation in sport and recreation pursuits influenced the development of motor skills. No direct correlation was found. Schools were however identified as significant providers of sport and recreation opportunities for the students tested.

The results of this times series research design approach were able to be compared to the cross-sectional design of the 1982 South Auckland Perceptual Motor Dysfunction Survey as means of determining the incidence level of students with significant motor skill problems and identifying the motor skill characteristics of such students. Differences are evident from these approaches and are discussed briefly.

ACKNOWLEDGEMENTS

Without the insight of the South Auckland Physical Education Council in 1982 neither the South Auckland Perceptual Motor Dysfunction Survey nor this longitudinal study would have been possible. Through their initiative and the professional guidance and support of Mr J. R. Hughes (Inspector Physical Education, Education Department) important benchmarks in Physical Education have been achieved in these research studies.

I wish to thank Patricia Eyre (nee Maurice) and Joy Russell for their valuable assistance in testing the students. Their help meant that the testing was completed efficiently and smoothly with a minimum of disruption to the schools involved.

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The write-up of this research work has been delayed several years because of a car accident involving the writer at the completion of the testing programme, and the recovery necessary as a result of this. With the support of friends, colleagues and family throughout, and the professional support of Mr J. R. Hughes and the Education Department at Massey University, this study has been able to be completed.

Support was received from the Statistics Department, the New Zealand Crippled Children Society Inc. and the New Zealand Association of Health Physical Education and Recreation Inc. to carry out this research. This support I trust has been justified by the results and discussion generated by this study and will be further justified in the future by the consideration and adoption of new policy and practise in Physical Education to better meet the needs of students who have difficulties in learning and developing fundamental physical motor skills.

Special thanks is extended to Associate Professor Mr Brian Shaw my project supervisor in the Education Department at Massey University for his continued guidance and patience. Thanks are also extended to Associate Professor Mr Richard Harker for his guidance with the analysis of computer results, and to Ms Diana Bloor for her assistance in analysing the data.

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TABLE OF CONTENTS

LIST OF FIGURES

LIST OF TABLES

CHAPTER ONE :

INTRODUCTION

Little research has been carried out in the area of physical education in New Zealand either to identify areas of significant achievement, to identify areas where there is significant impairment or concern among school students, or to support the findings of overseas research studies in this field. There are few bench-marks available in New Zealand to indicate that past and current physical education syllabuses, and the teaching practices of teachers have contributed adequately to the development of basic motor skills of students in our schools. If physical education teachers are to convince others in the education arena that what they do is effective and vital to the overall development of growing students, then they must undertake or have access to research that demonstrates the need for physical education in the school syllabus, and which shows how effective they are in providing what is needed.

The South Auckland Perceptual Motor Dysfunction Survey which was initiated by the South Auckland Physical Education Council in 1982, is one such significant piece of New Zealand physical education research (Donaldson and Maurice 1983). The aim of this study was to determine the incidence of students in Hamilton schools with significantly impaired motor skills for their age, and hence to determine the need for some form of adapted physical education programmes in Hamilton schools. This research study showed an incidence level of 18.6% of primary school students and 21.3% of students at the secondary level with significantly impaired motor skills. These results provided evidence, for the first time, that motor skill problems of some magnitude existed in New Zealand schools. It is likely a similar incidence of motor skill impairment, as was found in the Hamilton area, exists in schools throughout New Zealand (Donaldson and Maurice, 1983).

In the New Zealand education system little or nothing is currently being offered to help students with significantly impaired motor skills and there is increasing concern in some schools about what happens to these students. Some believe that as these students mature their motor skills will naturally improve

without specific help. Others believe that only through well planned intervention programmes can these students make significant motor skill improvement. To date there have been few longitudinal studies undertaken worldwide to give support to either approach.

This current research work is a four year follow-up study of those primary school students identified in the 1982 South Auckland Perceptual Motor Dysfunction Survey as having significantly impaired motor skills. The study also involves a follow-up of a number of students who were considered to be just above the cut-off point of those with significantly impaired motor skills to see whether their motor skills had improved or deteriorated in the subsequent four years. The work undertaken is believed to be the first longitudinal study of its kind of such magnitude to be conducted in New Zealand. Further, no other such comprehensive longitudinal motor skills testing programme appears to have been reported in the international literature that investigates the incidence of motor skill impairment in the same school population, using the same norm referenced test, and which can identify in some detail the nature and the degree of the motor impairment that is evident.

This type of research work can offer valuable information to those in the education field involved in curriculum development, and to those involved in implementing policy and syllabus as the basis for the teaching of physical education in schools. Furthermore it identifies for teachers, for College of Education Physical Education staff and for trainee teachers the specific motor skill areas which require increased teaching and practice if adequate improvement and mastery of motor skills in the school setting is to be achieved.

CHAPTER TWO :

THE PROBLEM

A number of issues and perspectives always influence and shape research work. This chapter considers the factors that have influenced and shaped this study. Within most fields of research there are terms or words used which take on distinct values or meaning. Some of the related literature uses the term "clumsy child" or "clumsiness" and therefore it is prudent to clarify the meaning of these words in relation to how they are used in the context of this study. Two different research designs can be adopted when investigating the effect or possible existence of such factors as maturation on motor skill development. The time series and cross-sectional research formats are discussed and their advantages and shortfalls are considered. The issue of whether clumsiness is confined to childhood and is a maturational factor is discussed briefly. Relatively little has been written and researched in this area of development and therefore determining where those with significantly impaired motor skills fit into the holistic picture is an issue of debate. Finally in order to keep this research work focussed specific outcomes have been outlined and four hypotheses have been formulated.

Definition And Use Of Terms

A variety of terminology has been used to describe students who have problems in developing motor skills. Whiting et al. (1969) described these students as 'motor impaired' while Dawdy (1981) used the term 'developmentally dyspraxic.' The disorder has been referred to as 'congenital apraxia' (Orton, 1937), 'developmental dyspraxia' (Gomez, 1972; Lesny, 1980a), 'developmental dyspraxia-dysgnosia' (Lesny, 1980b), 'developmental apraxia and agnosia' (Gubbay, 1975), and 'perceptual motor difficulties' (Domrath, 1968). The word 'clumsy' is however the most commonly used term in the literature to describe students who exhibit difficulty with tasks requiring motor co-ordination. The term 'clumsy' was first used by Orton (1937) and has since been adopted by a number of other authors, for example, Dare and Gordon (1970), Gubbay (1973), Gordon and McKinlay (1980), Hulme and Lord (1986), and Henderson (1987).

Care must be taken in the use of the label 'clumsy' because it has a colloquial as well as a technical or specialist meaning. The term 'clumsy' is used in related research findings which are referred to and discussed in this study and thus its usage needs to be defined to avoid confusion and misunderstanding.

In a colloquial sense 'clumsy' is used to describe students 'who knock things over, bump into things and fall over frequently because they are impulsive, distractible or hyperactive' or it is used as a synonym for 'idleness, untidiness, and lack of discipline' (Henderson and Hall, 1982; p.448) . These uses of the word 'clumsy' are rather loose descriptions of the behaviour of these students.

A more definitive description is necessary to describe the motor disorder collectively known as 'clumsiness'. In 1983 Knuckey and Gubbay identified the 'clumsy child' as -

> "one who is mentally normal, without bodily deformity and whose physical strength, sensation and co-ordination are virtually normal by standards of routine, conventional neurological assessment, but whose ability to perform skilled purposive movement is impaired."
> (Knuckey and Gubbay,1983; p.9)

More recently researchers have moved away from a focus on the 'clumsy child' toward defining the condition of 'clumsiness'. Hall (1988) defines clumsiness as -

> "a deficit in the acquisition of skills requiring fluent co-ordinated movement, not explicable by general retardation or demonstrable neurological disease."
>
> (Hall, 1988; p.375)

These more technical or specialist context meanings of 'clumsy' and 'clumsiness' as stated above are relevant to this study.

Without pre-empting the findings of this study it is prudent to note that students defined as 'clumsy' do not form a homogeneous group as would be expected from a definitive label. Students categorised under this label vary in the range of motor difficulties they exhibit, the severity of the problems they have, and in differences in the development of such problems over time (Henderson 1987). Thus the label 'clumsy children' is used in effect to "represent an extremely low scoring group for whom the mastery of motor skills is sufficiently retarded to warrant concern" (Hulme and Lord, 1986; p.267).

In an effort to avoid confusion in the use of the word 'clumsy' the terms impaired motor skills' or 'significantly impaired motor skills' will be used in this study in preference to 'clumsy', except where direct references are made which use the word 'clumsy' - such as in this section and the Review of Literature.

Theoretical Framework for the Proposed Study

This study is eclectic in nature in that it considers ideas and beliefs from a variety of sources rather than being based on a single theory or viewed from a purely pragmatic stance. A number of theoretical frameworks have influenced this study. The cross-sectional versus time series longitudinal study design; clumsiness as a maturational phenomenon; and assumptions about the identification of those with impaired abilities in a normal population, are aspects that have been highlighted and are discussed briefly in this section.

Research Design

Research studies which investigate such factors as the incidence of students with significantly impaired motor skills in schools, and changes over time in the motor skill patterns of students with significantly impaired motor skills, usually adopt either a cross-sectional or time series approach in their longitudinal research design. Cross-sectional studies, for example to determine the incidence of motor skill impairment, test different subject groups at various age levels at a particular time and then make assumptions from these results about the changes that occur, such as an increase or decrease in the incidence of motor impairment as students mature. This was the research design of the 1982 South Auckland Perceptual Motor Dysfunction Survey where groups of students were tested at the primary, intermediate and secondary school level (Donaldson and Maurice, 1983). Such study designs are organisationally easy to plan and the financial costs are relatively low. However the patterns that this type of research design portray may be misleading in that the life experiences of each group tested are different. These different experiences, for example one school age level having physical education classes twice a week and another having a daily fitness and physical education programme, may be what contributes more to changes over time rather than developmental influences (Thomas and Nelson, 1985; von Eye, 1985; Keeves, 1988).

A time series longitudinal research design, as conducted in this study, where students from the same population are examined at progressive age levels, overcomes the problem of the subjects at different ages having significantly different life experiences. This type of study makes it possible to identify changes directly as opposed to inferring such change as is the case in cross-sectional research. The time series study design has further advantages in that it permits the scrutiny of the types of changes within and between the subgroups of those tested, it provides a basis for the explanation of linkages between antecedent events and variations in test results, and it provides analysable empirical evidence to support or refute causes of outcomes that are of educational interest and importance (von Eye, 1985; Keeves, 1988).

The time taken to complete time series studies (in this situation four years) means that some students move away from the area and some change schools and are lost to the study. The problem that this loss of subjects creates is whether the characteristics of the original group remains the same in the retested group (Thomas & Nelson ,1985; von Eye, 1985). This factor has been addressed in this study. Measures have been taken to check the representative nature of the groups retested in 1986 in relation to the original groups identified in 1982.

Another possible shortcoming of time series longitudinal studies is that the limited observations undertaken may not adequately reflect the underlying process of changes that are recorded (von Eye, 1985). The main focus of this study has been on the motor skill development of students who were identified four years previously as having significantly impaired motor skills. A comprehensive motor test was used to determine the characteristics of this development and therefore it is possible to identify the improvements and declines in the motor skill abilities of these students to an extent that has not been possible in many other time series longitudinal studies because of the limited nature of the motor skills tests that have been administered. However only a limited collection of information about the events and experiences the students in this study have had in the intervening four years between testing has been made. Therefore it is only possible to suggest the effects that these

factors have had on their motor skill development. No investigation of the possible relationships between significantly impaired motor skill development and other educational problems or impairment has been attempted (as have Henderson, 1987; Gillberg and Gillberg, 1989) and thus it is quite possible that an incomplete picture of the underlying processes of change has been gained in this study.

Von Eye reports that there is evidence that growth curves based on cross-sectional research differ at least in part from those based on time series research (von Eye, 1985). It is likely then that the different longitudinal research design approaches taken to determine the incidence and characteristics of those with significantly impaired motor skills - that is those recorded in the cross-sectional 1982 South Auckland Motor Dysfunction Survey, and those found in this time series study - will provide varying results. The results gained in this study will be compared with those found in the 1982 South Auckland Motor Dysfunction Survey and points of note will be discussed in the later sections of this report.

Is Clumsiness a Maturational Factor ?

Maturation relating to skill development is simply defined as "changes in a person that are not caused by experience" (Ljung,1965; p.28) which occur "regardless of practise or training" (Bee, 1978; p.9). Maturation is the process whereby the emergence of a biologically determined age related sequence of physical, motor skill and mental patterns programmed by the genes, including the readiness to master new abilities, occurs. It is thought that the level of developmental progress at any given time may not be the same for each dimension involved and thus overall progress is determined by the dimension that is least developed (Papalia and Olds, 1992; Mowbray and Salisbury, 1975).

At an abstract level 'pure' maturation can be defined as development resulting entirely from internal forces that are uninfluenced by the environment.

However at the practical level it is impossible to eliminate environmental influences. This situation opens up discussion on the heredity-environment or nature-nurture effect; over how much and in what manner heredity - by virtue of the maturation process - contributes to development as contrasted to the contributions made by exterior environmental forces (Thomas, 1990).

The question as to whether clumsiness is a condition which children 'grow out of' without intervention is of considerable importance both theoretically and practically. From a theoretical stand point Sugden (1991) proposes that three possible developmental alternatives exist -

i) that of delayed motor skill development which implies that inevitably the student's skill level will catch up with the passage of time through maturation,

ii) that of dissociation where an uneven profile of development across the various aspects of movement skill occurs, or

iii) that of deviated motor skill development which suggests that a student's development has departed from the normal course and that such abnormalities will persist unless intervention can return the student to the normal path of development.

On a practical level there is, as yet, no consensus as to which developmental approach occurs or is predominant. Hall, a paediatrician who has for many years been involved in research and work with clumsy students, states that "motor difficulties seem to resolve in the teen years" (Hall, 1988; p.375). Losse and colleagues point out that it is not uncommon for parents of 'clumsy' students (students with significantly impaired motor skills) to be told by paediatricians to stop worrying as in time their child will catch up with their peers (Losse et al. 1991).

The provenance of this commonly held 'maturation' view is surprisingly obscure. Some descriptive case studies suggest that a proportion of 'clumsy'

students do improve (for example studies by Dare and Gordon, 1970) but most of these studies are questionable as they involved students who were highly selected (e.g. from middle class, supportive homes) and they are anecdotal in nature rather than based on formal age related tests, and thus the definitions of improvement are relative.

More substantive studies on the developmental course of 'clumsy' students have been reported by Knuckey and Gubbay (1983), Gillberg et al. (1989), and Losse et al. (1991). Knuckey and Gubbay concluded from their findings that the maturational prognosis of clumsy students was generally good except for the most severely impaired (Knuckey and Gubbay 1983). Gillberg et al.'s (1989) results showed that between the ages of 7 years and 13 years 70% of those with perceptual motor problems had 'grown out' of their motor skill difficulties while 30% had not (Gillberg et al., 1989; p.21).

In contrast Losse et al.'s study showed that almost all of the students identified as having motor difficulties soon after beginning primary school still had similar problems as teenagers. Thus they state that their findings are "incompatible with the benign view of clumsiness as a disorder confined to childhood years" (Losse et al., 1991; p.64).

The limited extent of the motor skill tests used in these cited research studies and questions raised about the validity and reliability of the data collected, quite clearly point to the need for more thorough and reliable research investigation to better support or to refute the notion of the maturational nature of motor skill development.

This research study has attempted to overcome many of the pitfalls seen in previous longitudinal research studies investigating the maturational effect of motor skill development - that of different tests being used at each testing time; the shallow nature of the tests used; no age appropriate norms for the tests selected; and the retested group not being representative of the original 'clumsy' groups identified. In this study the same reliable, age referenced, and comprehensive motor skill test - the Bruininks-Oseretsky Test of Motor

Proficiency - was used in both the test and retest situations which allows strong comparisons to be made; and the researcher checked the representative nature of the students retested four years later compared to the original significantly impaired group of students who were identified in 1982.

Where Do The Significantly Impaired Fit Into The Picture?

The question as to whether clumsy students (those identified as having significantly impaired motor skills) form a discrete diagnostic entity or whether they represent the lower portion of a continuum of motor skill ability are theoretical frameworks worthy of closer scrutiny and consideration related to this study.

At present there is a lack of evidence to support either theoretical notion with respect to clumsy students. However some insight into the implications of these theoretical frameworks can be gained from a review of research and discussion related to students identified as having 'dyslexia' (specific reading disability) as compared to those students with less specific reading problems. The findings of such studies in the reading domain may well parallel that of the identification of a discrete group of clumsy students in the area of motor skill development (Hulme and Lord 1986).

Rutter and Yule, in the Isle of Wight studies, found that children with dyslexia formed a 'hump' at the bottom of the normal distribution curve of reading capabilities. From these findings they postulated that the failure to learn to read represented a specific syndrome that was distinct from the normal distribution of poor readers (Rutter and Yule 1975). This viewpoint has, over the years, become predominant in the reading field. Indeed the current practice in America of early screening (at the kindergarten level) to identify dyslexic students and then to provide services to students with this disorder is based on the premise that dyslexia is a discrete entity that is stable over time.

More recent research undertaken by Shaywitz and colleagues using data from the Connecticut Longitudinal Study suggests that dyslexia may not in fact be a discrete diagnostic entity which is stable over time (Shaywitz et al. 1992). These researchers applied the normal distribution model of results to the actual reading results obtained in the Connecticut study. Their analysis provides evidence to suggest that dyslexia occurs along a continuum which blends imperceptibly with normal reading ability and that no distinct cutoff point exists to distinguish students with dyslexia clearly from students with normal reading ability. Shaywitz et al. (1992) conclude that dyslexic students simply represent the lower proportion of a continuum of reading capabilities.

The Shaywitz et al.(1992) study also found that only 28% of those identified as dyslexic in grade 1 were again classified as dyslexic in grade 3. Rather than attribute the fact that two thirds of those identified at grade 1 were no longer considered dyslexic in the third grade to the existence of maturational factors or to ineffective testing measures, these researchers postulate that the "diagnosis of dyslexia is unstable over time" (Shaywitz et al., 1992; p. 149).

These contrasting findings as to which theoretical framework prevails in the reading field regarding the identification of students with dyslexia, indicates that there is a need to reassess the theoretical framework from which the investigation and remedial direction of reading development is currently greatly influenced. A conceptual shift toward considering those with significantly impaired reading skills as being those students in the lower portion of a continuum would facilitate a shift in focus away from a preoccupation with developing better identification measures and the development of remedial programmes, to one of improving teaching methods and learning environments which better meet the needs of all students along a continuum of ability in the classroom setting (Algozzine and Ysseldyke, 1986).

Hall (1988) proposes that motor ability can be expected to be normally distributed. There is however no research data to substantiate this claim. A number of motor skills tests have been developed on the premise that motor

ability is normally distributed. The TOMI-Henderson Revision Test (Stott et al., 1984) and The Bruininks-Oseretsky Test of Motor Proficiency (Bruininks, 1978) are two such tests.

A great deal more research is needed to better understand the normal developmental path of motor skill acquisition and the nature of the problems some students face in the mastery of motor skills. Only when this is achieved can we determine whether those students with significant motor skill impairment form an identifiable diagnostic entity or whether they do in fact constitute the students who make up the lower portion of a continuum of motor skill ability. This research work will contribute to a greater understanding of motor skill development and help to assess the appropriateness of the theoretical frameworks identified and discussed here.

Statement of the Problem - Hypotheses

The purpose of this study is to conduct a four year follow-up investigation of the motor skill development of a number of school students in the Hamilton area. These students were initially tested in 1982 at the Standard Three level as part of the South Auckland Perceptual Motor Dysfunction Survey (Donaldson and Maurice, 1983). The main thrust of this study is to find out how those students whose motor skills in 1982 were identified as being significantly impaired, have progressed. A group of students whose motor skills were just above the level of significant impairment were also followed up to see whether their motor skills had continued to improve or had declined in the intervening four years.

It is expected that the results of this study will provide the information needed to determine the incidence of significant motor skill impairment at the secondary school level (Form Three) for the same population that was initially tested at the Standard Three level in the 1982 South Auckland Perceptual Motor Dysfunction Survey (Donaldson and Maurice, 1983).

Four hypotheses have been developed to maintain a clear picture of the significance of this research and to provide direction for the discussion of the results which can then be compared and contrasted with other related studies identified in the Review of Literature.

Specifically this study intends -

* To identify the current motor skill levels and the motor skill patterns of a group of school students at the Form Three level who had four years previously been identified as having significantly impaired motor skills when tested from a representative sample of Hamilton primary school students.

Hypothesis 1

The majority of students who were identified in the standard three 1982 Low Performance Group of the South Auckland Perceptual Motor Survey and who were retested in this study in 1986 will continue to have significantly impaired motor skills.

Hypothesis 2

That gross motor skills, particularly balance skills, will continue to be the main area of significant motor skill impairment in those students classified as having significantly impaired motor skills in 1982 and who were retested in 1986

* To determine the extent of the motor skill development in 1986 of the students identified in 1982 as having the most impaired motor skills - the 1982 Stanine 1 Group.

Hypothesis 3

That without involvement in remedial physical education programmes or consistent involvement in at least one sport those students in the most impaired motor skill group in 1982 - the Stanine 1 Group - will not improve their motor skill levels significantly and will continue to be in the Low Performance Group in 1986.

* To identify the current motor skill levels and motor skill patterns of a group of school students at the form three level whose motor skills four years previously were considered to be just above the level of significant impairment when tested from a representative sample of Hamilton primary school students.

Hypothesis 4

That some of the students whose motor skills were just above the level of significant impairment at the standard three level in 1982 will show a significant deterioration in their motor skill levels four years later at the form three level in 1986.

* To investigate student involvement in sport and recreation activities as possible reasons for the changes identified in the motor skill levels of these groups in the four year period from standard three to form three.

* To determine the extent of the motor skill development of the special class students tested in 1982 and retested in 1986.

* To make a comparison between the cross-sectional and time series research approach to determining the incidence of students with significantly impaired motor skills.

* To make a comparison between the cross-sectional and time series research approach in determining the motor skill trends from the primary to secondary school level.

CHAPTER THREE :

REVIEW OF LITERATURE

This literature review will first discuss the theory and research specifically related to the significantly impaired motor skills of students. Studies which have identified the incidence of students with motor skill problems in populations will be discussed first. Longitudinal research studies which have undertaken follow-up research to investigate the progress of students identified with motor skill problems will also be reviewed. The motor skill characteristics of students with significantly impaired motor skills will then be addressed. Research in cognate areas relevant to this current research will follow. The validity of the test used in this study, the loss of test populations, teacher perception of students with motor impairment, and whether student motor skill competence influences participation in sport are further points of focus in this chapter.

A critique of the research studies which are highlighted is interwoven into the text of this chapter. The key points will be summarised at the conclusion of this review. This chapter will be concluded with comment about the contribution this study will make to the current literature.

Incidence of Motor Skill Impairment

Hulme and Lord in a recent review of research on 'clumsy children' comment that "we do not so far have any good estimates of how common the problem is" (Hulme and Lord, 1986; p.267). Indeed a review of research literature on the incidence of motor skill impairment (clumsiness) found only five studies worldwide to have been published which undertook to specifically identify the incidence of motor skill impairment which exists in normal populations. Two other studies are discussed in which an incidence of students with motor skill impairment is reported. These two studies either calculated incidences by the extrapolation of results or used teacher judgement to identify students with significantly impaired motor skills.

One of the most often cited and earliest research work which identifies an incidence of motor impairment is that of Brenner and Gillman (1966). They undertook a study of 810 students (aged between 7 years 10 months and 9 years 8 months) attending school in the Cambridgeshire area (England) to provide normative data on the range of visuomotor abilities in the population and to see whether it was possible, by means of a group test battery, to select the students who had visuomotor disabilities. The test battery consisted of 11 items which tested a variety of visuospatial and visuomotor functions.

The summary of the Brenner and Gillman (1966) study reports 6.9% of the students (56 out of 810) as having a visuospatial and visuomotor defect. A closer examination of this study shows however that the percentage quoted is only the percentage of children who scored low and were tested as having IQ levels of 91 and above. Another 21 students in the group scored low and were considered to have IQ levels at 90 or below. Therefore a more accurate percentage of those in the Cambridgeshire area with visuospatial and visuomotor defects as shown in the study is 9.5% (i.e. 77 out of 810). Brenner and Gillman (1966) found no significant difference between the performance of males and females on these tests.

Keogh's (1968) research to consider the incidence and severity of awkwardness among regular school boys was conducted in Birmingham England in 1965. Unlike the Brenner and Gillman (1966) study Keogh's work has received little recognition. This may in part be due to the fact that the study was conducted in conjunction with a study of physically awkward educationally subnormal boys (Keogh and Oliver 1968).

In Keogh's (1968) study 58 regular school boys aged between nine years and nine years 11 months were chosen at random from three elementary schools and were individually given six physical skills tests. The six tests were balance beam, beam walk, 50-foot hop, standing broad jump, alternate foot hopping and simultaneous foot-finger tapping. A low mark was arbitrarily set as any score below the 10th percentile which indicated that performance was poor in comparison with other boys in this group. A marginal mark was any

score in the range from the 10th percentile to the 30th percentile indicating that performance was not adequate but was better than a low mark. Any student who scored low or marginal marks on four of the six tests was considered 'awkward'.

Keogh's results identified 11 students out of 58 (18.9%) as being 'awkward'. From these results Keogh suggested that "a physical education instructor would expect eight students in a regular class of 40 to have performance problems on most physical skills; three of the eight boys would be expected to perform consistently at a low level" (Keogh, 1968; p.808).

The research work of Gubbay (1975) in Perth (Australia) was conducted primarily to standardize eight screening tests for the rapid identification of clumsy children. Testing involved 992 students between the ages of eight and twelve years from five schools. Students were tested using eight tests of motor proficiency - the ability to whistle, skip, 'dribble' a tennis ball, catch a tennis ball after clapping hands together, tie a shoe lace, thread beads, pierce a pattern of pinholes, and insert six objects of varying size and shape into appropriate slots.

Gubbay (1975) identified clumsy students as being those with a "motor standard" score exceeding 13 where motor standard equalled chronological age plus the number of tests they failed or in which they scored less than the tenth percentile for the sample group. Fifty-six (56) clumsy students were identified in this way - 56 students from 992 is 5.7% of the sample population. Gubbay (1975) undertook further investigation of these 56 students and 56 selected control students. The parents of 52 clumsy students and 51 controls gave approval for further examination. Parents and teachers from both groups subsequently completed a questionnaire and students underwent neurological and EEG examinations. The identified clumsy students were shown to be significantly inferior to their controls in handwriting, sporting ability, popularity, and academic performance (Knuckey and Gubbay, 1983). More males than females were identified in Gubbay's 'clumsy' group - that is 58% males and 42% females.

Neurological/neurodevelopmental research of a group of seven year old Swedish students in Gotenburg was conducted in 1978 by Gillberg and colleagues (Gillberg and Rasmussen 1982; Rasmussen, Gillberg et al. 1983). A yes/no questionnaire relating to five areas of development (behaviour problems/attentional deficit signs, fine motor, gross motor, speech/language and perceptual problems) was completed by preschool teachers for each student. Some 340 students from 3448 students showed signs of abnormality in these identified areas from the questionnaires. A complex selection procedure identified an index group of 82 students from the identified 340 students who had symptoms of attention deficit in combination with problems of motor control, perception or conceptualization. A further 59 students were selected randomly as a control group. These 141 students underwent detailed neurological, psychiatric, psychological and EEG examinations. The Southern California Sensory Integration Test (Ayers 1972) was used as part of this assessment procedure.

As a result of this comprehensive assessment students in the index group were assigned to one of three groups - minimal brain dysfunction (MBD), motor perceptual dysfunction (MPD) or attention deficit disorder (ADD). At aged seven 95% of those in the MBD and MPD groups had either gross or fine motor dysfunction and 36% in these groups had both gross and fine motor dysfunction (Rasmussen, Gillberg et al. 1983). The MBD and MPD groups had significantly poor eye-hand co-ordination compared to the comparison group, and the MBD group also had poor balance compared to the comparison group (Rasmussen, Gillberg et al. 1983). From the original epidemiological data for this study the researchers derived by extrapolation that 11% of the six- to seven-year-old population had motor perceptual dysfunction (Gillberg et al., 1989).

In British schools the need to provide services for students with all types of learning disabilities has been recognised for some time and was emphasised by the Warnock Committee - *Special Education Needs (1978).* A major problem exists however in the identification of these students - particularly those who are considered 'clumsy' and those who will have motor skill

learning difficulties during their schooling years. In Britain each child undergoes a school-entry medical examination and the medical profession has advocated that more thorough neurodevelopmental examinations need to be carried out at this time to identify students with significantly impaired motor skills (Henderson and Hall 1982). In contrast Henderson and Hall (1982) advocate, and support with research, that with appropriate training teachers can identify clumsy students as accurately as doctors and at much less expense.

Henderson and Hall (1982) conducted a two year study with 20 teachers from four schools. In the first year they discussed with teachers general and specific problems relating to normal and abnormal motor development and ways to recognise below average motor function in students. In the second year teachers were asked to identify any student in their classroom who they considered had poor motor co-ordination for their age (approximately six years old) and whose lack of co-ordination was significantly affecting school progress. Twenty students were identified using this criteria from a total of 400 (i.e. 5% incidence) and more males than females were selected (81% males, 19% females). From this group of 20 students 16 were matched with a student of the same sex from the same class to make up a control group. These 32 students were given four tests: a neurodevelopmental examination, The Test of Motor Impairment (Stott et al., 1972) the Wechsler Intelligence Scale for Children (WISC), and the Schonnell Reading Test. The Test of Motor Impairment (Stott et al., 1972) consisted of 10 individual test items which assessed static and dynamic balance, ball skills and manual dexterity. A significant difference was identified between the control group and the 'clumsy' group on all measures of the Motor Impairment Test ($p<0.001$). However the 'clumsy' group proved to be a rather heterogeneous group with a wide range of scores on all other test measures. Based on the subjective judgement of the paediatrician involved in the testing programme there was an 89% agreement between his judgement and that of the teachers (Henderson and Hall, 1982).

The five percent (5%) incidence of motor skill impairment determined for Henderson and Hall's (1982) tested population needs to be treated with

caution however as the study was not specifically designed to examine prevalence. No check was made to determine how many other students were not selected by their teachers and who could also be classified as significantly motor skill impaired from the test criteria used.

Most of the students identified in Henderson and Hall's (1982) 'clumsy' group participated in a one year intervention study. Many students made significant progress in learning motor skills during this time but, as will be discussed later, these gains were not maintained after the intervention programme was completed (Losse et.al.,1991).

In 1982 a research project was set up in New Zealand by the South Auckland Physical Education Council to determine the incidence of students with significantly impaired motor skills in the state school population of the Hamilton area (Donaldson and Maurice, 1983). This project also investigated various means of identifying students with significantly impaired motor skills. Six hundred and thirty five students (635) were tested using the Bruininks-Oseretsky Test of Motor Proficiency. This test is a comprehensive test of motor proficiency which contains 46 separate test items (Bruininks, 1978). Three hundred and thirty five (335) students were tested at the Standard Three (Primary) level and 150 students were tested at each of the Form 1 (Intermediate) and Form 3 (Secondary) school levels. Schools were selected for testing to provide a balanced geographical, socio-economic, race and sex sample of the Hamilton city area. Complete class groups were randomly selected for testing at the primary level in order to assess the ability of teachers to identify students with significantly impaired motor skills.

This study -*The South Auckland Perceptual Motor Dysfunction Survey (1983)* - reports an incidence of those with significantly impaired motor skills at the primary school standard three level of 18.5 %. A 13.8% level of incidence was recorded at the Form 1 (Intermediate) level and a 21.3% incidence level was identified at the Form 3 (Secondary) level (Donaldson and Maurice, 1983). These percentages were determined using the Stanine Three cut-off point for gross, fine and composite scores of The Bruininks-Oseretsky Test of Motor

Proficiency. This cut-off point was confirmed by the degree of impairment identified at the Stanine Three level (see Appendix C) and was supported by visual observations of students in the playground and in physical education class lessons (See Donaldson and Maurice, 1983; p.28 for further details). There were more females than males in the low performance group at both the primary and secondary school level (i.e.49% males, 51% females at the primary level and 38% males and 62% females at the secondary level).

It is of note that Keogh's (1968) incidence level of 18.9 % and Donaldson and Maurice's (1983) incidence level of 18.5% are very similar for the same age level of students tested.

Roussounis et al. (1987) developed a six-item Standardized Motor Test Battery (SMTB) to assess the motor skill development of primary school students. The test comprised three fine motor skill tests - finger tapping, peg moving and bead threading; and three gross motor tests - standing on one leg, hopping, and heel-toe walking along a straight line. Two hundred and one (201) students aged approximately five years six months were tested from three schools in the Leeds area. A failure criterion was set at the 10th percentile for each test. Any student who failed two tests in either the fine or the gross motor areas was designated 'clumsy'. Seventeen students were thus assigned to the 'clumsy' group - an incidence of 8.5%. Eleven of these seventeen students (65%) were males and six students (35%) were females.

It can be seen from the above review of literature on the incidence of students with significantly impaired motor skills that a problem exists in the selection of the level of performance at which motor ability is said to be impaired. Croll, Moses and Wright (1984) highlight the fact that norm-referenced tests are the criteria on which most estimates of students with learning difficulties are based and therefore some students must always come out on the bottom of the pile. Thus the "notion of learning difficulties can be seen as being a statistical creation" (Croll, Moses and Wright, 1984; p.146). A point at which motor ability can be said to be impaired is thus an arbitrary decision determined by selecting a particular stanine or percentile cut-off level.

Longitudinal Studies

Longitudinal studies of school students with significant motor skill problems have been hampered by the lack of reliable motor skill tests for students aged 14 years and older (Losse et al., 1991). Six significant studies can however be found in the literature which are worthy of discussion.

The Dunedin Multidisciplinary Child Development Study in New Zealand is a longitudinal study of unequalled scale world wide. This study has been assessing a group of 1037 children born at Queen Mary Hospital between April 1972 and March 1973 on their health and developmental progress. At aged three years as part of this extensive testing programme children were tested on the motor scale of the Bayley Scales of Infant Development (Bayley 1969) to assess motor skill development. A stringent cut-off point two standard deviations below the mean was set to identify those students with delayed motor development. Thirty-one students were identified (3.5%) with delayed motor development. At five years of age this large group was tested again using the Leg Co-ordination Subtest of the McCarthy Scales of Chidren's Abilities (McCarthy, 1972) to assess motor development. The results showed that only ten of the original 31 students who were identified as having delayed motor development at three years of age still exhibited these features at five years of age. These findings suggest that two out of three students who were delayed at age three 'catch up' by the age of 5. These results also underscore the lack of stability of patterns of early motor development over time (Silva and Ross, 1980).

Students in the Dunedin Multidisciplinary study were further tested on their motor skill development at seven and nine years of age using the Basic Ability Test (Arnheim and Sinclair, 1974). However published articles discussing this feature of the testing (Wilson, Silva et al. 1981; Wilson, Silva et al. 1982; Silva, Birkbeck et al. 1984; Clymer and Silva, 1985) make no further reference to those students who have significantly impaired motor skills. Comparisons between the sexes and their superior ability in particular tests, the effect of

laterality on motor performance, and possible biological, developmental and social correlates of gross and fine motor performance are the focus of these publications.

Knuckey and Gubbay (1983) undertook an eight year follow-up study of the 56 clumsiest eight to twelve year old students (5.7% of the original group) and their controls which were initially identified and tested by Gubbay in Perth (Australia) in 1975. Neither the 'clumsy' students or their controls had received specific therapeutic or educational intervention during this time. Five of the eight motor proficiency tests used by Gubbay in 1975 were again used in the retest situation - the ability to 'dribble a tennis ball, to catch a tennis ball after clapping hands together, thread beads, pierce a pattern of pinholes and insert six objects of varying sizes and shapes into appropriate slots. Knuckey and Gubbay considered that the three other original tests - the ability to whistle, the ability to tie shoe laces in a double bow and the ability to skip - would not show a good differentiation value between the clumsy and control subjects at the 16 to 20 year old age level at which these students were retested (Knuckey and Gubbay, 1983).

The control and clumsy groups in the Knuckey and Gubbay (1983) study were significantly different in only two of the five tests - the clapping and catching a tennis ball and piecing 20 pinholes ($p<0.001$). An assessment of student current engagement in weekly sporting activities showed no difference between the 'clumsy' and control groups.

Knuckey and Gubbay (1983) further divided the clumsy group into three groups - severe, moderate and mild and the mean scores of motor proficiency were assessed. Their results "show that mild and moderate degrees of clumsiness improved to the level of the controls with maturity while those with severe degrees of clumsiness still differed from the controls on four of the five motor proficiency tests" (Knuckey and Gubbay, 1983; p.11).

Knuckey and Gubbay (1983) conclude from their research that clumsiness is a problem which is largely confined to childhood itself - rather than a long term disability - and that only a small proportion are likely to be affected by their disability after leaving school. These conclusions however need to be viewed with caution as 50% of the original sample was not able to be found for retesting and no information is given by Knuckey and Gubbay (1983) on the motor competence or sex incidence of those lost to the follow-up in relation to those who were originally tested. For example a comparison made by this author between the percentage of males and females identified as clumsy by Gubbay in 1975 - 59% males and 41% females - is quite different to the percentage of those retested by Knuckey and Gubbay in 1983 - 75% males, 25% females. This discrepancy alone suggests that the groups retested by Knuckey and Gubbay (1983) were not representative of the original groups identified by Gubbay in 1975. Furthermore Knuckey and Gubbay provide no data on the validity and reliability of the subdivision of their clumsy group into mild, moderate and severe categories. They also do not consider in their discussion that the failure to find significant differences between the original clumsy and control groups may have been due to the lack of sensitivity in the test items used (Losse et al., 1991). This research has been frequently quoted in discussions about clumsiness, yet as explained above, its procedural limitations are significant.

Bax and Whitmore (1987) report on a three and five year follow-up study of a group of 351 entrant students to 15 primary schools in North Paddington where they investigated whether neurodevelopmental assessments were good predictors of future learning and behaviour difficulties. This group of students was first tested in 1978. The gross and fine motor skills of these students were assessed during a paediatric examination at each time of testing. No specific information about the motor skill tests that were administered is recorded by Bax and Whitmore in their write-up of this study but they state that "77% of the clumsy students with normal ability at aged five.....had no problems at seven or ten years of age" (Bax and Whitmore, 1987; p.48).

Roussounis et al. (1987) conducted a two year follow-up of the 'clumsy' students they had initially identified in Leeds. A control group of students of the same sex and of similar age in the same classroom was also tested. The students, now aged approximately 7 years 6 months, were tested using the same six item test schedule (refer above for details of the tests). Roussounis et al. report that "without any specific intervention the students in the clumsy group had improved considerably....but were still significantly inferior in performance when compared with the control group (Roussounis et al., 1987; p.385). Roussounis et al. express a concern that the difference between the clumsy group and the control group is still evident but because of the improvement shown by the clumsy group they suggest that the clumsiness shown was "due to maturational lag" (Roussounis et al.,1987; p.382).

Gillberg and colleagues undertook a three and six year follow-up study of a group of students in Sweden who were first tested as seven year olds in 1977. This study is reported to be the first attempt at a long-term follow-up of neurodevelopmental problems in a non-treated population-based group of students in Sweden (Gillberg and Rasmussen, 1982; Gillberg and Gillberg, 1983; Rasmussen and Gillberg et al., 1983; Gillberg, 1985; Gillberg and Gillberg 1989; Gillberg et al., 1989). The follow-up studies used the same 13 item neurological /neurodevelopmental assessment procedure at each time of testing. Gillberg and colleagues found after the three year follow-up (when students were aged 10 years) that in 45% of cases the motor perceptual problems of these students had subsided (Gillberg et al., 1989). After six years (when these students were now 13 years old) the motor perceptual problems in 70% of the cases had disappeared (Gillberg et al., 1989). These results indicate that the majority of students with perceptual motor problems grow out of these problems between seven and thirteen years of age. Gillberg et al. (1989) are quick to point out that this conclusion holds only for the specific items included in their neurodevelopmental examination and that this result may not be representative of all children diagnosed as having neurodevelopmental problems.

The research work of Losse et al. (1991) is a 10 year follow-up study of the students selected by their teachers at six years of age as having poor co-ordination in the Henderson and Hall (1982) study. All 32 students (and several others tested at this time) were traced and data from 15 'clumsy' students and 13 'control' was able to be used in the Losse et al. (1991) follow-up study. Each student (now between 15 years 1 month and 17 years 4 months of age) was assessed on five measures concerned with neurodevelopmental status, general motor competence, intelligence (WISC), self concept and leisure interests. The clinical classification of each subject was unknown to the testers with the exception of the tester administering the "Interests" questionnaire. Information from school records and interviews with parents was also used in the study.

Losse et al. (1991) had difficulty finding a suitable test of motor competence for the follow-up study which would encompass both gross and fine motor skills and which had norms for young adults over the age of 15. They chose to use the eight test items designed for use with students 11 years and over from 'The Test of Motor Impairment' (TOMI) (Stott et al., 1984) but were unsure whether the items chosen would be sensitive enough to the differences between teenagers. These tests assessed manual dexterity, ball skills, and static and dynamic balance.

The designated 'clumsy' group after ten years still differed substantially from the control group on the neurodevelopmental battery, the TOMI and in the eyes of their teachers in all cases ($p < 0.005$). This result was despite the fact that the examiners of the neurodevelopmental battery and the TOMI felt that the tests tended to underestimate the differences between the groups (Losse et al., 1991).

Academically the 'clumsy' subjects were also shown to be much less competent than their peers in spite of the fact that they tried equally as hard. All the control group had or were about to sit public examinations at the time of testing whereas less than half the 'clumsy' group were at that level (Losse et.al., 1991).

The 'clumsy' group in the Losse et al. (1991) study also demonstrated more behaviour problems than the control group. The extent of these problems ranged from quite serious problems involving the police, to problems relating to poor concentration and disorganisation in the classroom. Two students had been removed from school and placed in schools for students with emotional and behavioural problems (Losse et al., 1991).

Results from the 'Interests' questionnaire administered by Losse et al. (1991) showed that the control group 'enjoyed' more activities in the sport, leisure and school domains than the 'clumsy' group. However this difference was only significant in the sports domain ($p<0.05$).

It was noted earlier in this review that many of the students identified in Henderson and Hall's (1982) 'clumsy' group, and who were retested by Losse et al. (1991), had participated in a one year intervention programme immediately after the initial testing to improve their motor skills. Most of these students are reported to have made 'significant progress' in their motor skills during this programme but it can be seen from Losse et al.'s 10 year follow-up of these students that the gains which were made at that time were not maintained after the year long programme was completed (Losse et al., 1991). This outcome highlights the need for research on the results of intervention programmes. To date there has been relatively little published research on the development or efficacy of different types of motor skill intervention programmes in New Zealand or overseas. In New Zealand Kernahan and colleagues have reported on the success of programmes undertaken in schools for students with perceptual motor difficulties (Kernahan and Fillary, 1986; Kernahan and Dunlop 1990), but the long term effect of these programmes has not been assessed.

Losse et al. point out that the practical implications of their longitudinal study is that if 'clumsy children progress through the school system without additional support the long-term prognosis is not good' (Losse et al., 1991; p.65)

Henderson, Knight et al. (1991) present a paper which is a case study of an intelligent girl who was identified as having severe co-ordination problems in early life and who was involved in the longitudinal research study undertaken by Losse et al. (1991). This case study highlights the effects that significantly impaired motor skills can have and shows what happened when these difficulties were recognised but not seen as 'special needs' and no assistance was given to the student. The writers of this article suggest that this girl's motor difficulties played a significant part in her underachievement and that by the time she left school she "had not achieved what might have been expected" and was a "rather unhappy teenager with few friends" (Henderson et al., 1991; p.6).

Motor Skill Characteristics of Students With Significantly Impaired Motor Skills

A number of researchers and writers make comment about the motor skill characteristics of students with impaired motor skills but few back up these comments with sound research evidence. For example Gordon and McKinlay state that "many clumsy children are clumsy only in specific areas of motor co-ordination" and support this statement with a single descriptive account of a student who displayed this pattern (Gordon and McKinlay, 1980; p.35). Another example from the literature is when Lord and Hulme comment that "it is almost certain that the group is heterogeneous" but as yet "separable subgroups have not been identified" (Hulme and Lord, 1986; p.267). It is not clear whether these comments are related specifically to the motor skills of 'clumsy' students or to the wider range of abilities these students display (e.g. motor skill deficits, behavioural problems, learning difficulties).

Henderson (1987) makes more specific comment about the variability that exists in motor skills amongst 'clumsy' students. She suggests that variation exists on three levels -

i) Variation in the range of difficulties. For some no activity can be managed with ease, whereas for others the problem appears to be quite specific.

ii) Variation in severity - from mild to severe.

iii) Variation in the development of such problems over time. Some students appear to grow out of their difficulties whereas others do not. There also appears to be students who do not have motor skill difficulties before entering school but develop motor skill problems as the demand on motor competence increases.

While Henderson's account of the variation of motor skills (above) is seen as a excellent appraisal of what has been written about the motor skills of 'clumsy' students, she supports these comments by only one reference to research - that of Silva and Ross (1980) where there is evidence - from the Dunedin Multidisciplinary Child Development Study - that some students grow out of their motor skill problems while others do not.

One reason for the lack of research evidence about the motor skill patterns of students with significantly impaired motor skills is that much of the research on this topic has focussed on finding simple and accurate ways to identify students with motor skill problems from groups of students with mixed motor skill ability. Henderson and Hall (1982) pursued teacher training as a viable option while others such as Gubbay (1975) and Roussounis et al. (1987) have focussed on developing short, easily administered tests. These tests by definition do not examine all areas of motor ability.

Another reason for the lack of research into the motor skill patterns of students with significantly impaired motor skills has been the lack of reliable motor skill tests on which to base findings. The development of the Bruininks-Oseretsky Test of Motor Proficiency (Bruininks, 1978) provides a test schedule which is valid and reliable (refer to 'Validity of Bruininks-Oseretsky Test of Motor Proficiency' section for further details).

Several researchers give some indication of the motor skill characteristics of students with significantly impaired motor skills. Cornish (1980) observed that the physical strength of clumsy students was below normal. In a review of assessment procedures at Northwick Hospital Middlesex (England) Baker (1981) states that all 'clumsy' students referred for treatment at this hospital over a seven year period had both gross and fine motor skill problems. She also points out that all students had some difficulty with balance and that these balance disorders impaired a child's fine motor control (Baker, 1981; p.356). Rasmussen and Gillberg (1983) found that the seven year old students in their minimal brain dysfunction (MBD) and motor perceptual dysfunction (MDP) groups had poor balance and poor eye-hand co-ordination compared to their control group (Rasmussen and Gillberg, 1983; p.321)

The South Auckland Perceptual Motor Dysfunction Survey (Donaldson and Maurice, 1983) conducted in Hamilton schools is the first known research study in Australasia to have examined in detail the motor skill deficits of students identified with significantly impaired motor skills (clumsy). The South Auckland Perceptual Motor Dysfunction Survey forms part of the data base for this current study and therefore the results of that survey will be frequently referred to in this report. However it is pertinent at this point in the context of this review of literature to outline the motor skill characteristics that emerged

from The South Auckland Perceptual Motor Dysfunction Survey (Donaldson and Maurice, 1983). In summary these points are -

i) At the primary school level 85% of the Low Performance Group exhibited gross motor skill impairment. At the secondary school level the incidence of those in the Low Performance Group with gross motor skill impairment increased to 94%.

ii) A similar percentage of males and females in the Low Performance Group have gross motor skill impairment at the primary level - 84.2% females, 85.9% males - whereas all females (100%) and only 75% of the males in the Low Performance Group at the secondary school level had these characteristics.

iii) A corresponding decrease in the incidence of fine motor skill impairment was evident, that is, 35% in the Low Performance group at the primary school level demonstrated fine motor skill problems whereas only 15% in the Low Performance Group at secondary school level had fine motor skill problems.

iv) The incidence of those in the Low Performance Group with both gross and fine motor skill impairment decreased from 22% at the primary school level to 9% at the secondary school level.

v) Balance was the most severely impaired motor skill at both the primary and secondary school levels. At the primary school level 94% of the low performance group had a one year plus deficit (behind chronological age) and 46% had over a three year deficit in their balance skills. At the secondary school level 97% of the Low Performance Group demonstrated a three year plus deficit in their Balance motor skills.

vi) Eighty-two percent (82%) of the primary school Low Performance Group demonstrated problems in three of the four gross motor skill areas tested - Balance, Bilateral Co-ordination, Strength, and Running Speed and Agility. Sixty-one percent (61%) displayed problems in all four of these gross motor skill areas.

Validity of Bruininks-Oseretsky Test of Motor Proficiency

The Bruininks-Oseretsky Test of Motor Proficiency is a restandardized and adapted version of the Oseretsky Test which was undertaken by Bruininks. The test was first published for use in 1978 and since then has received recognition as a valid and reliable test of motor proficiency (Kraft, 1986).

Henderson (1987) considers that a significant disadvantage of many motor skill tests is their lack of theoretical basis for construction. To overcome this shortcoming Bruininks (1978) went to considerable lengths to substantiate the content of The Bruininks-Oseretsky Test of Motor Proficiency with the research work of other prominent researchers in the motor learning field - that is Doll (1946), Guilford (1958), Cratty (1967), Fleisman (1964), Harrow (1972), Rarick and Dobbins (1972) [Refer to Bruininks, 1978; p.28-29 for reference details of the work outlined above].

In an article which discusses the current use of motor skill assessment tests of students in the United States the Bruininks-Oseretsky Test of Motor Proficiency is categorised as a product-orientated test of motor assessment (Kraft,1986). Product-orientated tests are the most prevalent type of test used in the assessment of motor skills and the majority of these tests, according to Kraft, are based on "quantitative measures (how fast, how many) rather than qualitative measures (how the child moves)" (Kraft, 1986; p.72). Kraft comments that many of these product-oriented tests are valuable to the extent that they describe the status of the student at a particular time in terms of

criterion measures and in comparison with peers. He also sees this as a failure of such tests in that they "fail to compare students to their own previous performance" (Kraft, 1986; p.72).

It is common practice for 'new' tests like The Bruininks-Oseretsky Test of Motor Proficiency to be validated through a comparison between an established test instrument that is seen to assess the same motor skill abilities. The Southern California Sensory Integration Test (SCSIT) (Ayers, 1972) has for some time been used by clinicians to evaluate motor skill ability and is considered to be reliable. Ziviani et al. (1982) undertook a correlation of The Southern California Sensory Integration Test (SCSIT) and The Bruininks-Oseretsky Test of Motor Proficiency (Bruininks, 1978) using a sample of 49 learning disabled students. High correlations were recorded between the Fine, Gross and Battery Composite scores of The Bruininks-Oseretsky Test of Motor Proficiency and relevant components of the SCSIT Test. Ziviani et al. therefore report that their results confirm the Bruininks-Oseretsky Test of Motor Proficiency "met the requirements of being a valid and reliable test for assessing motor function" in relation to the group tested (Ziviani et al., 1982; p. 523). They also suggest that the Bruininks-Oseretsky Test of Motor Proficiency would be a useful screening test to identify students with possible sensory integrative dysfunction.

In 1990 The Bruininks-Oseretsky Test of Motor Proficiency (Bruininks, 1978) was used as the criteria to validate the content of a newly formed motor skill test for preschoolers. The Early Motor Profile (Spiegel et al., 1990) was correlated with The Bruininks-Oseretsky Test of Motor Proficiency using 109 subjects. The use of the Bruininks-Oseretsky Test of Motor Proficiency in this manner shows that the test has gained acceptance in the field as a valid test of motor skill ability.

Mobility/Loss of Test Populations

Inevitably some students are lost in longitudinal studies when conducted in schools and communities. The degree of loss in longitudinal studies can be significant and the impact of such losses on the true representativeness of the groups retested can influence the results gained and so limit the impact of the research results.

Research studies which have small original test groups are more likely to have success in tracing students in follow-up studies. Losse et al (1991) in their ten year follow-up study of Henderson and Hall's (1982) original research group traced all 32 students, 16 identified as being 'clumsy' and 16 matched control students. One student had died and two students refused to be retested but allowed their school records to be used. No comment is made in the research summaries as to how many of the students had shifted away from the original test area between testing schedules.

Roussounis et al. (1987) also report a minimal loss of students when retesting a group of 17 clumsy students and their controls after two years. Only one clumsy student had moved out of the area - a 6% loss (Roussounis et al.,1987).

Bax and Whitmore's (1987) longitudinal study began in North Paddington, London in 1978 and investigated the neurodevelopmental assessments of 351 five year old students as predictors of future learning and behaviour difficulties. They report a 19% loss of students between the ages of five and seven years (i.e. 68 children out of 351 after two years) and a 34% loss of students when testing was undertaken at 10 years of age (i.e. 121 children out of 351 after five years). The make-up of the group of students who moved away differed from the study group retested in that more were non-English speaking and fewer had developmental problems at five years of age.

In an eight year follow-up study by Knuckey and Gubbay (1983) in Perth Australia forty percent (40%) could not be traced - many had left the state. Of 52 clumsy children 24 (46%) were retraced and 31 (61%) of 51 matched controls were retraced. Seven children (6.8%) refused follow-up testing which meant that overall more than 50% of the original sample was not tested in the follow-up study (Knuckey and Gubbay, 1983). No information of the motor competence of those lost to the follow-up study compared to those who were tested in the original study is provided in the report of this research study.

Gillberg and colleagues undertook a three and six year follow-up neurological/neurodevelopmental study of 112 seven year old students in Gotenburg Sweden (Gillberg and Gillberg, 1983; Gillberg, 1985; Gillberg and Gillberg, 1989; Gillberg et al., 1989). After three years (when the students were now 10 years old) 16 students (14%) had dropped out of the study - nine students (8%) had moved to places elsewhere in Sweden, five students (4%) had moved overseas and in two cases (2%) parents refused permission for their child to continue in the study (Gillberg, 1985). After six years (when students were now 13 years of age) Gillberg et al.(1989) also recorded a 14% loss of test population (16 students) though the reason for dropout varied from those recorded in the three year follow-up study. At this time (after six years) seven students (6%) of the test population had moved to live elsewhere in Sweden, four students (3.5%) had moved to another country and the parents of five students (4.5%) refused to let their child take part in the follow-up study. The differences shown in the reason for dropout from the three and six year follow-up studies is due to the fact that some students who had left the area when the three year follow-up was conducted had returned to the area and were tested in the six year follow-up. Others students had left the study area between the three and six year testing programmes.

In New Zealand the Dunedin Multidisciplinary Child Development Study has been assessing a group of 1037 children since they were born in Dunedin in 1972/1973. In 1984, after eleven years, 70 students (7% of the sample) had decided not to continue with the study and 79 students (8%) had left the

Dunedin area - 42 students (4%) were living overseas. By 1984, some 16 years since the study began, 25% of the original group lived away from Dunedin - 42 students (4%) of these were living overseas (Silva and McGee, 1984). Not all these students were lost to the study programme however, as some students who lived overseas and some who lived elsewhere in New Zealand were still able to be tested.

Teacher Perception of Motor Impairment

Henderson and Hall (1982) believed that teachers were in the best position to be able to identify students with impaired motor skills and with training could achieve this task with accuracy. After a year's training teachers in the Henderson and Hall study were asked to identify the students in their class who demonstrated impaired motor skills. Sixteen of the 20 students identified were then paired with a 'control' student and each student then undertook a neurodevelopmental examination. The paediatrician undertaking the neurodevelopmental examination did not know the teacher's classification of each child before testing. Henderson and Hall report that an 89% agreement was achieved between the subjective judgement of the paediatrician and that made by the teachers (Henderson and Hall, 1982). The research design of this study did not however allow for an assessment of the students with significant motor impairment who were not identified by the twenty teachers in the study during the initial selection process.

The ability of teachers to identify those students with significantly impaired motor skills was a focus of the South Auckland Perceptual Motor Dysfunction Survey (Donaldson and Maurice, 1983). The twelve teachers in this survey were categorised into two groups - those who had received some physical education training as part of their teacher training and those who had received little or no training in physical education. The 'trained' teachers were somewhat better able to identify students with significantly impaired motor skills - they identified 57% of students identified from the Bruininks-Oseretsky Test of Motor Proficiency as having significantly impaired motor skills. However

on average teachers were only able to identify 50% of those with significantly impaired motor skills as identified by the Bruininks-Oseretsky Test of Motor Proficiency results (Donaldson and Maurice, 1983). These results show that teachers who have not received specific training in identifying students with significant motor skill impairment cannot accurately identify these students.

Motor Skill Competence and Participation in Sport

The question of how important motor skill competence is to one's choices to participate or not to participate in activities has received some attention by researchers. Magill and Ash (1979) found no relation between performance on perceptual-motor tasks and involvement in sports for first to fifth graders in a Texas elementary school. They also record a 59% level of participation in sports for students in grades two to five.

Ulrich (1987) undertook a study to examine three aspects: (a) the relation between children's perceived physical competence and participation in organised sport; (b) the relation between children's demonstrated motor competence and their participation in organised sport; (c) the relation between children's perceived physical competence and their demonstrated motor competence (Ulrich,1987, p.59). The study tested 25 males and 25 females between the ages of 5 years 10 months and 10 years of age. The results of this study did not support the theoretical relation between perceptions of ability and participation within the motor domain for the young students tested (Ulrich 1987). The two most important reasons given for participation were "to have fun and to be with friends" and while it is possible that skill competence may be perceived as a requisite for fun, social involvement seemed a greater influence than skill competence (Ulrich, 1987; p.64). Of the students who did not participate in a sport only 28% rated not being good enough or not enjoying sports as being very important or somewhat important reasons for not participating (Ulrich, 1987). Reasons most frequently cited for not participating

were "(a) programs were too expensive, (b) programs too far away from home, and (c) they were not aware of programs or that the programs offered did not provided sufficient choices" (Ulrich,1987; p.64).

A significant relation was found by Ulrich (1987) between student's demonstrated motor competence and their participation in organised sport. The subjects who participated in sports programmes performed selected motor items better (especially sport skill items) than did nonparticipants. These results suggest that involvement in sport may have a significant and positive effect on skill level (Ulrich, 1987).

Validity of Related Literature

The incidence of students with significant motor skill impairment reported in the Gillberg et al. studies (Gillberg and Rasmussen, 1982; Gillberg and Gillberg, 1983; Rasmussen and Gillberg et al., 1983; Gillberg, 1985; Gillberg and Gillberg 1989; Gillberg et al., 1989) and in the Henderson and Hall (1982) study need to be treated with caution. In both studies students were initially identified as having significantly impaired motor skills using teacher judgement. These judgements were not substantiated by a formal motor skills testing regime of the sample population. Teacher judgement was found by Donaldson and Maurice (1983) not to be a reliable way of identifying students with significantly impaired motor skills from a representative sample in which all students were tested using a comprehensive motor skills test schedule (The Bruininks-Oseretsky Test of Motor Proficiency - Bruininks, 1978). Teachers in this study only identified 50% of those students identified by the test as being significantly behind in their motor skills.

The limitations of the Knuckey and Gubbay (1983) longitudinal study of students with significantly impaired motor skills has been discussed in detail. The loss of 50% of the original population for retesting with no comment about the representativeness of the retested group to the original group tested; the

delineation of the clumsy group into severe, moderate and mild groupings without justification of these divisions; and the limited, somewhat insensitive nature of the motor skill tests administered, are significant factors which limit the credence of these research results.

Contribution This Study Will Make To The Literature

This study, to the author's knowledge, represents the first attempt of a detailed long-term follow-up study of motor skill problems in a non-treated representative sample population group of school aged students in New Zealand. The author has been unable to find any other longitudinal study of this nature which has been published and recognised in the associated literature worldwide. The work of Gillberg and colleagues in Gotenberg Sweden (Gillberg and Rasmussen, 1982; Gillberg and Gillberg, 1983; Rasmussen and Gillberg et al., 1983; Gillberg, 1985; Gillberg and Gillberg 1989; Gillberg et al., 1989) is a similar study but because the tested sample was first selected through a teacher survey (teacher judgement) the study group cannot truly be regarded as being representative of the original population.

This current study is a four year follow-up study of research work initiated by the South Auckland Physical Education Council to determine the incidence of students with significantly impaired motor skills in the Hamilton area (Donaldson and Maurice, 1983). Without the initial foresight of this Council the current research would not have been possible. Such initial and follow-up studies in the physical education field serve as a benchmark in the New Zealand literature from which other studies can be compared and from which it is hoped changes and improvements in physical education teaching practices can be developed and adopted.

This study provides carefully researched evidence to the physical education fraternity which shows there exists a group of students in the school setting for whom the current physical education programmes do not adequately meet their developmental needs. As such this research highlights the need for further practical research to determine whether the incidence of motor skill impairment identified in this study is due to the lack of adequate skill learning or whether it is the result of limited practice of these skills.

CHAPTER FOUR :

METHODOLOGY

At the time of the South Auckland Perceptual Motor Dysfunction Survey (SAPMDS) in 1982 it was recognised that the data collected, particularly from students at the Primary School Standard Three level, could be used as the basis for a longitudinal study focussing on the ongoing development of the physical motor skills of school students. Such a follow-up study of the motor skill ability levels of students with a four year period between testing (Standard Three to Form Three) would highlight any effect of maturation on motor skill development. Such research results would more conclusively support, or refute, an increasing incidence of impaired motor skill ability levels with age, a trend which was evident in the 1982 South Auckland Motor Dysfunction Survey.

This current research work is a four year follow-up study of two selected groups of students from the standard three 1982 SAPMDS.

Research Population

All the students identified as having significantly impaired motor skills and a selection of those whose motor skills were considered just above the level of significant impairment at the primary school level in the SAPMDS were used as the baseline population for this current study. The criteria used for the initial selection of the population for the SAPMDS therefore determined the selection of students for this current study. The selection criteria used for the SAPMDS will be explained briefly.

Twelve schools were chosen for testing to provide a balanced geographical, socio-economic, sex and racial sample of the Hamilton area. All schools selected for testing followed a non-streaming policy. Classroom groups of students were selected at random in order to be able to evaluate teacher perception in identifying students in their class with significantly impaired motor

skills. A random selection procedure was followed in open plan class teaching situations to select students (See Appendix B for a more detailed explanation. Refer Donaldson and Maurice 1983, p. 20 for a full explanation)

The 1982 SAPMDS identified 62 primary school students (18.6% of the sample population) at the standard three level who had significantly impaired motor skills. The cut-off criterion was set at the Stanine 3 level for either Gross Motor Composite, Fine Motor Composite and/or Battery Composite scores. Those students scoring at, or below the Stanine Three level formed a Low Performance Group (See Appendix C for a detailed explanation of the criteria).

A further group of 37 students in the 1982 South Auckland Perceptual Motor Dysfunction Survey had skills that were just above the level of significant impairment - that is they scored at the Stanine 4 level for either Gross Motor Composite, Fine Motor Composite and/or Battery Composite). Twenty-three (23) students were selected from this group for testing to determine whether students in this group had continued to maintain or improve their motor skill level, or had regressed to a level where they could now be classified in the Low Performance Group.

The research undertaken in 1986 was to find and retest as many of the 62 students in the 1982 Low Performance Group of the South Auckland Perceptual Motor Dysfunction Survey (SAPMDS) as possible.

An updated third form intake list was obtained from all state secondary schools in the Hamilton area in March 1986. These lists were used to try and locate all students in the 1982 Low Performance Group and those selected in the 1982 Stanine 4 Group for testing. A list of students not found in this way was compiled and this list was then sent out to all Intermediate and Secondary Schools in the Hamilton area asking for information as to the whereabouts of these students.

The students identified from the 1982 South Auckland Perceptual Motor Dysfunction Survey for retesting in 1986 had progressed through the state funded education system and all but two (2) at the time of retesting were attending secondary school. No students had received any special long-term physical skills instruction in the school setting since the previous testing schedule nor had they received any specific therapeutic intervention. This information was gained from students and verified by physical education staff and school records. These criteria are consistent with the 1982 SAPMDS selection criteria.

Test Procedures

The Bruininks-Oseretsky Test of Motor Proficiency was administered to all students retested in 1986. A questionnaire to obtain further information about student involvement in physical education and sport was also administered to all students.

i) The Bruininks-Oseretsky Test of Motor Proficiency

The Bruininks-Oseretsky Test of Motor Proficiency (BOTMP) was used as the test schedule both in 1982 and in 1986. This test was originally chosen in 1982 because -

* it provided a comprehensive test of motor proficiency
* it was considered a valid and reliable test
* detailed manuals and resource kits were available for use in New Zealand
* the test was normed for ages from four years six months to 14 years six months of age which meant that the same test could be used at the primary, intermediate and secondary school levels
* the Waikato Hospital Child Development Clinic used the test as part of their assessment procedures which meant that assistance in the training of proficient testers was possible.

The Bruininks-Oseretsky Test of Motor Proficiency is made up of eight subtests, each designed to assess an important aspect of motor development. The eight subtests are comprised of 46 separate test items. Figure 1 illustrates how the eight subtests make up the structure of this test. Four subtests - Running Speed and Agility (one item), Balance (eight items), Bilateral Co-ordination (eight items) and Strength (three items) - measure gross motor skills. Three subtests - Response Speed (one item), Visual Motor Control (eight items) and Upper Limb Speed and Dexterity (eight items) - measure fine motor skills. One subtest measures both gross and fine motor skills - Upper Limb Co-ordination (nine items).

It can be seen from Figure 1 that the eight subtests are grouped to determine three measures of motor proficiency - a Gross Motor Composite score which is an index of the ability to use the large muscles effectively; a Fine Motor Composite score which is an index of the ability to use small muscles of the lower arm and hand effectively; and a Battery Composite score which is an index of general motor proficiency.

At present the Bruininks-Oseretsky Test of Motor Proficiency has only been standardized using American samples. Scores for Gross, Fine and Battery Composites in this standardized sample population follow a normal distribution curve with a stanine mean of five.

The 1982 South Auckland Perceptual Motor Dysfunction Survey results showed the Gross Motor Composite scores at all age levels followed the American normed pattern. The Fine Motor Composite and Battery Composite scores of this Hamilton sample were however negatively skewed at the upper stanine levels which resulted in higher mean scores for these composites in the New Zealand research study than in the American standardized sample. The higher Battery Composite scores were to a large extent influenced by higher Fine and Upper Limb subtest scores. Refer to the SAPMDS (Donaldson and Maurice, 1983; p.22) for further details.

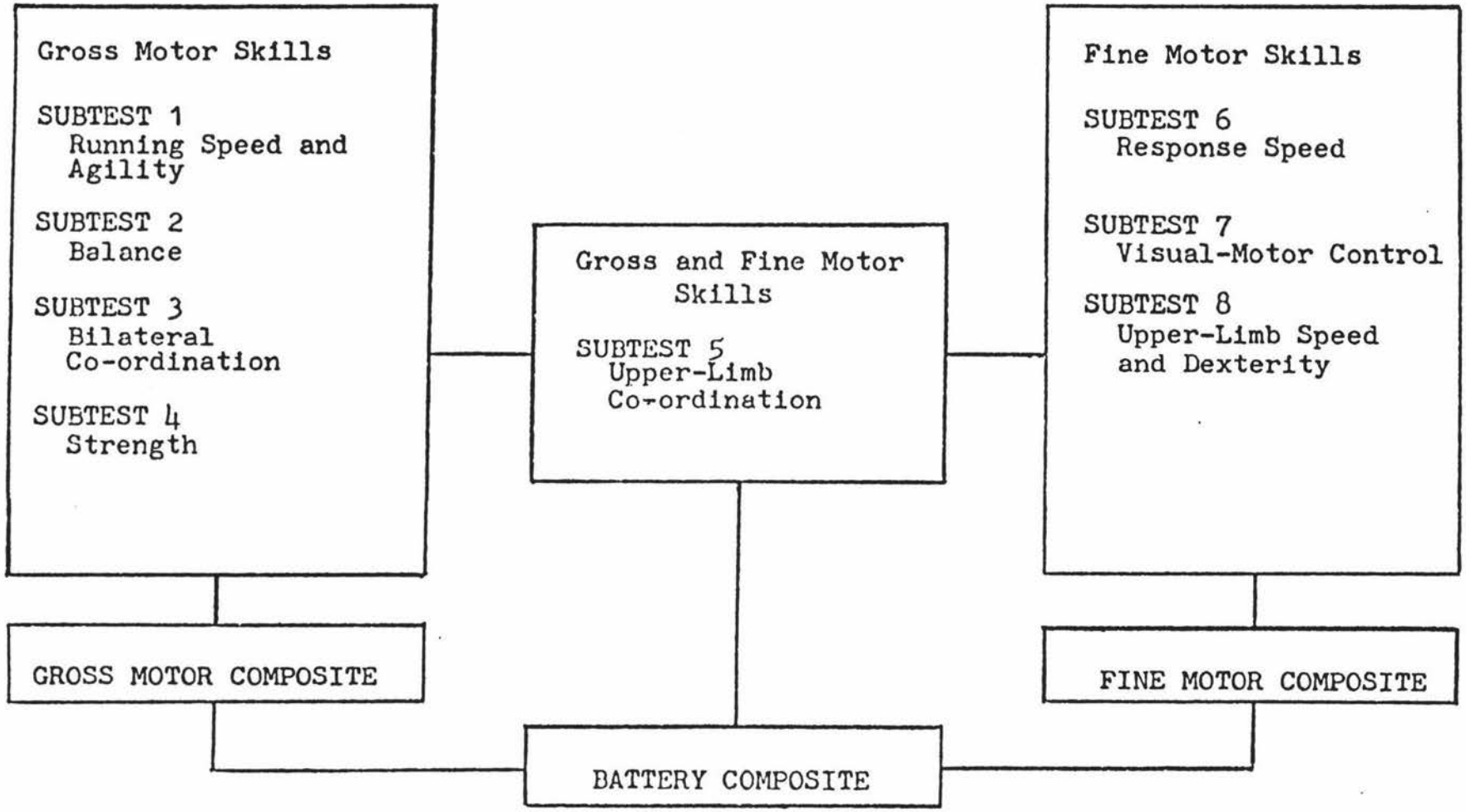


FIGURE 1 Structure of the Bruininks-Oseretsky Test of Motor Proficiency

The effect of this discrepancy between the American normed population and the SAPMDS results is one of under-estimating those in the 1982 SAPMDS who are significantly behind in their fine motor skill development because fewer students are in the lower stanine levels. This under-estimation of those with significantly impaired fine motor skills affects the current research study in the same way.

ii) Questionnaire

The questionnaire was prepared by the researcher to obtain information from students about their participation in sport and leisure activities in the four years between the 1982 and 1986 tests of motor proficiency. For each activity a child identified, further questions were asked about how often they participated, how long they had been attending, whether they participated in a school or community club setting, who had got them involved in the activity, and why they had stopped participating if they had given up the activity. Questions were also asked about how often they had physical education classes at intermediate school, what sort of activities and skills they learnt and whether they enjoyed these classes. The questions were asked verbally and responses were recorded by the interviewer. Every effort was made to put the student at ease during the interview. When answers from students were not specific enough to record accurately, further explanations were requested.

These data were analysed to identify any significant trends in participation and to identify significant comments made by students which could be related to motor proficiency test scores. A copy of the questionnaire is in Appendix A.

Pilot Studies

Extensive training was initially undertaken by two testers in the administration of this test under the guidance of skilled testers at the Waikato Hospital Child Development Clinic prior to testing in 1982.

A pretest sample programme of thirty students was conducted in 1982 using students not involved in the study. This provided practice in the administration of the test under school trial conditions. It also allowed the testers to determine retest and inter-rater reliability to ensure that the Bruininks-Oseretsky Test of Motor Proficiency Test manual standards were achieved (See Donaldson and Maurice 1983, p.13 for details of the standards recorded).

The same two skilled testers who undertook the Bruininks Oseretsky Test of Motor Proficiency testing programme in 1982 undertook the retesting programme in 1986. A pilot testing programme was again undertaken by the testers in 1986 using students not involved in the study. This allowed the testers to refamiliarize themselves with the test and to establish that retest and inter-rater reliability was at the required Bruininks-Oseretsky Test of Motor Proficiency manual standard (Bruininks, 1978; p.39).

Data Collection

The testing programme was conducted in June and November 1986. Students were tested in areas of their school that were familiar to them and which were free of noise and visual distractions which could influence test results. Where possible indoor facilities were used for testing purposes but on the few occasions when this was not possible, sheltered outside areas were chosen and care was taken to avoid sun and wind distractions.

Student tests were usually completed in one 45-60 minute session. On the few occasions when complete testing was not possible in one session testing was undertaken in complete subtest units.

Particular care was taken to establish a positive friendly relationship with students and to encourage them to put forth their best effort. When it was felt that students were negative or reluctant to be tested these concerns were noted.

A number of students were absent at the time of testing. At least one further follow-up visit was made to the school to test these students.

At the time of retesting in 1986 the testers were not conversant with each student's 1982 Bruininks-Oseretsky Test of Motor Proficiency test results so as to avoid, as much as possible, tester influence of results.

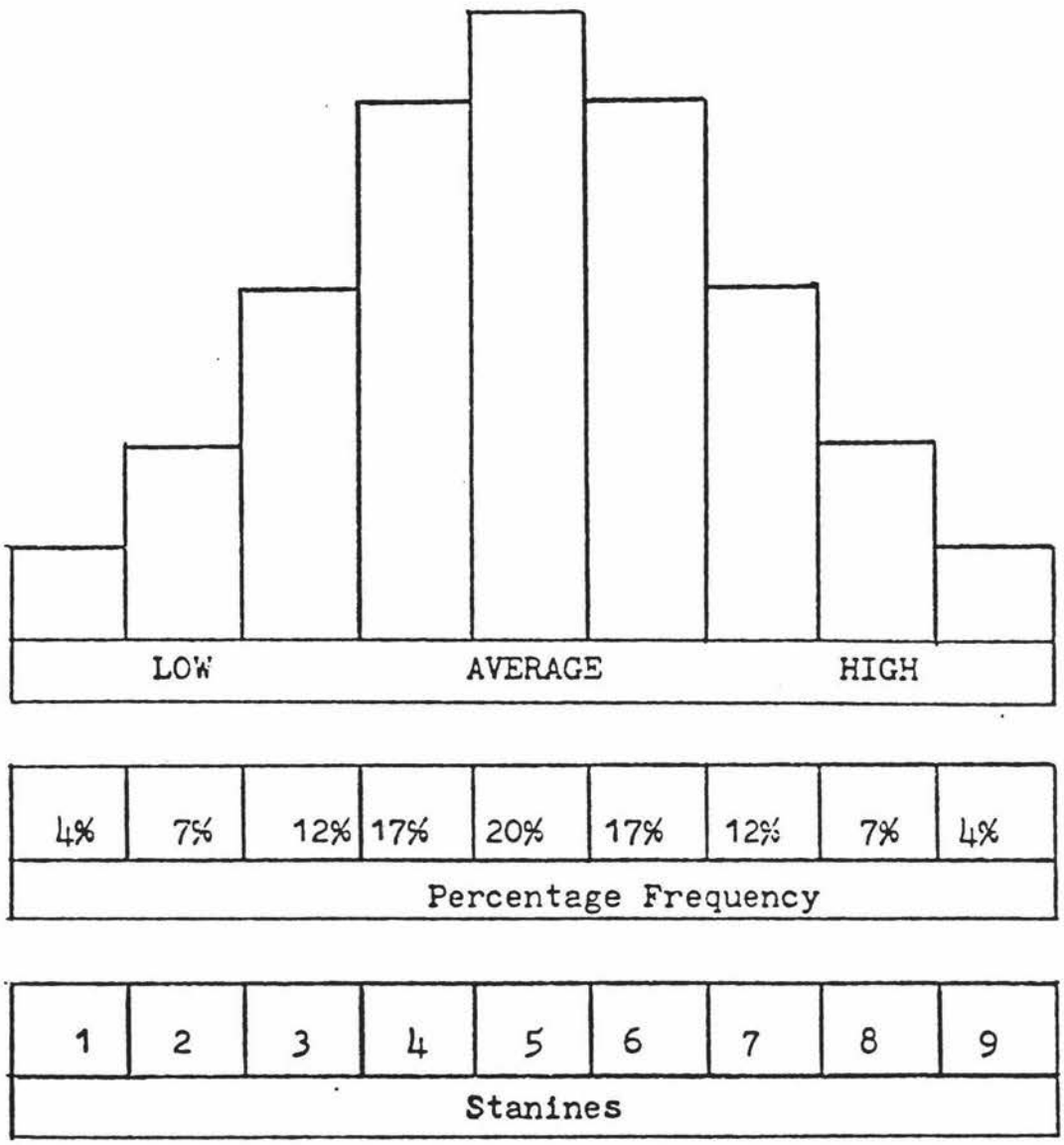
Treatment of the Data

To identify overall group changes that have occurred a separate analysis of the retested 1982 Low Performance Group and the retested 1982 Stanine 4 Group has been undertaken. Each group of students has been further divided into stanine levels according to their lowest stanine score for Gross, Fine or Battery Composite scores to facilitate a more detailed assessment of the results. This grouping format has been adopted on the premise that a student's weakest motor skill level will determine the degree of overall progress that is achieved.

The Gross Motor Composite, Fine Motor Composite and Battery Composite scores of The Bruininks-Oseretsky Test of Motor Proficiency are able to be expressed as standard scores, in percentile rank form or as stanine scores. Standard scores and percentile rank scores are much finer units of measurement and are preferred by many researchers because of their greater accuracy. Stanine scores have however been used in this research study because it is considered in the test manual that standard scores and percentile rank scores give more accurate interpretation of the results than test reliability warrants (Bruininks,1978; p.136). This means that quite large differences are necessary to effect changes in stanine scores.

Stanines are standard scores that range from a low of one (1) to a high of nine (9). A stanine of five (5) denotes the average performance within a given reference group.

Figure 2: Percentage Frequency of Stanine Scores for an Normally Distributed Population



The Bruininks-Oseretsky Test of Motor Proficiency manual also cautions users of the test not to over interpret individual test and subtest results. No individual comparison of results has been made.

The Bruininks-Oseretsky Test of Motor Proficiency results have been interpreted using mean group age equivalent scores in the eight motor subtest skill areas identified. Each group's highest and lowest scores have also been recorded to indicate the range of skill ability that exists between individuals in each group. On tables where this information is presented a zero score means that the motor

skill level is at the group's chronological level. A negative score shows that the motor skill is impaired in relation to the chronological age level whereas a positive score indicates that the motor skill level is advanced or at a level above what would be expected. In light of the reliability of the subtest measures using age equivalents only differences of 12 months (one year) or more have been considered as significant in this research when interpreting mean difference scores behind chronological age (Refer to Bruininks, 1978; p.25-42, p. 137). The Gross Motor and Fine Motor Skill characteristics of the Low Performance Group and the Stanine Four Group have been assessed by sex to identify particular patterns that may exist. Several sex differences in motor skill ability were found in the 1982 South Auckland Perceptual Motor Dysfunction Survey (Donaldson and Maurice 1982) between primary and secondary level students with impaired motor skills and these trends may also be evident in the current study results.

Group mean score differences between student chronological age and skill ability in each of the eight skill subtests that are delineated in the Bruininks-Oseretsky Test of Motor Proficiency are compared from 1982 to 1986. The highest and lowest scores in these eight subtests are also tabulated for comparison. These comparisons help identify improvements and declines in particular motor skills which enhance or impede motor skill development.

Several distinctive groups of students have emerged in 1986 out of the 1982 Low Performance Group and the 1982 Stanine 4 Group. Some students have made significant improvements in the intervening four years to no longer be classified as having significantly impaired motor skills while others have regressed or failed to make any real progress in this time. These groups are identified and the improvements or regressions made are discussed in relation to group mean differences between student chronological age and the skill ability demonstrated. Variations in the highest and lowest group scores of the eight subtests are also identified when this is significant.

An important question to ask in relation to the motor development of 'clumsy' students is whether their clumsiness has increased or diminished with age. In order to assess this it is necessary that the original and follow-up motor tests are identical and that appropriate age-norms are available (Losse et al., 1991). The opportunity to do this has rarely been possible in past research studies of motor skill development in 'clumsy' students but these conditions have been achieved in this study. The Bruininks-Oseretsky Test of Motor Proficiency was used to test the students in 1982 and again in 1986, and because normative data are available for this test, it is possible to compare the degree of impairment or improvement at each time of testing relative to the age of the students.

In the calculation of the percentage of motor skill subtest impairment in 1982 and 1986 relative to each group's average age (to identify areas of increased or diminished motor skill development) only differences greater than 10 percent have been considered as significant. This degree of significance is congruent with the margin of error calculated by Bruininks for the Bruininks-Oseretsky Test of Motor Proficiency when using age difference scores (Bruininks, 1978; p.137). National norms are not known for these percentage differences and thus cannot be translated into standard deviation units.

The time difference in testing and the relatively specific nature of the test items, rules out any significant 'practice effect' between testings.

Delimitations and Limitations of the Study

The retesting of students in 1986 was limited to those students who were identified in 1982 as having significantly impaired motor skills, and a selected group of students whose motor skills were considered to be just above the level of significant impairment. Only those students who still resided in the Hamilton area and who were attending state funded schools from these groups were retested. This was due to the limited availability of finance to travel to other places throughout New Zealand (and overseas) to test those students who had

left the area. This limitation has meant that it is not possible to make specific comment about the effect moving locations and moving schools has on the ongoing development of motor skills for those students with significant motor skill impairment.

Time limitations imposed on the researcher for testing meant that not all students in the Stanine 4 Group were able to be retested. Students from the Stanine Four Group were originally selected to achieve a matched pairing with a student from the Retested 1982 Low Performance Group who derived from the same primary school standard three class, was the same sex and where possible had similar low Composite Motor scores. However due the loss of population from both the Retested 1982 Low Performance Group and the Retested Stanine 4 Group only six pairings were achieved. This number was considered too small for the results to be meaningful and was not pursued further.

Only students attending state funded schools in the Hamilton area were retested because these schools are required to teach physical education in accordance to the prescribed syllabus which provides a consistent basis from which to make comment.

Every effort was made by the testers to put the students at ease during testing and to get accurate results from the testing programme. Any lack of co-operation or resistance to testing was recorded with accompanying comments about the effect this had on the results. A close scrutiny of all the data was made at the completion of testing with view to discarding results which were not considered accurate measures of any student's motor skill level at the time of testing.

This study focuses almost exclusively on the motor skill abilities of those students tested. Where relevant, comment has been made as to possible reasons for trends that are evident in the data from information that was

obtained in the interviews of students. More extensive investigation would be necessary to conclusively support these comments and to relate these study findings to possible links with other learning difficulties reported to be experienced by students with significantly impaired motor skills.

CHAPTER 5 :

RESULTS AND DISCUSSION

This chapter will be separated into several sections for the presentation of data and the discussion of results. Because of the complexity of reporting in each of these sections a brief abstract of results will be reported at the start of each distinct section. Figure 3 is a diagrammatic presentation of the make-up of the different groups discussed in this study. It has been presented so that a holistic view of the study can be gained and to illustrate how each section ties together.

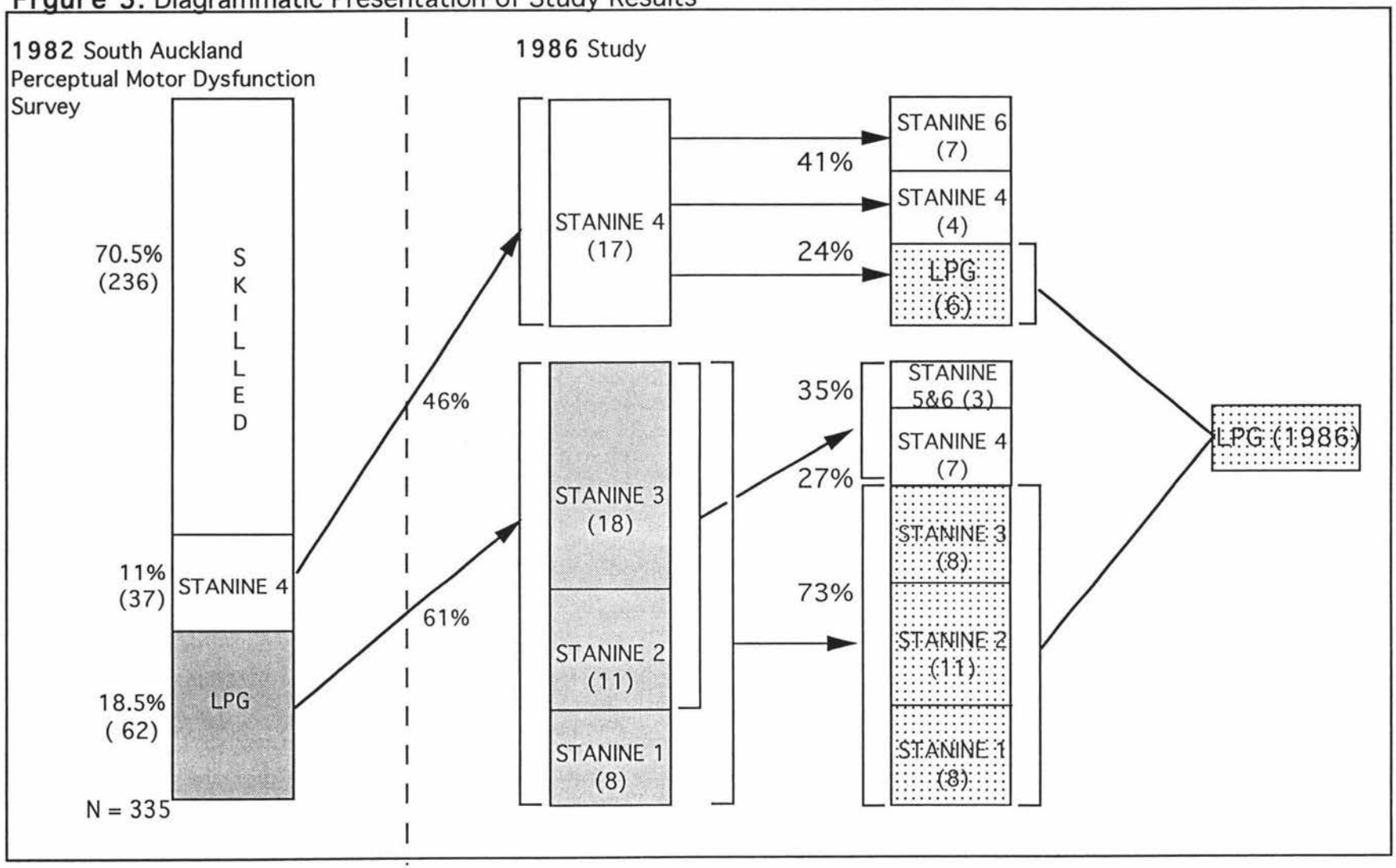
Matters related to the testing process are discussed first. This includes comment about the selection of students for retesting and factors that have affected this such as absenteeism and mobility of populations. Comment has been made about the exclusion of unreliable data and whether the retested 1986 groups are representative of the original 1982 South Auckland Perceptual Motor Dysfunction Survey groups.

The main focus of this study has been to see how the motor skills of those from the 1982 SAPMDS Low Performance Group have developed over the four years from 1982 to 1986. This information is presented under the Retested 1982 Low Performance Group heading.

In light of the research work of Knuckey and Gubbay (1983), who showed that all but the most significantly motor skill impaired improved their motor skills as they matured, it is pertinent to have a close look at the motor skill development of those students with the most impaired motor skills from the Retested 1982 Low Performance Group. This group has been identified as the Retested 1982 Stanine 1 Group.

A sample of the original 1982 SAPMDS Stanine 4 Group was also tested in this study to see if any students from this group showed a deterioration in their motor skills from 1982 to 1986. The results of this work is discussed under the Retested 1982 Stanine 4 Group heading.

Figure 3: Diagrammatic Presentation of Study Results



As a result of the testing in 1986 those students from the Retested 1982 Low Performance Group who continued to have significant motor skill problems, and a small group of students from the Retested 1982 Stanine 4 Group who showed a regression in their motor skills have collectively made up the 1986 Low Performance Group. The skill ability levels of this group have been discussed in order to determine the extent of the motor skill problems of these students at this level.

A separate section has been identified to look closely at the sport and recreation involvement reported by the students retested in 1986. The involvement of those in the Retested 1982 Low Performance Group is discussed first with special comment being made about the participation of those in the Stanine 1 Group. This discussion is followed by a close look at the sport and recreation participation of students in the Retested Stanine 4 Group.

A number of 'special class' students were tested in 1982 and retested again in 1986 as part of the study programme. A brief comment has been made about the motor skill development of these students - students who had been identified in the school system as having special learning needs.

A separate section of this chapter has been made which considers the use of the results achieved through this testing programme. It is possible to determine through extrapolation a percentage of the 1982 Hamilton sample in the SAPMDS who had significant motor skill impairment in 1986. It is also possible to compare the percentage of those with significant motor skill impairment at the secondary school level as determined through the retesting of the same sample of students first tested in 1982 and retested in 1986, with the percentage obtained in 1982 from the SAPMDS secondary school sample.

Finally a 'Summary of Findings' section brings together the important points made in this chapter.

RESEARCH SAMPLE MATTERS

Abstract: Thirty-eight (38) of the original 62 students in the 1982 Low Performance Group were retested i.e. 61%. Seventeen students from 1982 Stanine 4 Group were retested -46% of the original 1982 Stanine 4 Group. Twenty-four percent (24%) were not tested because they had left the area - high mobility of population. Eight percent (8%) not tested due to absence from school. Data from one student removed from study as unreliable. Retested 1982 Low Performance Group representative of original 1982 Low Performance Group in SAPMDS. Retested 1982 Stanine 4 Group not representative of original Stanine 4 Group in SAPMDS in respect of fine motor skills.

Students Tested

The students identified from the 1982 South Auckland Perceptual Motor Dysfunction Survey for retesting in 1986 had progressed through the state funded education system and all but two (2) at the time of retesting were attending secondary school. No students had received any special long-term physical skills instruction in the school setting since the previous testing schedule nor had they received any specific therapeutic intervention. This information was gained from students and verified by physical education staff and school records.

Table 1 shows that forty-seven (47) of the original 62 students (76%) in the 1982 Low Performance Group were located in the Hamilton area. Thirty-eight (38) of these students were actually tested (61%). Twenty-four percent (24%) of the 1982 Low Performance Group had left the area (i.e. 18% known to have left and 6% not traced and presumed to have left the area) in the intervening four years between testing.

Two students in the Low Performance Group in 1982 study (one boy and one girl) were still living in the Hamilton area but were now attending a private school. Two other students in this group (both girls) were also living in the Hamilton area but were in Social Welfare custody. They were not regularly attending a state secondary school at the time of testing so were not retested

(See Table 1). Losse et al. (1991) also comment that two students involved in their longitudinal study had been removed from school and had been placed in schools for students with emotional and behavioural problems.

Table 1: Students Selected for Testing in 1986

	Low Performance Group 1982		**Stanine Four Group 1982**	
Total Number		62		37
Number Selected for Testing 1986	62(100%)			23(62%)
Number Tested 1986		38(61%)		17(46%)*1
Reason Not Tested				
Absent	5		1	
Left the Area	11		5	
No Trace Found	4		-	
Social Welfare Custody	2		-	
Attending Private School (Hamilton)	2		-	
		24 (39%)		6 (16%)*2
Total		62		23

*1 46% of Stanine Four Group but 74% of those selected for testing
*2 16% of Stanine Four Group but 26% of those selected for testing

From Table 1 it can be seen that 23 of the 37 students in the Stanine 4 Group, that is 62%, were selected for retesting in 1986. Of the 23 students selected 18 (78%) were able to be located in the Hamilton area while five students had left the area. One student in this group was absent on the two visits made to the school for testing therefore 17 students (74% of those selected) were able to be retested in the Stanine 4 Group. This was 46% of the original 1982 Stanine 4 Group.

The parents of all students found for retesting in the Hamilton area in 1986 gave permission for their child to be involved in the retesting programme.

Absenteeism

Absenteeism among five students (three girls and two boys - 8%) in the 1982 Low Performance Group Retest Group prevented follow-up testing in 1986. This problem was not as pronounced in the testing of the 1982 Stanine 4 Group Retest Group - only one student (a girl) was absent on the two occasions when testing had been arranged at the school she attended (Refer to Table 1).

A check to see whether absence was a common feature of these student's school participation was not made, but the fact that the follow-up visits were programmed several weeks apart indicates that absenteeism could possibly be a contributing factor to continued or increased impaired motor skills.

Information about the amount of time which the students retested in 1986 had been absent from school during the intervening four years of testing was not collected and therefore it is not possible to make an assessment of the impact this may have had on the development of student's motor skills. However, in another context absenteeism from secondary school was a key contributing factor to reading skill development, and a similar trend in the development of competency in other areas such as motor skills, is not unlikely (Donaldson 1979).

Mobility of Test Population

The four year time span between testing, from 1982 to 1986, means that some students will be lost to the study because they have moved away from the area or they have changed schools and no longer meet the criteria for continued involvement in the study.

This study shows that 24% of those identified in the 1982 Low Performance Group had left the Hamilton area by 1986 (i.e. 11 known to have left the area and four not traced - See Table 1) Twenty -two percent (22%) of those

selected for retesting in the Stanine 4 Group had also left the Hamilton area by 1986 (5 students out of 23).

This loss of population can be compared to the 34% loss of population by Bax and Whitmore (1987) in their neurodevelopmental assessment which was followed up in London after a five year period. A 14% loss of population is reported by Gillberg and colleagues in Sweden (Gillberg et al., 1989) in their six year follow-up study.

A similar percentage of the test population leaving the area - 25% of the sample - has been recorded in the Dunedin Multidisciplinary Child Development Study but this was recorded over an eleven year study period (Silva & McGee 1984, p.4).

This study's loss of population indicates that Hamilton families with students of school age are relatively mobile.

Students that had left the Hamilton area were not retested so it is not possible to determine from this study, the effect that moving from one place to another has on a young population whose motor skill development is significantly impaired. It is possible that mobility is a contributing factor to the ongoing impaired development of physical motor skills in these students because changing locations invariably limits involvement in school and community clubs and involvement in other activities where practise and skill learning can take place.

Age/Sex of Groups

Table 2 shows that more girls than boys were identified in the Low Performance Group in 1982 (58% girls compared to 42% boys). Similarly more girls (55%) than boys (45%) were tested in the Low Performance Group in 1986. The ages of those tested in the Low Performance Group in 1982 (which were retested in 1986) ranged from 9 years 5 months to 11 years 0

months with the mean age being 10 years 2 months. The ages of those tested in the Low Performance Group in 1986 ranged from 13 years 4 months to 14 years 8 months with the mean age of those tested being 13 years 11 months.

The greater percentage of females found in the SAPMDS 1982 Low Performance Group and subsequently also in the significantly impaired group in the 1986 study, is in contrast to the 'clumsy' groups identified in other related studies. The studies of Gubbay (1975), Henderson and Hall (1982), and Roussounis et al. (1987) all show a higher percentage of males than females with significant motor skill impairment.

Table 2: Age and Sex of the Low Performance Group and the Stanine 4 Group 1982/1986.

Low Performance Group				
Age Range:	1982	9 years 5 months to 11 years 0 months Mean: 10 years 2 months		
	1986	13 years 4 months to 14 years 8 months Mean: 13 years 11 months		
Sex:		Males	Females	Total
	1982	26 (42%)	36 (58%)	62
	1986	17 (45%)	21 (55%)	38
Stanine Four Group				
Age Range:	1982	9 years 3 months to 10 years 6 months Mean: 10 years 0 months		
	1986	12 years 6 months to 14 years 10 months Mean: 13 years 9 months		
Sex:		Males	Females	Total
	1982	18 (49%)	19 (51%)	37
	1986	9 (53%)	8 (47%)	17

The ages of those tested in Stanine 4 Group in 1982 (which were retested in 1986) ranged from 9 years 3 months to 10 years 6 months with the mean age being 10 years 0 months. In 1986 the Stanine 4 Group mean age was 13 years 9 months with the ages ranging from 12 years 6 months to 14 years 10 months. Nine (9) boys and eight (8) girls were tested in this group (Refer to Table 2).

Unreliable Data

A close examination was undertaken of each student's results collected in 1982 and 1986 to identify any inconsistencies in testing due to factors not associated to actual motor skill performance. Comments that were recorded relating to behaviour or attitude during testing were considered in light of the results which were recorded in that year and compared to those recorded in the second test situation.

In all but one case, the results were regarded as an accurate assessment of each student's motor skill ability. The information collected from one subject in the Low Performance Group in 1982, when compared to the results achieved in 1986, was considered to be inconsistent. The gains identified as being made by this student - a male - were far in excess of any other student for both Gross and Fine Motor Composite Scores and no reasons for this were identified in the questionnaire. Comments made at each time of testing suggest that the 1986 test results were an accurate assessment of the student's motor skill ability but the results obtained in 1982 were considered to be lower than the student's actual ability due to his reluctant and unco-operative attitude at the time of testing. Subsequently data from this student was removed from the analysis of results.

Are Those Available for Retesting In 1986 Representative Of The 1982 Low Performance and Stanine 4 Groups?

It is important to determine whether those retested in 1986 from both the Low Performance Group and the Stanine 4 Group are representative of these original groups in 1982. Table 2 identifies the composition of each of these groups by gender. A chi-square test found that there was no significant difference in the sex make-up of those retested and those not retested in both the 1982 Low Performance Group and the Stanine 4 Group (See Appendix D for details).

The fact that the groups retested in this study in 1986 are not significantly different in relation to the sex incidence of the groups identified in 1982 compares favourably to the disproportionate ratio between the sex incidence of those identified by Gubbay in 1975 and those retested by Knuckey and Gubbay in 1983 i.e. 59% boys and 41% girls were identified in the clumsy group by Gubbay in 1975 compared to a 75% boy and 25% girl ratio of clumsy children tested in 1983 by Knuckey and Gubbay.

A two-tailed t-test found no significant difference between the Gross Motor Composite Scores, Fine Motor Composite Scores and Battery Composite Scores of those retested and those not retested from the 1982 Low Performance Group (See Appendix D for details).

A two-tailed t-test of the Stanine 4 Group also found no significant differences between the Gross Motor Composite Scores of those retested and those not retested in this group. A significant difference was identified however between the Fine Motor Composite Scores and Battery Composite Scores of those retested and those not retested in the Stanine 4 Group (See Appendix D for details). The significant difference found between the Battery Composite Scores of each group are by enlarge due to the differences that are present in the Fine Motor Composite Scores. The difference between the Fine Motor

Composite scores of those tested and those not retested in the Stanine 4 Group was not entirely unexpected for several reasons-

i) Those with low Fine Motor Composite Scores were under-represented in all stanine groups at Stanine 4 and below as the 1982 SAPMDS results were negatively skewed or bunched at the upper stanine levels. Only five (5) students had Stanine 4 Fine Composite scores - 13.5% of the Stanine 4 Group.

ii) All five students with Stanine 4 Fine Composite scores were selected for retesting. Only two were retested - three had left the area.

iii) The selection of Stanine 4 Group students was undertaken to achieve a pairing with a subject in the Low Performance Group by age, sex and from the same 1982 class with, where possible, the same low composite motor scores. This meant that only students with Gross Motor Composite stanine scores of six or less and Fine Motor Composite stanine scores of less than seven from the Stanine 4 Group were selected. All those not selected in the Stanine 4 Group had Fine Composite scores of Stanine 7 or above.

The significant difference identified between the Fine and Battery Composite Stanine scores of those retested and those not retested in the Stanine 4 Group means that care must be taken when interpreting any results and trends evident in these areas of the research.

The analysis of subject selection data in longitudinal studies, as undertaken above, to determine how representative retested groups are in relation to the originally identified groups is essential in order to be able to validate the findings of these types of studies. Such analysis of research groups is not well reported in a number of the longitudinal research studies of students with significantly impaired motor skills. For example the most frequently quoted

longitudinal study on this topic - that of Knuckey and Gubbay (1983) in their follow-up study of a group of clumsy students which were first identified in research carried out by Gubbay in 1975 - makes no comment on whether the retested group is representative of the original group. In light of the big discrepancy apparent in the sex composition of the two research groups - that is 59% males and 41% females in 1975 compared to 75% males and 25% females in 1983- it is highly likely that the retested group was not representative of the original group with respect to their initial motor skill ability.

RETESTED 1982 LOW PERFORMANCE GROUP

Abstract: All students in Retested 1982 Low Performance Group had significantly impaired motor skills when tested at standard three level in the 1982 South Auckland Perceptual Motor Dysfunction Survey. Of the 37 students in this group 15 made at least a one stanine improvement in their lowest Motor Composite score between 1982 and 1986. Ten (10) of these students (27%) made significant progress to no longer be classified in the Low Performance Group in 1986. Fifteen students (15) made no improvement and seven students showed a deterioration in their lowest Motor Composite score over the four year period. Ninety-six percent (96%) of students from this group who were still classified in the Low Performance Group in 1986 had low gross motor skills and 30% had low fine motor skills. All gross motor skill subtests show an average of -2 years or more deficit in 1986. Balance was the most impaired motor skill both in 1982 and 1986 with all students (including the significant improvers) on average showing a -6 year deficit in this skill in 1986. Visual Motor Control was the only motor skill to be at or above this Group's average motor skill subtest level in both 1982 and 1986. A ten year variation between the highest and lowest scores is recorded for seven of the eight motor skill subtests in 1986 - Upper Limb Co-ordination shows only an eight year variation between the highest and lowest scores recorded.

The 'significant improvers' made improvements in three of their four gross motor skill subtests and maintained their fine motor skill subtest levels at their age level between 1982 and 1986. The 'non-improvers' showed a deterioration in all gross motor skill subtests (to be 20% or more behind their average age in these four motor skill subtests in 1986) and were only able to maintain their age level competence in the Visual Motor Control subtest in 1982 and 1986.

The 1982 Low Performance Group of the South Auckland Perceptual Motor Dysfunction Survey at the Primary School Standard Three level made up 18.6% of the sample population and was comprised of 62 students. From this original group of 62 students with significantly impaired motor skills, 38 students were able to be retested in this follow-up longitudinal study in 1986. These 38 students are, as a group, the main focus of this research study. Their motor skill development, as determined by extensive testing using the Bruininks-Oseretsky Test of Motor Proficiency, is analysed as a group to identify patterns of improvement and deterioration. The data have then been further examined to attempt to identify the characteristics of those students in the group who have made significant progress compared to those students who have not shown such improvement.

The retested group of 38 students was made up of 21 female students and 17 male students. The data collected from one student - a male - was at the completion of testing regarded as unreliable and was subsequently not used in the data analysis The group of students from the 1982 Low Performance Group who were retested in 1986 will hereafter be referred to as the Retested 1982 Low Performance Group.

The original 1982 Low Performance Group was made up of students who scored at the Stanine 3 level or below in either their Gross Motor Composite score, their Fine Motor Composite score or their Battery Composite score.

Stanine Level Improvement

The Low Performance Group was in 1982 and has again in 1986 been further divided for analysis purposes, into three stanine levels - Stanine 1, Stanine 2, and Stanine 3 - according to each student's lowest Motor Composite score (that is Gross Composite, Fine Composite or Battery Composite scores).

Table 3 shows that the 37 students in the Retested 1982 Low Performance Group comprised 18 students at the Stanine 3 level, 11 students at the Stanine 2 level and eight students at the Stanine 1 level when tested in 1982.

It can be seen from Table 3 that the motor skills of ten students (five females and five males) had improved significantly over the intervening four years to be at the Stanine 4 level or above in 1986. This means that in 1986 these students motor skills are no longer considered significantly impaired. These ten students make up 27% of the Retested 1982 Low Performance Group.
The results on Table 3 show that 27 students from the Retested 1982 Low Performance Group are still categorised in the Low Performance Group in 1986 - that is they score at the Stanine 3 level or below in either Gross Motor Composite, Fine Motor Composite or Battery Composite scores. These 27 students represent 73% of the Retested 1982 Low Performance Group.

Table 3 : Retested 1982 Low Performance Group Distribution by Lowest Motor Composite Stanine Scores and by Sex in 1982/1986

	← 1982 →			← 1986 →		
Stanine Level	**Total**	**Males**	**Females**	**Total**	**Males**	**Females**
Stanine One	8	4	4	8	2	6
Stanine Two	11	5	6	11	6	5
Stanines Three	18	7	11	8	3	5
Stanine Four	-	-	-	7	4	3
Stanine Five	-	-	-	2	-	2
Stanine Six	-	-	-	1	1	-
Total	37	16	21	37	16	21

Table 3 shows that the same number of students are found at the Stanine I and Stanine 2 levels in 1982 and 1986. The students that made up these stanine groups in 1982 did not, as a whole, make up the same stanine groups in 1986 (this can be seen from the different sex make-up of these stanine levels in Table 3). Several students from the Stanine 1 and Stanine 2 levels in 1982 progressed into higher stanine levels in 1986 while other students at the Stanine 2 and Stanine 3 levels dropped back into lower stanine levels.

The spread of males and females between the stanine levels in 1982 - as shown on Table 3 - is fairly even. In 1986 however more females than males can be found at the Stanine 1 level (six females and two males).

Table 4 illustrates more clearly the pattern of movement that has occurred between each student's lowest motor skill stanine level from 1982 to 1986. Five (5) of the eight (8) students at the Stanine 1 level in 1982 still had skill levels at the Stanine 1 level in 1986. Two students progressed from the

Stanine 1 level to the Stanine 2 level while one student at the Stanine 1 level in 1982 progressed to the Stanine 3 level in 1986. A significant point to note from Table 4 is that no students at the Stanine 1 level in 1982 improved their motor skills sufficiently in the intervening four years to progress out of the Low Performance Group by 1986.

It can be seen from Table 4 that five of the 11 students at the Stanine 2 level in 1982 still had their lowest motor skill composite score at that level in 1986. Three students at the Stanine 2 level in 1982 (that is 27% of the those at the Stanine 2 level) improved their lowest motor skill composite score at least two stanine points to progress out of the Low Performance Group by 1986. Two other students at the Stanine 2 level in 1982 also improved their lowest motor skill composite score to move up to the Stanine 3 level but they were still classified in the Low Performance Group in 1986. One student's lowest motor skill composite score deteriorated from the Stanine 2 level in 1982 to drop back to the Stanine 1 level in 1986.

Table 4 : Stanine Progress of the Retested 1982 Low Performance Group When Compared By Lowest Motor Composite Stanine Scores in 1982/1986

1982		← 1986 Level →				
Stanine Level	**Total Number**	**At Same Stanine Level**	**Improved to St 2**	**St 3**	**Improved Out of LPG**	**Declined to St 2**	**St 1**
Stanine 1	8	5	2	1	-	-	-
Stanine 2	11	5	-	2	3	-	1
Stanine 3	18	5	-	-	7	4	2
Totals	37	15	2	3	10	4	3

Table 4 shows that seven of the ten students (70%) to make significant motor skill improvement and to progress out of the Retested 1982 Low Performance Group in 1986 came from the Stanine 3 Group. These seven students made up 39% of the Stanine 3 Group.

In contrast to the seven students who made significant motor skill improvements at the Stanine 3 level by 1986, five students made no improvement to their lowest motor skill composite score and six students (33% of Stanine 3 Group) illustrated a deterioration in their 1982 lowest motor composite Stanine 3 level over that time. Four students had deteriorated one stanine level (to the Stanine 2 level) by 1986 while two students dropped two stanine levels to the Stanine 1 level by 1986 (See Table 4).

In summary Table 4 shows that 15 students (41%) in the Retested 1982 Low Performance Group made a stanine level improvement of one or more in their lowest Motor Composite stanine level between 1982 and 1986. In contrast 15 students (41% of the Retested 1982 Low Performance Group) made no improvement in their lowest Motor Composite stanine score in the four years between testing. Seven (7) students showed a lowest stanine Motor Composite score deterioration from 1982 to 1986 - these students made up 19% of the Retested 1982 Low Performance Group. Thus overall 60% of the Retested 1982 Low Performance Group made no advancement or demonstrated a deterioration in their lowest motor composite stanine level between 1982 and 1986. (N.B. Percentages have been rounded to the nearest percentage hence the slight variation in percentage).

Gross and Fine Motor Skill Characteristics

Table 5 identifies the changes in gross and fine motor skill characteristics from 1982 to 1986 for the Retested 1982 Low Performance Group. In the context of this study a low motor score (gross, fine or battery) is when the Motor Composite Score is at the Stanine 3 level or below and a high score is when the Motor Composite Score is at the Stanine 4 level or above. More females than males

were in the Retested 1982 Low Performance Group (55% females, 45% males) hence the number of females to males on the tables in this section are not true percentages according to sex. Table X in Appendix E has correlated much of the information on Table 5 taking into consideration the initial discrepancy in gender of the original population.

It can be seen from Table 5 that 23 students, 62% of the Retested 1982 Low Performance Group, had low gross motor and high fine motor skill characteristics in 1982. More females than males were identified in 1982 as having these characteristics (15 females and eight males). Seven students with these motor skill characteristics (30% of this group) made significant improvement in their gross motor skills between 1982 and 1986 to no longer be classified in the Low Performance Group (the students on Table 5 with high gross, high fine motor skills). These seven students made up 70% of the group of significant improvers.

Fifteen of the 23 students (65%) in the Retested 1982 Low Performance Group with low gross and high fine motor skill characteristics in 1982 continued to display these characteristics in 1986. One student who had low gross and high fine motor skill characteristics in 1982 showed a deterioration in his fine motor skills to record both low fine and low gross motor skill characteristics in 1986.

Table 5 shows that in 1982 five (5) students in the Retested 1982 Low Performance Group (14%) were identified as having high gross and low fine motor skills - four students were males and one student was a female. All five students had changed their motor skill characteristics by 1986. Two students (both males) with these characteristics made significant improvement in their fine motor skills to no longer be classified in the Low Performance Group (one student made a two stanine improvement, the other a five stanine improvement), while two other students (both males) showed a deterioration in their gross motor skills to exhibit both low fine and low gross motor skills in 1986. One student (a girl) showed a deterioration in gross motor skills and an improvement in fine motor skills between 1982 and 1986 and therefore still remained in the Low Performance Group in 1986.

Eight (8) students (representing almost a quarter of the Retested 1982 Low Performance Group - 22%) had low gross and low fine motor skills in 1982. A similar percentage of males and females had these characteristics (11%) at that time. In 1986 four of the eight students continued to display these motor skill characteristics. Of the other four students two significantly improved their fine motor skills, one student significantly improved his gross motor skills, and one student (a girl) had made significant progress in both motor skill areas to no longer be classified in the Low Performance Group.

One student is identified in Table 5 in the Retested 1982 Low Performance Group due to a low Battery Composite score in 1982. This student showed a deterioration in her gross motor skills in 1986 but maintained high fine motor skills. She therefore remained in the Low Performance Group in 1986.

A summary view on Table 5 of the motor skill impairment of the Retested 1982 Low Performance Group shows that 31 students (84% of the group) had low gross scores and 13 students (35%) had low fine scores in 1982. A higher percentage of females (51%) had gross motor skill problems than males (32%). In contrast more males had fine motor skill problems than females in 1982 (22% males compared to 14% females). In 1986 27 students continued to be in the Low Performance Group. Ninety-six percent (26 out of 27) of these students had low gross motor skills - all 16 female students had low gross motor skills and 10 out of 11 (91%) of the males have low gross motor skills. Thirty percent (8 out of 27) displayed low fine motor skills. Seven students in 1986 had both low gross and low fine motor skills - this was 26% of those students still classified in the Low Performance Group. This figure of 26% can be compared to the 36% of students in Gillberg et al's (1989) group who displayed both gross and fine motor skill problems.

Table 5: Changes in Gross and Fine Motor Skill Characteristics of Retested 1982 Low Performance Group from 1982 to 1986

Characteristics	1982			1986											
				Low Gross/High Fine			High Gross/Low Fine			Low Gross/Low Fine			HighGross/HighFine*		
	Total	Males	Females	Total	Males	Females	Total	Males	Females	Total	Males	Females	Total	Males	Females
Low Gross/ High Fine	23	8	15	15	4	11	-	-	-	1	1	-	7	3	4
High Gross/ Low Fine	5	4	1	1	-	1	-	-	-	2	2	-	2	2	-
Low Gross/Low Fine	8	4	4	2	2	-	1	1	-	4	1	3	1	-	1
Low Battery Only	1	-	1	1	-	1	-	-	-	-	-	-	-	-	-
Totals	37	16	21	19	6	13	1	1	-	7	4	3	10	5	5
Total Low Gross	31	12	19	19	6	13	-	-	-	7	4	3			
Total Low Fine	13	8	5	-	-	-	1	1	-	7	4	3			

Note: * High Gross/High Fine means students no longer in Low Performance Group

The percentage of females (100%) and males (91%) with impaired gross motor skills in the Retested 1982 Low Performance Group in 1986 at the secondary school level are identical to the percentages recorded in the 1982 South Auckland Perceptual Motor Dysfunction Survey at the secondary school level (Refer Table 8 Donaldson and Maurice 1983, p.34). Comment is made later in this study as to possible reasons why students continue to have impaired motor skills particularly impaired gross motor skills.

From Table 5 it is evident that 19 out of 37 of the students in the Retested 1982 Low Performance Group - that is 51% - demonstrated the same motor skill features in 1986 which originally categorised them in the Low Performance Group in 1982. Fifteen of these 19 students continued to display Low Gross/Low Fine motor skills and four students continued to display Low Gross /Low Fine motor skills. This method of interpreting the data does not mean that these students made no improvement in their motor skill levels but it highlights that their motor skill characteristics remained constant.

It was expected that those students in the Retested 1982 Low Performance Group who had their lowest Motor Composite score at Stanine 3 and their other motor composite scores at Stanine 4 or above would be most likely to show significant improvement. Fourteen students (five males and nine females) had these motor skill characteristics in 1982 - eleven had their gross motor composite score at Stanine 3, two had their Fine Motor Composite score at Stanine 3 and one student had a Battery Composite score at Stanine 3. However by 1986 only seven of these fourteen students had improved significantly to no longer be classified in the Low Performance Group - six of whom had Stanine 3 gross motor skills and one with Stanine 3 fine motor skills.

Three students who had their lowest Motor Composite score (gross, fine or battery) at Stanine 2 in 1982 made significant improvement to no longer be classified in the Low Performance Group in 1986. Two of these students had their Gross Motor Composite score at the Stanine 2 level and one student had a Stanine 2 Fine Composite score.

A close examination of the eight subtest ability levels of particular gross and fine motor skills and changes that have occurred from 1982 to 1986 will identify whether improvements in particular motor skills have led to significant improvements.

Motor Skill Subtest Characteristics

Eight motor skill subtest areas are identified in the Bruininks-Oseretsky Test of Motor Proficiency and are grouped into gross and fine motor skills areas as shown in Table 6 (see also Figure 1, p. 47). The average scores on Table 6 represent the Retested 1982 Low Performance Group's average degree of ability or impairment related to the Group's average chronological age for each motor skill subtest.

The information on Table 6 is discussed in conjunction with the information presented on Table 7. Table 7 identifies the number and percentage of students with specific degrees of impairment in the Retested 1982 Low Performance Group for each identified motor skill subtest. This information highlights in a different way the degree of the problem that exists in particular motor skill areas.

Table 6 shows that in 1982 the Retested 1982 Low Performance Group's average scores for all gross motor skills (Balance, Bilateral Co-ordination, Strength, and Running Speed and Agility) were over a year behind the Group's average chronological age. Balance skills showed the greatest average deficit (-2 years 5 months) and also the biggest variation in scores (that is a 12 year difference between the highest and lowest scores - Table 6). From Table 7 it can be seen that 49% of the students in the Retested 1982 Low Performance Group had Balance skill deficits of three years or more in 1982. A more detailed tabulation of balance results for this Group (Table 35 Appendix F) shows that in 1982 84% have a Balance skill deficit of more than one year. These findings can be compared to those of Baker (1981) who reported that all students with significantly impaired motor skills had balance problems.

Cornish (1980) stated that all clumsy students had below normal physical strength. In this study Table 7 shows that only 46% of the Retested 1982 Low Performance Group had deficits of two or more years in Strength in 1982. From Table 35 (Appendix F) it can be seen that in 1982 70% of the students had a deficit of one or more years in Strength. In 1986 76% of the Retested 1982 Low Performance Group demonstrated one or more years deficit in Strength (Table 36, Appendix F) with almost half of this group showing a five year plus deficit (49% Table 7).

The Upper Limb Co-ordination subtest motor skill average in 1982, as shown on Table 6, was at the Retested 1982 Low Performance Group's chronological age level.

In 1982 the Retested 1982 Low Performance Group had average motor skill levels at, or above their chronological age in two of the three fine motor skill subtests. The Visual Motor Control skill average in 1982 was over a year above the Group's chronological age level and was the only motor skill average score to be above the Group's average chronological age level at that time. The Upper Limb Speed and Dexterity subtest average score was a year behind the Retested 1982 Low Performance Group's average chronological age in 1982, while the Response Speed subtest average in 1982 was at the Retested 1982 Low Performance Group's average chronological age level.

Table 6 shows that in 1986 all subtest average scores for the Retested 1982 Low Performance Group were over two years behind the Group's chronological age except for the Visual Motor Control subtest average which was at the Group's chronological age level. In 1986, as in 1982, Balance skills were the most impaired (average of - 6 years 8 months). The lowest score, or greatest degree of impairment, in 1986 was also recorded for Balance (-10 years 2 months) a score which shows that this student is performing this motor skill at below a five year old level at 14 years of age. A ten year variation between the highest and lowest scores is recorded for seven of the eight motor skill subtests in 1986 - Upper Limb Co-ordination shows only an eight year variation between the highest and lowest scores recorded (see Table 6).

Table 6 : Range and Average Degree of Impairment of Subtest Motor Skills for the Retested 1982 Low Performance Group

	1982	1986
GROSS MOTOR SKILLS		
BALANCE		
Average	- 2 years 5 months	- 6 years 8 months
Lowest	- 6 years 1 month	-10 years 2 months
Highest	+ 6 years 2 months	- 3 years 6 months
BILATERAL CO-ORDINATION		
Average	- 1 year 8 months	- 2 years 3 months
Lowest	- 5 years 1 month	- 7 years 5 months
Highest	+ 4 years 3 months	+ 2 years 5 months
STRENGTH		
Average	- 1 year 8 months	- 2 years 7 months
Lowest	- 5 years 10 months	- 8 years 3 months
Highest	+ 2 years 6 months	+ 2 years 2 months
RUNNING SPEED AND AGILITY		
Average	- 1 year 3 months	- 3 years 1 month
Lowest	- 4 years 7 months	- 8 years 9 months
Highest	+ 4 years 5 months	+ 1 year 8 months
UPPER LIMB CO-ORDINATION		
Average	+ 0 years 3 months	- 2 years 1 month
Lowest	- 5 years 10 months	- 6 years 10 months
Highest	+ 5 years 10 months	+ 1 year 8 months

Table 6: Continued

	1982	1986
FINE MOTOR SKILLS		
RESPONSE SPEED		
Average	+ 0 years 6 months	- 2 years 3 months
Lowest	- 5 years 4 months	- 7 years 9 months
Highest	+ 6 years 1 month	+ 2 years 7 months
VISUAL MOTOR CONTROL		
Average	+ 1 year 4 months	+ 0 years 8 months
Lowest	- 4 years 10 months	- 7 years 1 month
Highest	+ 6 years 2 months	+ 2 years 7 months
UPPER LIMB SPEED AND DEXTERITY		
Average	- 1 year 0 months	- 2 years 1 month
Lowest	- 4 years 7 months	- 7 years 5 months
Highest	+ 1 year 4 months	+ 2 years 5 months

A four year decline in the average Balance scores from 1982 to 1986, which is evident on Table 6, shows that as a Group no improvement in Balance skills took place in the four years between testing. Students on average display Balance skills over six-and-a-half years below their chronological age in 1986 which is a significant impairment. The extent of this problem is also highlighted in Table 7 which shows that in 1986 all students had Balance skills three years or more behind their chronological age while 86% had Balance skill levels more than five years in arrears of their chronological age. A further tabulation of Balance results for the Retested 1982 Low Performance Group in 1986 (on Table 35 in Appendix F) shows that 16 students (42%) in the Group have Balance skill levels seven years or more behind their chronological age.

Table 6 shows that the averages of all other gross motor subtest skills (i.e. Bilateral Co-ordination, Strength, and Running Speed and Agility) in 1986 are also significantly impaired - they are at least two years behind the Retested 1982 Low Performance Group's average chronological age. From Table 7 it can be seen that in 1986 nearly half the Group (between 49%- 51%) are three years or more behind in Bilateral Co-ordination, Strength, and Running Speed and Agility subtest skills while almost 25% of the Group have motor skill levels in these subtest areas five or more years behind their chronological age.

It should also be noted from Table 6 that the average scores of these three gross motor skills deteriorated from 1982 to 1986. However only the Running Speed and Agility subtest average deterioration of -1 year 10 months from 1982 to 1986 (-1 year 3 months in 1982 to -3 years 1 month in 1986) is significant - that is a difference of more than a year.

Upper Limb Co-ordination skills deteriorated significantly between 1982 and 1986 for the Retested 1982 Low Performance Group. Table 6 shows that in 1982 the Group's skill average in this subtest was at their average age level but by 1986 they were on average two years behind their chronological age level. Table 7 shows that in 1986 41% of the students in the Retested 1982 Low Performance Group had Upper Limb Co-ordination motor skills more than three years behind their age.

All three fine motor skill subtest Group average scores deteriorated between 1982 and 1986 (Refer to Table 6). This deterioration in average scores was significant for Response Speed (-2 years 9 months) and for Upper Limb Speed and Dexterity (- 1 year 1 month) but was not significant for Visual Motor Control (- 8 months). Table 7 shows that by 1986 57% of the Retested 1982 Low Performance Group had deficit Response Speed scores three years or more behind their chronological age. Some 38% of the Retested 1982 Low Performance Group also displayed Upper Limb Speed and Dexterity skills three years below their chronological age level in 1986.

Table 7 : Degree of Impairment of Subtest Motor Skills for Retested 1982 Low Performance Group in 1982 and 1986

	← 1982 →		← 1986 →	
	-2 years	**-3 years**	**-3 years**	**-5 years**
GROSS MOTOR SKILLS				
Balance	23 (62)	18 (49)	37 (100)	32 (86)
Bilateral Co-ordination	15 (41)	11 (30)	18 (49)	9 (24)
Strength	17 (46)	5 (14)	18 (49)	8 (22)
Running Speed and Agility	12 (32)	4 (11)	19 (51)	10 (27)
Upper Limb Co-ordination	10 (27)	6 (16)	15 (41)	2 (5)
FINE MOTOR SKILLS				
Response Speed	10 (27)	8 (22)	21 (57)	13 (35)
Visual Motor Control	6 (16)	4 (11)	6 (16)	3 (8)
Upper Limb Speed and Dexterity	17 (46)	3 (8)	14 (38)	4 (11)

( ) - percentage scores rounded to the nearest one percent.

Visual Motor Control subtest skills are seen to be a constant positive average subtest skill factor in both 1982 and 1986 for the Retested 1982 Low Performance Group (See Table 6). The Group's average Visual Motor Control skill level in 1982 was above the Group's average chronological age level by +1 year 4 months and although there was a slight decline in this average Group skill level in 1986 the decline was not significant (under one year variation - see Table 6). In 1986 the Visual Motor Control average level was at the Group's average chronological age level.

The highest score recorded for the Retested 1982 Low Performance Group on subtest skills in 1986 on Table 6 was for Visual Motor Control (+2 years 7 months). However, as can be seen by the lowest recorded score for this motor skill of -7 years 1 month, not all in this group possessed good Visual Motor Control skills. Table 7 shows that in 1986 16% still illustrated a skill deficit in Visual Motor Control of three or more years behind their chronological age level.

Are Things Really Any Worse in 1986 ?

Few previous longitudinal studies of students with significantly impaired motor skills (clumsy children) have been able to determine whether the degree of impairment assessed in later years has comparatively increased or diminished over the intervening years. This inability to make such a comparison is because in most research studies the same test has not been used at each time of testing and the tests used are not normed for the populations tested.

The figures in Table 6 clearly indicate a deterioration in all motor skill areas from 1982 to 1986, for example -2 years 5 months behind chronological age in 1982 for Balance and -6 years 8 months behind chronological age in Balance in 1986. These figures have however not fully taken into consideration the change in age over this time.

A calculation of the average deficit in each motor skill area as a percentage of the average chronological age for the Retested 1982 Low Performance Group in 1982 and 1986 provides comparative information in this study to evaluate the extent to which the Group's motor skills have developed or deteriorated between 1982 and 1986. These results are shown on Table 8.

Table 8 shows that in 1982 the Retested 1982 Low Performance Group demonstrated significant impairment in all four of the gross motor skill subtests. Balance, Bilateral Co-ordination, Strength, and Running Speed and Agility skills in 1982 show a percentage deficit of greater than minus 10% of the

group's average chronological age. Balance was the most impaired subtest skill in 1982 with a deficit of -24%. In contrast a +13% skill level above the average chronological age of the Group is recorded in 1982 for the Visual Motor Control subtest. Upper Limb Co-ordination, Response Speed, and Upper Limb Speed and Dexterity subtests were within 10% of the Group's average chronological age in 1982.

Table 8: Average Degree of Impairment Scores as a Percentage of Average Chronological Age for the Subtests Motor Skills of the Retested 1982 Low Performance Group in 1982/1986

	1982 Percentage	1986 Percentage	Change in Percentage
GROSS MOTOR SKILLS			
Balance	-24.0	-48.0	-24.0
Bilateral Co-ordination	-17.0	-16.0	+ 1.0
Strength	-16.5	-18.5	- 2.0
Running Speed And Agility	-11.0	-22.0	-11.0
Upper Limb Co-ordination	+ 2.5	-15.0	-17.5
FINE MOTOR SKILLS			
Response Speed	+ 5.0	-16.0	- 21.0
Visual Motor Control	+13.0	+ 5.0	- 8.0
Upper Limb Speed and Dexterity	- 10.0	-15.0	- 5.0

* minus (-) percentage = percentage below average chronological age
  plus (+) percentage = percentage above average chronological age

* **N.B.** Until national norms are known, these percentage differences cannot be translated into standard deviation units.

It can be seen from Table 8 that in 1986 all subtest motor skill areas except Visual Motor Control (+ 5%) are significantly impaired (i.e. more than minus 10% below average chronological age). These subtest motor skill impairment percentages of chronological age vary from a -15% impairment for Upper Limb Speed and Dexterity and Upper Limb Co-ordination, to a -48% impairment for Balance - that is a 33% variation.

The results on Table 8 show that the percentage change in the subtest skills of Balance, Running Speed and Agility, Upper Limb Co-ordination and Response Speed have in 1986 deteriorated by double or more than double the percentage of impairment recorded in 1982 (for example Balance : 1982 = - 24% compared to 1986 = - 48%). The Balance percentage from 1982 to 1986 was the greatest negative percentage change shown in the eight subtests - that is a - 24% change.

The Upper Limb Co-ordination and Response Speed percentage of chronological age subtest scores, as shown on Table 8, went from being slightly positive scores in 1982 to significantly negative percentage scores in 1986 (Upper Limb Co-ordination from +2.5% in 1982 to -15% in 1986; Response Speed from +5.0% in 1982 to -16% in 1986).

In summary four motor subtest skills - Bilateral Co-ordination, Strength, Visual Motor Control and Upper Limb Speed and Dexterity - did not decline significantly between 1982 and 1986, that is the decline was not greater than 10% of chronological age. However the change in degree of impairment was significant for the four other motor skill subtests - Balance, Running Speed and Agility, Upper Limb Co-ordination and Response Speed (greater than -10% change in percentage). By 1986 seven of the eight motor skill subtest scores were greater than -10% of the group's chronological age. The -48% impairment recorded for Balance in 1986 identifies that this subtest skill is the most impaired of the eight motor skill subtest areas. This degree of impairment means that on average students in this group are functioning at approximately

half their age level in Balance skills. The percentage degree of impairment in the Balance motor subtest skill was some 20% worse than any other subtest motor skill in 1986. This significant deficit may be having a 'carryover' effect on other motor skill areas

Comparison Between the 'Significant Improvers' and the 'Non-improvers'

Ten students in the Retested 1982 Low Performance Group had by 1986 made considerable improvement in their motor skills to no longer be classified in the Low Performance Group. The improvements these student made has to this point been identified and discussed in conjunction with others in the Retested 1982 Low Performance Group. It is worthwhile now to focus more closely on identifying the motor skill areas in which the 'significant improvers' have made substantial gains and where in contrast little or no gains have been made by the 'non-improvers'.

Table 9 compares the average degree of impairment in the subtest motor skills for the 'significant improvers' and the 'non-improvers'. Table 10 identifies the degree of impairment as a percentage of average age in the motor skill subtests for these two groups. The information contained on these tables will be discussed together.

Table 9 shows that both the 'significant improvers' and the 'non-improvers' made little or no improvement in their Balance skills between 1982 and 1986. The 'non-improvers' demonstrated a -2 years 5 months average deficit in 1982 and four years later were functioning at -7 years 2 months which shows a deterioration of over four years. The 'significant improvers' managed to make only small gains on their 1982 balance skill levels by 1986 (slightly less than a four year change in deficit from 1982 to 1986). Table 10 shows that the non-improvers were operating at half their age level (- 51%) for Balance in 1986 while the 'significant improvers' were operating at a slightly better level (at - 40% of their age).

Table 9 : The Range and Average Degree of Impairment of Subtest Motor Skills for the Retested 1982 Low Performance Group 'Significant Improvers' and 'Non-Improvers'

	1982 Retested Low Performance Group (37 Students)	**1986 Non Improvers (10 Students)**	**1986 Significant Improvers (27 Students)**
GROSS MOTOR SKILLS			
BALANCE			
Average	- 2 years 5 months	- 7 years 2 months	- 5 years 7 months
Lowest	- 6 years 1 month	- 10 years 2 months	- 9 years 3 months
Highest	+ 6 years 2 months	- 3 years 8 months	- 3 years 6 months
BILATERAL CO-ORDINATION			
Average	- 1 year 8 months	- 2 years 11 months	- 5 months
Lowest	- 5 years 1 month	- 7 years 5 months	- 4 years 9 months
Highest	+ 4 years 3 months	+ 2 years 5 months	+ 1 year 10 months
STRENGTH			
Average	- 1 year 8 months	- 3 years 6 months	- 8 months
Lowest	- 5 years 10 months	- 8 years 3 months	- 4 years 5 months
Highest	+ 2 years 6 months	+ 1 year 3 months	+ 2 years 2 months
RUNNING SPEED AND AGILITY			
Average	- 1 year 3 months	- 4 years 2 months	- 2 months
Lowest	- 4 years 7 months	- 8 years 9 months	- 3 years 3 months
Highest	+4 years 5 months	+ 8 months	+1 year 10 months

Table 9 Continued

	1982 Retested Low Performance Group (37 Students)	1986 Non Improvers (10 Students)	1986 Significant Improvers (27 Students)
UPPER LIMB CO-ORDINATION			
Average	+ 3 months	- 2 years 3 months	- 1 year 1 month
Lowest	- 5 years 10 months	- 6 years 10 months	- 4 years 3 months
Highest	+5 years 10 months	+ 11 months	+ 1 year 8 months
FINE MOTOR SKILLS			
RESPONSE SPEED			
Average	+ 6 months	- 2 years 5 months	- 1 year 9 months
Lowest	- 5 years 4 months	- 7 years 9 months	- 5 years 3 months
Highest	+ 6 years 1 month	+2 years 7 month	+ 2 years 1 month
VISUAL MOTOR CONTROL			
Average	+ 1 years 4 months	+ 3 months	+ 1 year 7 months
Lowest	- 4 years 10 months	- 7 years 1 months	- 9 months
Highest	+ 6 years 2 months	+ 2 years 7 months	+ 2 years 2 months
UPPER LIMB SPEED AND DEXTERITY			
Average	- 1 year 0 months	- 2 years 8 months	- 7 months
Lowest	- 4 years 7 months	-7 years 5 months	- 3 years 3 months
Highest	+ 1 year 4 months	+2 years 5 months	+1 year 10 months

It can be seen from Table 9 that in 1982 the Retested 1982 Low Performance Group was on average a year or more behind in all gross motor skills (between -11% and -24% of their age - Table 10). The 'significant improvers' showed a distinctive improvement in Bilateral Co-ordination, Strength and Running Speed and Agility to be at their age level in these motor skills by 1986 (a +10% to +14% improvement shown on Table 10). In contrast the 'non-improvers' showed a further deterioration in all these gross motor skills by 1986. The percentage decline for these motor skills (as shown on Table 10) was most significant for Running Speed and Agility (i.e. a -19% change in percentage of chronological age).

Both the 'significant improvers' and the 'non-improvers' showed a marked deterioration on their Upper Limb Co-ordination motor skills - as seen by the greater than one year deficit on Table 9. However only the 'non improvers' have a greater than 10% of chronological age deficit in 1986 on Table 10.

All fine motor skills were at or above the Retested 1982 Low Performance Group age level in 1982. Visual Motor skills continued to be at or above both the 'significant improvers' and the 'non-improvers' average age level in 1986 whereas the Response Speed skills of both groups showed a significant decline (i.e. over -1 year in age equivalent scores, and a - 17% drop in age percentage for the 'non-improvers' with a - 12% drop in age percentage for the 'significant improvers'). The Upper Limb Speed and Dexterity motor skills for the Retested 1982 Low Performance Group were slightly below the average age level in 1982. The 'significant improvers' continued to maintain these motor skills at their average age level whereas the non-improvers record a significant decline in these motor skills (- 19% of average age in 1986).

In summary the 'significant improvers' on average made improvements in three of the four gross motor skill subtests and maintained their motor skill levels in all fine motor skill subtests between 1982 and 1986. In contrast the 'non-improvers' gross motor skill levels had by 1986 all declined to levels in excess of 20% behind their average age and they were only able to maintain age level competence in the visual motor subtest (refer to Table 10).

Table 10 : Degree of Impairment Scores as a Percentage of Average Age for the Subtest Motor Skills of the Retested 1982 Low Performance Group 'Significant Improvers' and 'Non-Improvers'

	1982 Retested Low Performance Group (37 Students) % of C.A.	1986 Non Improvers (27 Students) % of C.A.	Change in %	1986 Significant Improvers (10 Students) % of C.A.	Change in %
GROSS MOTOR SKILLS					
Balance	- 24.0	- 51.0	- 27.0	- 40.0	-16.0
Bilateral Co-ordination	- 17.0	- 21.0	- 4.0	- 3.0	+14.0
Strength	- 17.0	- 25.0	- 8.0	- 5.0	+12.0
Running Speed and Agility	- 11.0	- 30.0	- 19.0	- 1.0	+10.0
Upper Limb Co-ordination	+ 3.0	- 16.0	- 19.0	- 8.0	- 11.0
FINE MOTOR SKILLS					
Response Speed	+ 5.0	- 17.0	-22.0	- 12.0	- 17.0
Visual Motor Control	+13.0	+ 2.0	-11.0	+11.0	- 2.0
Upper Limb Speed and Dexterity	-10.0	- 19.0	- 9.0	- 4.0	- 6.0

% of C.A. = percentage of chronological age

* **N.B.** Until national norms are known, these percentage differences cannot be translated into standard deviation units.

RETESTED 1982 STANINE 1 GROUP

Abstract : Retested Stanine 1 Group was made up of those students retested from the most motor skill impaired group identified in 1982 South Auckland Perceptual Motor Dysfunction Survey. No students in this group improved sufficiently to no longer be classified in the Low Performance Group in 1986. However two of the eight students in this group made a two stanine improvement and one student made a one stanine improvement in their lowest Motor Composite score between 1982 and 1986. Five students made no improvement and continued to be at the Stanine 1 level in 1986. Three students had both their Gross and Fine Motor Composite scores at the Stanine 1 level in 1982 and continued to have these characteristics in 1986. Six students had Gross Motor Composite scores at the Stanine 1 level in 1982 and four still had Gross Motor Composite scores at this level in 1986.

Balance was the most impaired motor skill subtest with no improvement shown between 1982 and 1986. All eight students were by 1986 three or more years behind their age level in Balance with six of the eight students exhibiting Balance skills five or more years behind their age. Bilateral Co-ordination skills were also significantly impaired - all students were three or more years behind their age level in this skill, six had impairment over five years behind their age. The 1986 percentage of age figures confirm that the students in the Retested Stanine 1 Group have considerable deficits in all motor skill areas.

Students in the Stanine 1 Group were the most motor skill impaired group identified in the 1982 South Auckland Perceptual Motor Dysfunction Survey (SAPMDS). In light of the previous research findings of an eight year follow-up study on motor skill impairment by Knuckey and Gubbay (1983), which reported that only the most severely impaired group of students made no significant motor skill improvement over that time, it was considered that a close examination of this particular group's motor skill development may highlight important aspects in determining motor skill competence. This section closely examines the motor skill features, particularly the improvements made, of those retested in 1986 from the 1982 SAPMDS Stanine 1 Group.

In the 1982 South Auckland Perceptual Motor Dysfunction Survey fourteen students - eight girls and six boys - scored at the Stanine 1 level. These fourteen students made up 4.5% of the sample population and constituted almost a quarter of the 1982 Low Performance Group (the 1982 Low

Performance Group was 18.5% of the sample population). The Stanine 1 classification meant that these students had either Gross Motor Composite, Fine Motor Composite or Battery Composite Motor scores; or both Gross and Fine Motor Composite scores, at the Stanine 1 level - the lowest test level possible. Students in this group were therefore the most motor skill impaired group identified in the 1982 SAPMDS.

In 1986 only eight of the original fourteen 1982 South Auckland Perceptual Motor Dysfunction Survey Stanine 1 students were able to be retested. These eight students are designated the Retested 1982 Stanine 1 Group in this study.

The Retested 1982 Stanine 1 Group was made up of four boys and four girls. Three students retested in this group were, in 1982, placed in special classes within the schools they attended but were integrated part-time into the normal classes that were chosen for testing in 1982 and so were included in the SAPMD survey. In 1986 two of these three special class students retested - one boy and one girl - were still attending intermediate school whereas their peers were now attending secondary school.

Stanine Level Improvement

Table 4 (page 71) shows that none of the eight students retested in 1986 from the 1982 South Auckland Perceptual Motor Dysfunction Survey Stanine 1 level had improved their motor skills to the extent that they were no longer classified in the Low Performance Group. In 1986 five students continued to be at the Stanine 1 level, two students had progressed to the Stanine 2 level and one student had improved to the Stanine 3 level.

Gross and Fine Motor Skill Characteristics

Table 11 shows that five of the eight students in the Retested 1982 Stanine 1 Group exhibited both low Gross and low Fine Motor Composite scores in 1982

(i.e. Motor Composite scores at Stanine 3 or below) each with at least one of these composite scores at the Stanine 1 level. Four of these five students still exhibited low gross and low fine motor composite scores in 1986, three with their lowest composite score at the Stanine 1 level and one at the Stanine 2 level. The other student improved his Gross Motor Composite score by two stanine levels in 1986 (i.e. from Stanine 2 to Stanine 4) but still remained in the Low Performance Group because of his low ability level in fine motor skills. Thus all five students with both low gross and fine motor composite scores in the Retested 1982 Stanine 1 Group were still in the Low Performance Group in 1986.

Three of the five students who had both low gross and low fine motor composite scores in 1982 had scores at the Stanine 1 level in each of these motor skill areas (see Table 11). These three students again scored at the Stanine 1 level for gross and fine motor composite scores in 1986 which indicates that no significant progress had been made in their motor skill development over the intervening four years between testing. Two of these students were special class pupils.

The above results contrast somewhat with Baker's (1981) results. She found that all 'clumsy' students referred for treatment at the Northwick Hospital in Middlesex England - that is the most 'clumsy' students - had both fine and gross motor skill problems. In this study only five of the eight students in the most impaired group - that is the Retested 1982 Stanine 1 Group - had both low gross and low fine motor skills in 1982 and only four students exhibited these characteristics in 1986.

Table 11 identifies that seven students (out of the eight) in the Retested 1982 Stanine 1 Group exhibited low gross motor composite scores (i.e. scores at the Stanine 3 level and below). Six of these students had gross motor composite scores at the Stanine 1 level and one student had a gross motor composite score at the Stanine 2 level in 1982. Two of these students made significant progress to improve their gross motor composite scores by two stanine levels by 1986, but overall six of these students still had low gross

motor composite scores at the time of retesting - four with gross motor composite scores at Stanine 1, one at Stanine 2 and one at Stanine 3. A closer look at the specific gross motor skills is undertaken later in this chapter.

Table 11 : Gross and Fine Motor Skill Characteristics of Retested 1982 Stanine 1 Group

	←1982→			←1986→		
	Total	**Male**	**Female**	**Total**	**Male**	**Female**
Stanine 1 gross/ stanine 1 fine	3	1	2	3	1	2
Stanine 1 gross/ low score fine	1	-	1	-	-	-
Stanine 1 gross/ high score fine	2	1	1	1	-	1
Stanine 1 fine/ low score gross	-	-	-	-	-	-
Stanine 1 fine/ high score gross	1	1	-	-	-	-
Stanine 1 battery only/ low score gross and fine	1	1	-	1	1	-
Low score gross/ low score fine	-	-	-	1	-	1
High score gross/ low score fine	-	-	-	1	1	-
High score fine/ low score gross	-	-	-	1	1	-
Total	8	4	4	8	4	4
Total low score gross	7	3	4	7	3	4
Total low score fine	6	3	3	6	3	3
Total low score gross and fine	5	2	3	4	1	3

High score = Stanine 4 or higher Low score = Stanine 2 or 3

Two students in this 1982 group (one boy and one girl) had gross motor composite scores at the Stanine 1 level and high fine motor composite scores (one at Stanine 4 and one at Stanine 5 - see Table 11). By 1986 the boy (with a fine motor composite score at Stanine 5) had improved his gross motor composite score two stanine levels to Stanine 3 but showed a decline of one stanine in his fine motor composite score. The girl in contrast showed no improvement in either fine or gross motor composite scores in 1986. Thus both these students continued to be in the Low Performance Group in 1986, the girl still at the Stanine 1 level and the boy now at the Stanine 3 level.

Only one student in the Retested 1982 Stanine 1 Group - a boy - had a fine motor composite score at the Stanine 1 level and a gross motor composite score at a high level (Stanine 6). This student's skill abilities changed markedly between the four years of testing. In 1986 he showed a two stanine improvement in his fine motor composite score from 1982 (i.e. from Stanine 1 to Stanine 3) but showed a four stanine decline in his gross motor motor score over the same period (i.e. from Stanine 6 to Stanine 2). This student thus remained in the Low Performance Group category in 1986 but graduated from the Stanine 1 level to the Stanine 2 level.

Motor Skill Subtest Characteristics

Table 12 shows the average degree of impairment and the range of scores recorded in each of the eight subtests (as identified in the Bruininks-Oseretsky Test of Motor Proficiency) for those in this the Retested 1982 Stanine 1 Group.

An average degree of impairment of -1 year 8 months or greater was recorded for all subtests in 1982. Seven of the eight subtests showed an average degree of impairment of two years or more behind the Group's average chronological age (see Table 12). The greatest average degree of impairment in 1982 is recorded for Bilateral Co-ordination (-4 years) and a -3 years 3 months impairment is recorded for Balance (refer to Table 12).

In Table 12 it can be seen that the range of scores in each of the subtests in 1982 vary considerably. At one extreme in 1982 a 12 year variation between individual subtest scores is recorded for the Group in Balance (-6 years 1 month to +6 years 1 month) while a three to five year variation between the highest and lowest scores for each subtest is most common.

Two motor skill subtest areas, Bilateral Co-ordination and Upper Limb Co-ordination, show their highest scores in 1982 as being negative scores i.e. deficits of over two years (see Table 12). Table 13 shows that all the students in the Retested 1982 Stanine 1 group were over two years behind in both these motor skill areas (Bilateral Co-ordination and Upper Limb Co-ordination) in 1982. Seven out of eight students (88%) were in fact over three years behind their chronological age in Bilateral Co-ordination and six students (75%) were three or more years behind their chronological age in Upper Limb Co-ordination in 1982 (see Table 13).

In 1982 a problem of some magnitude in the area of gross motor skills is clearly indicated from the above discussion and from the negative average, and the highest and lowest scores recorded on Table 12 for that year. This problem is further highlighted in Table 13 which shows that in 1982 six out of eight students (75%) in the Retested Stanine 1 Group were two years or more behind their age in all gross motor skill subtests i.e. Balance, Bilateral Co-ordination, Strength, Running Speed and Agility. A scrutiny of each child's 1982 individual scores shows that only one student in the Retested Stanine 1 Group recorded positive scores in any of the gross motor skill subtests (positive scores for Balance and Running Speed and Agility).

The average age of the Retested 1982 Stanine 1 Group in 1982 was 10 years 2 months. A -4 year 7 month to -6 year 1 month range in the "lowest" scores is apparent in the motor skill subtests in 1982 which means that some students in this group were at that time coping with motor skills functional at the four to six year old level. Indeed a close look at each individual child's subtest motor

scores shows that seven of the eight students in this group had at least one motor skill subtest score four years or more behind their age and were thus functioning at a six year old level or lower in one particular motor skill area when aged ten years old (the other student had five of the eight motor skill areas functioning at least two years behind his chronological age level). Five of these eight students (63%) had four or more motor skill areas functioning at a level over three years behind their chronological age in 1982.

Table 12 shows that in 1986 all average motor skill subtest scores for the Retested 1982 Stanine 1 Group were at least -2 years 8 months behind the average chronological age for the Group. Six of the eight subtest motor skill average scores were over four years behind the group's chronological age (See Table 12). Only the average motor skill subtest scores of Visual Motor Control and Upper Limb Co-ordination were less than four years behind the Group's average chronological age.

Between 1982 and 1986 the average motor skill subtest scores deteriorated some two years in six of the eight subtests (i.e. Balance, Bilateral Co-ordination, Strength, Running Speed and Agility, Upper Limb Speed and Dexterity and Response Speed). The average scores in the other two motor skill subtest areas - Upper Limb Co-ordination and Visual Motor Control- while still negative, remained at approximately the same level as recorded in 1982 (Refer to Table 12).

In 1982 a 12 year range between the lowest and the highest subtest scores was evident for Balance. In 1986 the largest range in subtest scores was 8 years 5 months and was shown in the Running Speed and Agility subtest (i.e. -8 years 9 months to + 4 months - see Table 12). A five to eight year variation between the 'highest' and 'lowest' scores for each subtest was most common in 1986 (compared to three to five years in 1982).

Table 12: Range and Average Degree of Impairment of Subtest Motor Skills for the Retested 1982 Stanine 1 Group in 1982 and 1986.

	1982	1986
GROSS MOTOR SKILLS		
BALANCE		
Average	- 3 years 3 months	- 8 years 5 months
Lowest	- 6 years 1 month	- 10 years 2 months
Highest	+ 6 years 1 month	- 4 years 5 months
BILATERAL CO-ORDINATION		
Average	- 4 years 0 months	- 6 years 0 months
Lowest	- 5 years 1 month	- 7 years 5 months
Highest	- 2 years 4 months	- 3 years 9 months
STRENGTH		
Average	- 2 years 11 months	- 4 years 2 months
Lowest	- 5 years 10 months	- 8 years 3 months
Highest	- 1 month	+ 10 months
RUNNING SPEED AND AGILITY		
Average	- 2 years 3 months	- 4 years 8 months
Lowest	- 4 years 7 months	- 8 years 9 months
Highest	+ 4 years 5 months	+ 4 months
UPPER LIMB CO-ORDINATION		
Average	- 3 years 10 months	- 3 years 8 months
Lowest	- 5 years 10 months	- 6 years 10 months
Highest	- 2 years 1 month	+ 3 months

Table 12 : Continued

	1982	1986
FINE MOTOR SKILLS		
RESPONSE SPEED		
Average	- 1 year 8 months	- 5 years 2 months
Lowest	- 5 years 4 months	- 7 years 8 months
Highest	+ 1 year 5 months	- 2 years 6 months
VISUAL MOTOR CONTROL		
Average	- 2 years 0 months	- 2 years 8 months
Lowest	- 4 years 10 months	- 7 years 1 month
Highest	+ 1 year 9 months	+ 1 year 9 months
UPPER LIMB SPEED AND DEXTERITY		
Average	- 2 years 8 months	- 4 years 10 months
Lowest	- 4 years 7 months	- 7 years 5 months
Highest	+ 4 months	- 2 years 6 months

In 1986 four of the eight 'highest' motor skill subtest scores are negative scores. The most negative 'highest' subtest score of -4 years and 5 months was recorded for Balance and a ten year difference between the 'highest' score recorded for this subtest in 1982 and that recorded in 1986 is evident. The Bilateral Co-ordination 'highest' subtest score in 1986, as in 1982, was also negative (-3 years 9 months). These figures further highlight the magnitude of the skill problems being experienced by the students in this group in these two motor skill areas (see Table 12).

The greatest subtest average degree of impairment in 1986 is recorded for Balance (- 8 years 5 months, see Table 12). Table 13 shows that all eight students in this group were three or more years behind their chronological age for Balance, with six out of eight students being over five years behind their

chronological age on this motor skill. The fact that all students in this group have significant problems with their balance skills concurs with Baker's (1981) findings.

The biggest change in average subtest scores from 1982 to 1986 is also evident for the Balance motor skill subtest with a deficit of 5 years 2 months shown in the intervening four years between testing. This significant decline suggests that no improvement in balance skills has taken place by those in this group between 1982 and 1986. A view of each individual's data however shows that four students in the Group made some progress in balance during the four years. Three students showed eighteen months progress and one student made two years progress in four years. One student made four years progress in the intervening four years in balance (even though she was over three years behind in her balance skills in 1982) which can perhaps be attributed to her regular involvement in a gymnastics club over this time. Two students made no improvement in balance over the four years between testing - they in fact deteriorated another four years in their balance skills (over and above the intervening four years) from where they were in 1982. One student recorded a staggering decline in his balance skills from 1982 to 1986 (a deficit of some 10 years) and no explanation for this deficit can be explained from the information gained during testing.

An average degree of motor skill impairment in Bilateral Co-ordination for this Group in 1986 of - 6 years is significant though it is no longer on average the most impaired motor skill (see Table 12). All eight students in this Group in 1986 have Bilateral Co-ordination motor skill levels three years or more behind their chronological age while six of these students demonstrate an impairment of five years or greater in this motor skill area (see Table 13). An examination of individual scores for the Bilateral Co-ordination motor skill subtest shows that four students made eighteen months progress in this skill area over the four years between testing, two students made three years progress over the four year period, and one student made no progress in that time - hence all these students show a further deterioration of their bilateral motor skills

between 1982 and 1986. One student (who was four years behind his chronological age in Bilateral Co-ordination motor skills in 1982) made a four year improvement in four years.

Cornish's (1980) research work showed that 'clumsy' students had below average strength. These study results show that in 1982 seven of the eight students in the Retested 1982 Stanine 1 Group were two or more years behind their chronological age level in this skill (see Table 13). In 1986 six of the eight students in this Group had Strength motor skills one year or more behind their chronological age level.

TABLE 13 : Degree of Impairment of Subtest Motor Skills for the Retested 1982 Stanine 1 Group in 1982 and 1986

	← 1982 →		← 1986 →	
	-2 years	**-3 years**	**-3 years**	**-5 years**
GROSS MOTOR SKILLS				
Balance	6 (75)	6 (75)	8 (100)	6 (75)
Bilateral Co-ordination	8 (100)	7 (88)	8 (100)	6 (75)
Strength	7 (88)	3 (38)	5 (63)	5 (63)
Running Speed and Agility	6 (75)	4 (50)	5 (63)	5 (63)
Upper Limb Co-ordination	8 (100)	6 (75)	6 (75)	3 (38)
FINE MOTOR SKILLS				
Response Speed	5 (63)	4 (50)	7 (88)	4 (50)
Visual Motor Control	5 (63)	3 (38)	4 (50)	3 (38)
Upper Limb Speed and Dexterity	6 (75)	3 (38)	7 (88)	4 (50)

( ) - percentage scores rounded to the nearest one percent.

A -3 year 6 month decline can be identified in the average degree of impairment score for the fine motor skill Response Speed subtest from 1982 to 1986 for this group. This suggests that on average little or no improvement in this motor skill area has taken place over the intervening four years and this suggestion is further reinforce by the fact that in 1986 seven out of the eight students in this group demonstrated Response Speed motor skills three or more years behind their chronological age. A scrutiny of individual scores however shows that five students made some improvement in the four years between testing while three students showed a considerable decline in this motor skill area in 1986 compared to their score in 1982. Of the five students who showed improvement three made four years progress in the four years, one made three years progress and the other made 16 months progress in that time. Two students demonstrated a four year regression in 1986 from their 1982 score in this motor skill area while one student showed a 21 month regression in that time.

Only two positive visual motor subtest scores were recorded in 1986 by the Retested 1982 Stanine 1 Group. Each of these students (one boy and one girl) had clearly established arm and leg dominance in 1982 and this dominance was unchanged in 1986. Their eye dominance in 1986 was found to be consistent with their arm and leg dominance (i.e. left eye, left arm, left leg dominant, or right eye, right arm, right leg dominant). One other student (a boy) had established arm and leg dominance in 1982 which was maintained in 1986. His eye dominance in 1986 was opposite to that of his arm and leg dominance (i.e. eye left, arm right, leg right dominant). This dominance pattern varies to those of the other two. He displayed three years improvement in the visual motor subtest over the four years but in 1986 remained some four years behind his chronological age in this skill. This student displayed considerable regression in balance and bilateral motor skills over the four year period and problems in these motor skill areas may have prevented the advancement of visual motor skills further.

Five of the eight students in the Retested 1982 Stanine 1 Group displayed variances in either or both their arm and leg dominance between 1982 and 1986. Two girls changed their writing hand - from being left handed to becoming right handed - between 1982 and 1986. One of the girls had displayed mixed hand usage when using balls in 1982 i.e. catching with her left hand but throwing with her right hand. In 1986 she demonstrated a right hand dominance in writing, when using balls, and in manipulating pegs, but alternated hands when threading beads. The other student wrote with her left hand but could use both hands with similar ability, and was left foot dominant but could and did use both legs for balance and kicking in 1982. She had developed a right hand dominance for writing but still displayed mixed foot dominance in 1986.

Are Things Any Worse In 1986?

The information provided on Table 12 and Table 13 shows that the motor subtest skills of this group have deteriorated between 1982 and 1986. These calculations have however not fully taken into consideration the four years between testing. The average degree of impairment calculated as a percentage of the group's average age at the time of testing on Table 14 provides comparative information to evaluate the extent to which this Group's motor skills have deteriorated. These calculations further demonstrate the degree of the problem students in this group are experiencing in the development of their motor skills.

Table 14 shows the percentage of impairment relative to the age of the group increases negatively between 1982 and 1986 in five of the eight subtests - Balance, Bilateral Co-ordination, Running Speed and Dexterity, Response Speed, and Upper Limb Speed and Dexterity. A decline of more than 10% is recorded for Balance, Running Speed and Agility and Response Speed between 1982 and 1986 with Balance and Response Speed showing a decline in 1986 which is double that recorded in 1982.

Table 14 : Degree of Impairment as a Percentage of Average Chronological Age for Subtest Motor Skills of the 1982 Stanine 1 Group in 1982 and 1986

	1982 Percentage	1986 Percentage	Change in Percentage
GROSS MOTOR SKILLS			
Balance	-31.0	-60.0	-29.0
Bilateral Co-ordination	-39.0	-42.0	- 3.0
Strength	-29.0	-29.0	- 0.0
Running Speed and Agility	-22.0	-33.0	-11.0
Upper Limb Co-ordination	-37.0	-26.0	+11.0
FINE MOTOR SKILLS			
Response Speed	-16.0	-37.0	-21.0
Visual Motor Control	-20.0	-19.0	+ 1.0
Upper Limb Speed and Dexterity	-26.0	-34.0	- 8.0

* minus (-) percentage = percentage below average chronological age
plus (+) percentage = percentage above average chronological age

* **N.B.** Until national norms are known, these percentage differences cannot be translated into standard deviation units.

It can be seen from Table 14 that Strength and Visual Motor Control skills were kept at the same percentage of age in 1982 and 1986. Some progress was made in these motor skills over this period to achieve this result. Upper Limb Co-ordination shows an 11% gain in percentage of age between 1982 and 1986 hence this skill is the most improved for this group over this period of time.

The 1986 percentage of age figures on Table 14 show that the students in the Retested Stanine 1 group have considerable deficits in all motor skill areas. All gross motor skills and two of the fine motor skill subtest areas are functioning at two-thirds the age of this group. Balance skills are at half this group's age level, a factor which may be having an effect on other motor skills.

Numbers Found for Retesting

The fact that only eight of the original 14 students at the Retested Stanine 1 level in 1982 were able to be retested in 1986 is possibly an indicator of circumstances which significantly affect a student's acquisition of motor skills while young. Of the six students not retested (i.e. 43% of the original group) three were known to have left the area and one was not able to be traced. One student was absent both times when testing was scheduled and the other student was in Social Welfare custody.

The mobility of the test population has been mentioned earlier and was at the 25% level overall. Twenty-nine percent (29%) of the Retested Stanine 1 Group in 1982 were not available for retesting in 1986 because they had left the area which is four percent higher than the average. Unfortunately no information was gathered during testing in 1982 to enable comment as to how changes in living locations and situations affected motor skill development at that time. It is quite possible that a number of those who scored low in 1982 had recently moved into the Hamilton area. A negative effect of this mobility on motor skill acquisition seems likely, and needs further investigation.

The effect of absenteeism on the acquisition of skills has also been touched on elsewhere. Absenteeism may well pre-empt the lack of initial motor skill learning at the primary level and also result in fewer opportunities to practise motor skills. This must in turn affect the level of motor skill competence achieved.

Unfortunately no follow-up enquiry was made concerning the student in this group who was in Social Welfare care to ascertain whether her motor skill ability level had played, or was playing a part in the problems she currently faced. One other student at the Stanine 2 level in 1982 was also in Social Welfare care in 1986. It is possible that the lack of motor skill competence was a contributing factor to the problems these girls were experiencing. The case study discussed in the Review of Literature by Henderson, Knight et.al. (1991) of an intelligent five year old student is worth noting in this regard. Henderson, Knight et al.(1991) relate how a girl became increasingly frustrated and angry about her inability to master basic motor skills and in not receiving any help to improve these skills as she grew up. Henderson, Knight et al.'s (1991) report shows that she had few friends and had become a very unhappy teenager.

RETESTED 1982 STANINE 4 GROUP

Abstract: All students in Retested 1982 Stanine 4 Group had motor skills just above the level of significant impairment in the 1982 South Auckland Perceptual Motor Dysfunction Survey. Six students (35% of the group) regressed into the Low Performance Group in 1986. Four students remained at the Stanine 4 level and seven students improved significantly to be at the Stanine 5 or Stanine 6 level in 1986. All students who regressed showed a deterioration in their gross motor skills. Balance subtest skills declined significantly for both groups but to a greater extent for the 'Stanine 4 Regressors'. Biggest difference between 'Stanine 4 Plus' Group and 'Stanine 4 Regressors' was in Strength, and Running Speed and Agility subtests.

The Stanine 4 Group at the primary school level in the South Auckland Perceptual Motor Dysfunction Survey (SAPMDS) was made up of 37 students which was 11% of the original Hamilton primary school sample population (Donaldson and Maurice 1983). Students at the Stanine 4 level had their lowest Motor Composite Score just above the level of significant impairment. Table 1 (page 60) shows that 23 of these 37 Stanine 4 students were selected for retesting as part of this 1986 study - that is 62% of the original Stanine 4 group. Eighteen of the 23 students selected were located in the Hamilton area while five students had left the area. One of the 18 students found for retesting was absent from school on the two occasions when visits were made to that school for testing. Therefore 17 students in the Stanine 4 Group were retested in 1986 which was 74% of those selected for testing and 46% of the original Stanine 4 Group from the SAPMDS. These students will be referred to in this study as the Retested 1982 Stanine 4 Group.

The Retested 1982 Stanine 4 Group of 17 students was made up of eight females (8) and nine males (9). Students were categorised in the Stanine 4 Group in 1982 because they scored at the Stanine 4 level in their lowest Motor Composite score (Gross Motor Composite, Fine Motor Composite or Battery Composite scores).

Stanine Level Improvement/Deterioration

Table 15 shows that six students (35% of the Retested 1982 Stanine 4 Group) had regressed in their lowest Motor Composite score to be at the Stanine 3 level in 1986 - three were females and three were males. These six students were classified in the Low Performance Group in 1986 because their lowest Motor Composite score was now at the Stanine 3 level.

It can be seen from table 15 that four students (24% of the Retested 1982 Stanine 4 Group) continued to be at the Stanine 4 level in 1986 - three of these students were females and one a male. Seven students (41% of the Retested 1982 Stanine 4 Group) had improved significantly to be either at the Stanine 5 or Stanine 6 level in 1986 - five of these students were males and two were females.

Table 15 : Retested 1982 Stanine 4 Group Distribution by Lowest Motor Composite Stanine Scores and by Sex in 1982 and 1986

	← 1982 →			← 1986 →		
Stanine Level	**Total**	**Males**	**Females**	**Total**	**Males**	**Females**
Stanine One	-	-	-	-	-	-
Stanine Two	-	-	-	-	-	-
Stanine Three	-	-	-	6	3	3
Stanine Four	17	9	8	4	1	3
Stanine Five	-	-	-	5	4	1
Stanine Six	-	-	-	2	1	1
Total	17	9	8	17	9	8

Gross and Fine Motor Skill Characteristics

Table 16 shows that all six students from the Retested Stanine 4 Group who regressed into the Low Performance Group by 1986 had Stanine 4 Gross and high Fine Motor Composite scores (Stanine 5 plus) in 1982. In contrast four students with these same motor skill characteristics in 1982 improved by 1986 to have high Gross and high Fine Motor Composite scores.

The six students to regress into the Low Performance Group in 1986 did so because of a regression of their Gross Motor Composite scores - from Stanine 4 to Stanine 3. Two of these students in 1986 had their Fine Motor Composite scores at the Stanine 4 level while, in contrast, the other four students demonstrated high Fine Motor Composite scores (i.e. at the Stanine 5, Stanine 6, or Stanine 7 level).

It can be seen from Table 16 that only three of the 17 students in the Retested 1982 Stanine 4 Group maintained the same motor skill characteristics in 1986 as they displayed in 1982 - that is Stanine 4 Gross and high Fine Motor Composite scores in 1982 and 1986.

Table 16 : Changes in Motor Skill Characteristics of Retested Stanine 4 Group

	1982			1986															
				* Low Gross/ St 4 Fine			* Low Gross/ High Fine			St 4 Gross/ High Fine			St 4 Fine/ High Gross			High Gross/ High Fine		
Characteristics	Total	Males	Females	Total	Males	Females	Total	Males	Females	Total	Males	Females	Total	Males	Females	Total	Males	Females
Stanine 4 Gross/ High Fine	14	8	6	2	2	-	4	1	3	3	1	2	1	-	-	4	4	-
Stanine 4 Fine/ High Gross	2	1	1	-	-	-	-	-	-	-	-	-	-	-	-	2	1	1
Stanine 4 Battery	1	-	1	-	-	-	-	-	-	-	-	-	-	-	-	1	-	1
Totals	17	9	8	2	2	-	4	1	3	3	1	2	1	-	1	7	5	2

*In Low Performance Group 1986

Comparison Between the 'Stanine 4 Plus' Group and the 'Stanine 4 Regressors'

This research study's principal focus has been on those students who have significantly impaired motor skills. Six students in the Retested 1982 Stanine 4 Group who had motor skills just above the level of significant impairment in 1982, had by 1986 shown a regression in their gross motor skills to now be classified in the Low Performance Group. It is worthwhile comparing the motor skill subtest scores of these six students (i.e. those from the Retested 1982 Stanine Four Group group who had shown a regression in their 1982 motor skill levels) with the 11 students from the Retested Stanine 4 Group who had either maintained their lowest Motor Composite score at the Stanine 4 level (four students) or who had improved their lowest Motor Composite score to the Stanine 5 and Stanine 6 levels (seven students). This comparison will highlight more clearly where the improvements and regressions have occurred in particular motor skill subtests.

It can be seen from Table 17 that the 'Stanine 4 Regressors' showed a significant deterioration in three of the four gross motor skill subtests - Balance, Strength, and Running Speed and Agility between 1982 and 1986 (i.e. more than a one year deficit). By 1986 this group on average was operating at least two years below their age level in each of these three motor skill areas. No improvement was made by these six students in Balance skills over the four years (evident by a greater than four year negative difference between 1982 and 1986 average Balance scores).

Table 18 reinforces the extent of the Balance deficit by showing that on average the 'Stanine 4 Regressors' have Balance motor skills at approximately half their age level (-48%) in 1986. Table 18 also shows that by 1986 the 'Stanine 4 Regressors' had significant deficits in Balance, Strength, and Running Speed and Agility - that is deficits greater than 10% of their age.

Table 17 : The Range and Average Degree of Impairment of Subtest Motor Skills for Retested 1982 Stanine 4 Group, 'Stanine 4 Plus' Group and 'Stanine 4 Regressors'

	1982 Retested Stanine 4 Group (17 Students)	1986 Stanine 4 Plus Group (11 Students)	1986 Stanine 4 Regressors (6 Students)
GROSS MOTOR SKILLS			
BALANCE			
Average	- 1 year 6 months	- 4 years 5 months	- 6 years 8 months
Lowest	- 4 years 8 months	- 6 years 8 months	- 8 years 1 month
Highest	+ 2 years 2 months	+ 3 months	- 4 years 10 months
BILATERAL CO-ORDINATION			
Average	+ 2 months	+ 1 year 1 month	- 5 months
Lowest	- 2 years 6 months	- 4 years 6 months	- 4 years 9 months
Highest	+ 4 years 4 months	+ 2 Years 8 months	+ 2 years 7 months
STRENGTH			
Average	- 1 month	- 6 months	- 1 year 11 months
Lowest	- 2 years 0 months	- 3 years 9 months	- 4 years 10 months
Highest	+4 years 8 months	+ 2 years 11 months	+ 1 year 11 months
RUNNING SPEED AND AGILITY			
Average	+ 5 months	- 2 months	- 2 years 7 months
Lowest	- 1 year 7 months	- 5 years 3 months	- 5 years 7 months
Highest	+ 5 years 10 months	+ 2 years 6 months	+ 2 years 6 months

Table 17 Continued

	1982 Retested Stanine 4 Group (17 Students)	1986 Stanine 4 Plus Group (11 Students)	1986 Stanine 4 Regressors (6 Students)
UPPER LIMB CO-ORDINATION			
Average	+11 months	- 11 months	- 11 months
Lowest	- 2 years 6 months	- 5 years 8 months	- 4 year 1 month
Highest	+4 years 9months	+1 year 11 months	+ 1 year 3 months
FINE MOTOR SKILLS			
RESPONSE SPEED			
Average	+ 1 year 4 months	- 1 year 0 months	- 2 years 2 months
Lowest	- 2 years 10 months	- 4 years 7 months	- 4 years 7 months
Highest	+ 6 years 8 months	- 2 years 8 months	+ 1 year 8 months
VISUAL MOTOR CONTROL			
Average	+ 3 years 7 months	+ 1 year 4 months	+ 2 years 0 months
Lowest	- 1 year 4 months	- 2 years 4 months	+ 1 year 5 months
Highest	+ 6 years 0 months	+ 2 years 8 months	+ 2 years 8 months
UPPER LIMB SPEED AND DEXTERITY			
Average	- 6 months	- 5 months	- 5 months
Lowest	- 2 years 6 months	- 3 years 9 months	- 2 years 7 months
Highest	+ 10 months	+ 2 years 2 months	+2 years 1 month

The 'Stanine 4 Regressors' did however manage to maintain their Bilateral Co-ordination subtest skills at their age level between 1982 and 1986 - less than a year behind chronological age on Table 17.

In contrast the 'Stanine 4 Plus' Group maintained their gross motor skills of Strength and Running Speed and Agility at their age level between 1982 and 1986 and showed an improvement in Bilateral Co-ordination subtest skills. They, like the 'Stanine 4 Regressors', showed a deterioration in Balance skills but the decline was not as pronounced (-6 years 8 months for 'Stanine 4 Regressors' and -4 years 5 months for 'Stanine 4 Plus Group').

All the fine motor skill subtest scores for the 'Stanine 4 Regressors' and the 'Stanine 4 Plus' Groups were maintained at or above each group's age level in 1986. The Upper Limb Co-ordination subtest levels were also at the same level for both groups in 1986 and this was just below the level of significance (-11 months Table 17).

The discussion above shows that the major difference between the 'Stanine 4 Regressors' and the 'Stanine 4 Plus' groups was in the Strength and Running Speed and Agility motor skill subtests. The 'Stanine 4 Plus' Group maintained these skills at their age level while the 'Stanine 4 Regressors' deteriorated in these subtests.

Table 18: Degree of Impairment Scores as a Percentage of Average Age for the Subtest Motor Skills for the Retested 1982 Stanine 4 Group and the 1986 'Stanine 4 Plus Group' and 'Stanine 4 Regressors'

	1982 Retested Stanine 4 Group (17 Students)	1986 Stanine 4 Plus Group (11 Students)		1986 Stanine 4 Regressors (6 Students)	
	% of C.A	% of C.A.	Change in %	% of C.A.	Change in %
GROSS MOTOR SKILLS					
Balance	-16.0	-32.0	-16.0	-48.0	-32.0
Bilateral Co-ordination	+ 2.0	+ 8.5	+ 6.5	- 3.0	- 5.0
Strength	- 1.0	- 4.0	- 3.0	-14.0	-13.0
Running Speed and Agility	- 4.0	- 1.0	- 5.0	-19.0	-23.0
Upper Limb Co-ordination	+10.0	- 7.0	-17.0	-7.0	-17.0
FINE MOTOR SKILLS					
Response Speed	+14.0	- 7.0	-21.0	+16.0	+ 2.0
Visual Motor Control	+36.0	+10.0	-27.0	+14.0	-23.0
Upper Limb Speed and Dexterity	+ 5.0	- 3.0	- 8.0	- 3. 0	- 8.0

% of C.A. = percentage of chronological age

* **N.B.** Until national norms are known, these percentage differences cannot be translated into standard deviation units.

THE 1986 LOW PERFORMANCE GROUP

Abstract : All students in this group have lowest Motor Composite score at or below Stanine 3 level in 1986. Group made up of 27 students from Retested 1982 Low Performance Group and six students from the Retested 1982 Stanine 4 Group. In 1986 32 of the 33 students in the group have significant gross motor impairment. Eight (24%) have both gross and fine motor skills significantly impaired. A wide range of motor skill subtest ability is evident in this group. All gross motor skills showed a significant decline from 1982 to 1986. Balance skills worst - all students three or more years behind age level in this motor skill. By 1986 this group showed significant impairment in motor skills - on average functioning at -15% of their age level in seven of the eight motor skill subtest areas. Only Visual Motor Control was at this group's average age level.

Figure 3 (page 57) shows that the 1986 Low Performance Group is made up of 27 students from the Retested 1982 Low Performance Group who in 1986 still had their lowest Motor Composite Score at the Stanine 3 level or lower, and six students from the Retested Stanine 4 Group whose lowest Motor Composite Score had regressed from the Stanine 4 level to the Stanine 3 level between 1982 and 1986. All but two of these students were at the Form 3 level in 1986 - two students were still at the Form 2 level. An analysis of the motor skill ability of this group has been undertaken in order to record the extent of the motor skill impairment these students were experiencing at the Form 3 secondary school level.

This 1986 Low Performance Group was not identifiable as a distinct group in 1982 from the South Auckland Perceptual Motor Dysfunction Survey (SAPMDS). The 1982 data used in this comparison was however able to be determined from individual test results from the 1982 SAPMDS.

Stanine Levels

Table 19 shows that the 1986 Low Performance Group was made up of 14 students (42% of 1986 Low Performance Group) were at the Stanine 3 level, 11 students at the Stanine 2 level and eight students were at the Stanine 1 level. Fifty-eight percent (58%) of the 1986 Low Performance Group were at the Stanine 1 and Stanine 2 levels.

There were more females than males in total in the 1986 Low Performance Group (55% females and 45% males). More females than males were found at the Stanine 1 and Stanine 3 levels whereas there are more males than females at the Stanine 2 level.

Table 19 : 1986 Low Performance Group Distribution by Lowest Motor Composite Score and by Sex

Stanine Level	Total	Males	Females
Stanine 3	14	6	8
Stanine 2	11	7	4
Stanine 1	8	2	6
Total	33	15	18
Percentage Total		45	55

Gross and Fine Motor Skill Characteristics

Table 20 shows that 24 of the 33 students (73%) in the 1986 Low Performance Group have low gross/high fine motor skill characteristics. As discussed earlier in the Retested Stanine 4 Group all six students who regressed from this group

into the 1986 Low Performance Group (that is those who had high gross and high fine motor skill characteristics in 1982) did so because of a decline in gross motor skills only.

Thirty-two of the 33 students (97%) in the 1986 Low Performance Group (97%) have significantly impaired gross motor skills while nine students (27%) have significantly impaired fine motor skills. Eight students (24% of the group) had significantly impaired gross and fine motor skills.

Motor Skill Subtest Characteristics

It can be seen from Table 20 that 14 students who had low gross/high fine motor skills in 1982 still had these motor skill characteristics in 1986. Four of the students with low gross/low fine motor skills also maintained these motor skill characteristics in 1986. Thus in all 55% of the 1986 Low Performance Group demonstrated the same motor skill characteristic in 1986 as they possessed in 1982.

It needs to be noted here that the reduced number of students in the 1986 Low Performance Group with fine motor skill impairment is largely due to the reduced number of students with these motor skill deficits in the 1982 South Auckland Perceptual Motor Dysfunction Survey.

Table 21 shows the average degree of impairment and the lowest and highest motor skill subtest scores for the 1986 Low Performance Group. It is immediately obvious when looking at this table that a wide range of ability is evident in this group for each motor skill subtest. A five year difference is evident between the lowest and highest scores for all motor subtest scores in 1982 and a seven year difference between the lowest and highest scores is recorded for all motor subtest scores in 1986.

Table 20 : Changes in Gross and Fine Motor Skill Characteristics of the 1986 Low Performance Group Between 1982 and 1986

	1986 Motor Skill Characteristics		
Characteristics 1982	**Low Gross/ Low Fine**	**Low Gross/ High Fine**	**High Gross/ Low Fine**
Low Gross/ Low Fine	4	2	1
Low Gross/ High Fine	2	14	-
Low Fine/ High Gross	2	1	-
Low Battery Only	-	1	-
High Gross/ High Fine	-	6	-
Totals	8	24	1
Total Low Gross	8	24	-
Total Low Fine	8	-	1

It can be seen from Table 21 that in 1982 all gross motor skills were significantly behind their age level (i.e. more than minus one year). All gross motor skills got further behind chronological age levels from 1982 to 1986 (see Table 21) though the decline in Bilateral Co-ordination from 1982 to 1986 was not significant (less than minus a year's difference). Balance motor skills showed the greatest decline with no improvement shown in this skill at all between 1982 and 1986 (i.e. more than a four year deficit between the 1982 and 1986 average scores). Table 22 shows that in 1986 all students in this group had Balance motor skills three or more years behind their age with 88% of the group functioning over five years behind their age level in this skill. Table 23 shows a significant decline in Balance skills as a percentage of age

between 1982 and 1986 (i.e. -23% in 1982 to -51% in 1986) and identifies that on average in 1986 this group was operating at 50% below their age level for this motor skill.

Table 21 : The Range and Average Degree of Impairment of Subtest Motor Skills Related to Average Chronological Age for the 1986 Low Performance Group.

	1982		1986	
GROSS MOTOR SKILLS				
BALANCE				
Average	- 2 years	4 months	- 7 years	1 month
Lowest	- 6 years	1 month	- 10 years	2 months
Highest	+ 6 years	2 months	- 3 years	8 months
BILATERAL CO-ORDINATION				
Average	- 1 year	7 months	- 2 years	6 months
Lowest	- 5 years	1 month	- 7 years	5 months
Highest	+ 4 years	3 months	+ 2 years	7 months
STRENGTH				
Average	- 1 year	9 months	- 3 years	2 months
Lowest	- 5 years	10 months	- 8 years	3 months
Highest	+	2 months	+ 1 year	11 months
RUNNING SPEED AND AGILITY				
Average	- 1 year	4 months	- 3 years	10 months
Lowest	- 4 years	7 months	- 8 years	9 months
Highest	+ 4 years	5 months	+ 2 years	7 months

Table 21 : Continued

	1982	1986
UPPER LIMB CO-ORDINATION		
Average	+ 2 months	- 2 years 0 months
Lowest	- 5 years 10 months	- 6 years 10 months
Highest	+ 5 years 10 months	+ 1 year 3 months
FINE MOTOR SKILLS		
RESPONSE SPEED		
Average	+ 0 years 4 months	- 2 years 5 months
Lowest	- 5 years 4 months	- 7 years 9 months
Highest	+ 6 years 8 months	+ 2 years 7 months
VISUAL MOTOR CONTROL		
Average	+ 1 year 11 months	+ 0 years 7 months
Lowest	- 4 years 10 months	- 7 years 1 month
Highest	+ 6 years 2 months	+ 2 years 8 months
UPPER LIMB SPEED AND DEXTERITY		
Average	+ 1 year 0 months	- 2 years 3 months
Lowest	- 4 years 7 months	- 7 years 5 months
Highest	+ 1 year 4 months	+ 2 years 5 month

Running, Speed and Agility motor skills also showed a significant decline between 1982 and 1986 as seen on Table 21 and this is reinforced on Table 23 where a 15% difference in the percentage of age is recorded from 1982 to 1986. Sixty-four percent (64%) of this group have a deficit of four years or more for the Running Speed and Agility motor skill (see Table 22).

Table 22 shows that 52% of the 1986 Low Performance Group have Bilateral motor skills three or more years behind their age level and 58% are performing at a level three or more years behind their age in Strength.

Upper Limb Co-ordination motor skills also showed a significant decline between 1982 and 1986. This can be seen by a -1 year 10 month difference in scores on Table 21 from 1982 to 1986, and a -17% difference in age percentage recorded between 1982 and 1986 on Table 23 for this motor skill. Table 21 shows that in 1986 this motor skill was on average two years below students average age level. Thirty-nine percent (39%) of students in the 1986 Low Performance Group had Upper Limb Co-ordination skills three or more years behind their age level (see Table 22).

In 1982 all fine motor skills were at or above the groups's average age level with Visual Motor Control skills nearly two years above this group's average age level (see Table 21). However by 1986 only Visual Motor Control had stayed at the groups's age level with Response Speed and Upper Limb Speed and Dexterity declining to deficits of over two years between 1982 and 1986. In 1986 42% of the 1986 Low Performance Group demonstrated Response Speed motor skills three or more years behind their age level, and 39% of this group showed deficits of three or more years below their age level in Upper Limb Speed and Dexterity skills.

Table 22: Degree of Impairment of the 1986 Low Performance Group Subtest Skills

	-1 year	- 3 years	- 4 years	-5 years	-6 years
GROSS MOTOR SKILLS					
Balance	33 (100)	33 (100)	32 (97)	29 (88)	26 (79)
Bilateral Co-ordination	33 (100)	17 (52)	13 (39)	9 (27)	4 (12)
Strength	26 (79)	19 (58)	13 (39)	8 (24)	2 (6)
Running Speed and Agility	24 (73)	21 (64)	21 (64)	14 (42)	7 (21)
Upper Limb Co-ordination	21 (64)	13 (39)	6 (18)	3 (9)	2 (6)
FINE MOTOR SKILLS					
Response Speed	23 (70)	14 (42)	10 (30)	5 (15)	4 (12)
Visual Motor Control	6 (18)	6 (18)	4 (12)	3 (9)	3 (9)
Upper Limb Speed and Dexterity	24 (73)	13 (39)	7 (21)	4 (12)	2 (6)

( ) - percentage scores rounded to the nearest one percent

Table 23 shows that Balance was operating 50% below their average age level, and both Strength and Running Speed and Agility was operating at approximately 25% below the group's average age level.

A close examination of each person's motor skill subtest abilities in this group showed that in reality 28 of the 33 students (85% of the 1986 Low Performance Group) had five or more of the eight motor skill subtest areas functioning below their age level. Nineteen of these students (58% of the group) had six or more

motor skill subtests below their age level. It seems likely that the impact of having five or more motor skills significantly impaired in this way would be greater than if only one or two motor subtest areas were significantly impaired.

Table 23: Departure of Average Degree of Impairment Scores from Average Chronological Age as a Percentage of Average Chronological Age of the Subtests Skills for 1986 Low Performance Group.

	1982 Percentage	1986 Percentage	Change in Percentage
GROSS MOTOR SKILLS			
Balance	- 23.0	- 51.0	- 27.0
Bilateral Co-ordination	- 16.0	- 18.0	- 2.0
Strength	- 5.0	- 18.0	- 23.0
Running Speed and Agility	- 13.0	- 28.0	- 15.0
Upper Limb Co-ordination	+ 2.0	- 15.0	- 17.0
FINE MOTOR SKILLS			
Response Speed	+ 4.0	- 17.0	- 21.0
Visual Motor Control	+ 19.0	+ 4.0	- 15.0
Upper Limb Speed and Dexterity	- 10.0	- 16.0	- 6.0

* minus (-) percentage = percentage below average chronological age
  plus (+) percentage = percentage above average chronological age

* **N.B.** Until national norms are known, these percentage differences cannot be translated into standard deviation units.

INVOLVEMENT IN SPORT AND RECREATION ACTIVITIES

Abstract : No direct correlation was found between sport involvement and improvement or regression in motor skill abilities of students between 1982 and 1986 - some results supported this notion whereas other results refuted it. Seventy-five percent of students in the Retested Low Performance Group were participating in a sport or recreation pursuit in 1986, 25% of this group were not involved in any sport or recreation activities. Six of the eight students at the Stanine 1 level had either not been involved in any activity or had only tried one activity between 1982 and 1986. Only 10 students (28% of the Retested Low Performance Group) indicated involvement in a leisure activity - eight received music tuition. More Stanine 4 Group students were involved in sport and recreation activities in 1986 - 82% involved, 18% not involved - and all students had participated in at least one activity between 1982 and 1986. Schools play an important role as providers of sport and recreation opportunities for students with significantly impaired motor skills.

In 1986 all the students retested were asked a variety of questions about their involvement in sport and recreation activities between 1982 and 1986 as it was thought that such involvement may have facilitated significant motor skill improvement.

Students were asked to identify what sports and recreation activities they were currently involved in and what other activities they had been involved in over the previous four or more years. Students were asked to state how long they had been involved in each activity, to identify whether they were involved in these activities in the school or club setting, and to comment on who had influenced them to be involved in each activity. Where students indicated they had ceased their involvement in a sport or recreation activity they were also asked to comment on why they had not continued these activities.

The answers to these questions have been tabulated to -

i) show the past and present level of involvement in sport and recreation activities,

ii) investigate whether the number of activities students have been involved in has influenced motor skill improvement

iii) see whether the length of involvement in a particular sport or recreation activity has influenced motor skill improvement.

iv) determine the degree of participation in school and club activities

v) identify the factors which influenced these students involvement in the sport and recreation activities they took part in.

Students were considered to be involved in a sport if they played regularly in an organised club or school team or if they were involved in regular sports practices. A sport that was undertaken on a casual basis and student involvement in learning and playing a musical instrument was categorised (in this study) as a recreation activity.

Retested 1982 Low Performance Group

Thirty-six of the 37 students in the Retested 1982 Low Performance Group completed the questionnaire about their involvement in sport and recreation activities. One student - a male, whose lowest motor skill level was at the Stanine 2 level in both 1982 and 1986, did not complete the questionnaire.

The fifteen "improvers" identified on Table 24 improved their lowest motor skill ability level (that is their Gross Motor Composite, Fine Motor Composite or Battery Composite scores) by one or more stanine levels between 1982 and 1986 to be at the stanine level indicated on Table 24 in 1986. The significant improvers identified in the Stanine 4+ category are those students from the Retested 1982 Low Performance Group who had improved to the extent that they were no longer classified in the Low Performance Group in 1986.

Fourteen students are identified on Table 24 as being at the same motor skill ability level both in 1982 and in 1986 for either their Gross Motor Composite, Fine Motor Composite or Battery Composite scores. This means that these students weakest motor skills had not made any significant improvement over

the intervening four years between testing. Seven students in the Retested 1982 Low Performance Group are identified on Table 24 as having "regressed". These students lowest Motor Composite score had regressed between 1982 and 1986 to the level indicated on Table 24.

Table 24 shows that in 1986 75% of the Retested 1982 Low Performance Group were currently participating in at least one sport or recreation activity. In contrast some 25% were not involved in any sport or recreation activity at that time. Eleven percent of the Retested 1982 Low Performance Group indicated that they had not been involved in any sport or recreation activity in the past four years.

It is evident from Table 24 that in 1986 58% of the Retested 1982 Low Performance Group were regularly participating in some type of sports activity. Nineteen percent (19%) of the Group indicated that they had not been involved in any organised sports activity on a regular basis between 1982 and 1986.

A close scrutiny of students at the Stanine 1 level in 1986, as seen on Table 24, shows that four of the eight students (half of this group) were not currently involved in any sport or recreation activity. Three students at this level indicated that they had never been involved in either a sport or recreation activity on a regular basis.

Fourteen of the fifteen improvers had since 1982 participated in at least one sport or recreation activity for at least a year. Only one of the improvers had taken no part in any sport or recreation activity in this time. Table 24 shows that in 1986 twelve of the fifteen improvers were still actively involved in a sport or recreation activity.

Five of the seven students who "regressed" on Table 24 said that they were involved in a sports activity in 1986 (all four from the Stanine 2 level) while the two students who had regressed to the Stanine 1 level in 1986 were not participating in a sport or recreation activity at that time.

Table 24 : Retested 1982 Low Performance Group Involvement in Sport and Recreation Activities

Stanine Level 1986	Number	Involved In Sport 1986	Involved In Sport or Rec 1986	Not Involved In Sport or Rec 1986	Never Been Involved in Sport or Rec	Never Been Involved in Sport
Stanine 1						
Same	5	0	3	2	2	3
Regressed	3	1	1	2	1	1
Stanine 2						
Improvers	2	2	2	0	0	0
Same	4	3	3	1	0	0
Regressed	4	4	4	0	0	0
Stanine 3						
Improvers	3	1	2	1	1	2
Same	5	3	4	1	0	1
Stanine 4+						
Significant Improvers	10	7	8	2	0	0
Total	36	21	27	9	4	7
Percentage Total		58	75	25	11	19

Ten of the 14 students identified on Table 24 as being at the same motor skill ability level indicated that they were involved in either a sport or recreation activity in 1986 - only six of these students were participating in a sports activity at that time. Four students categorised in the 'same' group indicated that they had not regularly been involved in a sports activity between 1982 and 1986.

Table 25 identifies the number of activities students in the Retested 1982 Low Performance Group said they had participated in between 1982 and 1986. Several points are worthy of note from this table.

Six of the eight students at the Stanine 1 level in 1986 had either participated

in only one activity or had not participated in any activity at all in the last four years. It seems likely therefore that the lack of opportunities these students had to practise their motor skills - whether by choice or circumstance - considerably limited the ongoing development and mastery of their motor skills. Ulrich (1987) noted that involvement in sport had a significant positive effect on motor skill development.

Table 25 : Number of Sport or Recreation Activities Tried by Retested 1982 Low Performance Group between 1982 and 1986

Stanine Level	Number in Group	Number of Activities Tried 0	1	2	3	4+
Stanine 1						
Same	5	2	1	1	1	-
Regressed	3	1	2	-	-	-
Stanine 2						
Improvers	2	-	-	1	1	-
Same	4	-	1	1	-	2
Regressed	4	-	-	1	1	2
Stanine 3						
Improvers	3	1	-	1	1	-
Same	5	-	1	3	1	-
Stanine 4+						
Significant Improvers	10	-	3	1	3	3
Total	36	4	7	8	6	5
Percentage Total		11	22	25	22	20

Seven of the ten significant improvers at the Stanine 4+ level in 1986 indicated that they had been involved in two or more sport or recreation activities in the previous four years. This greater level of involvement in activities is also apparent in many of the other improvers identified on Table 25 where overall 11 of the 14 improvers had been involved in two or more sport or recreation activities between 1982 and 1986.

A positive relationship between greater involvement in sport and recreation

A positive relationship between greater involvement in sport and recreation activities and the improvement of motor skills is a possible outcome. Although this is indicated in the results shown above, not all the results in this study support this notion. The four students who regressed to the Stanine 2 level in 1986, three of the four students who stayed at the Stanine 2 level in 1982 and in 1986, and four of the five students who stayed at the Stanine 3 level in 1982 and 1986, also indicated that they had been involved in two or more sport or recreation activities in the four years between testing. These 11 students did not make significant improvements to their weakest motor skill scores (that is Gross Motor, Fine Motor or Battery Composite scores) between 1982 and 1986.

Table 26 identifies the greatest number of years students in the Retested 1982 Low Performance Group had participated in one particular sport or recreation activity up to 1986. It can be seen that nine of the ten significant improvers at the Stanine 4+ level in 1986 had been involved in one particular sport or recreation activity for three or more years.

A close look at all the improvers identified on Table 26 shows that 12 of the 15 students identified in this category had been involved in one sport or recreation activity for three or more years.

The results on Table 26 also show that all eight students at the Stanine 1 level had been involved in a sport or recreation activity for no more than two years with four of the eight students at this level having not maintained involvement in any activity for greater than one year.

The above results suggest that continued involvement in one sport or recreation activity for three or more years facilitated improvement in motor skills and conversely that limited ongoing involvement in such activities had done little to improve students motor skill levels. Some conflicting results are however shown on Table 26 which diminish this assertion. All four of the students who regressed to the Stanine 2 level in 1986, and four of the eight

students who stayed at the Stanine 2 and Stanine 3 levels in 1982 and 1986 - thus making no significant motor skill improvement - also indicated that they had been involved in a particular sport or recreation activity for three or more years.

Table 26: Most Number of Years Involved in Same Activity by Retested 1982 Low Performance Group

Stanine Level	Number in Group	Number Years Involved Same Activity 0	1	2	3	4+
Stanine 1						
Same	5	2	2	1	-	-
Regressed	3	2	-	1	-	-
Stanine 2						
Improvers	2	-	1	-	-	1
Same	4	-	1	-	1	2
Regressed	4	-	-	-	2	2
Stanine 3						
Improvers	3	1	-	-	1	1
Same	5	-	2	2	-	1
Stanine 4+						
Significant Improvers	10	-	1	-	5	4
Total	36	5	7	4	9	11
Percentage Total		14	19	11	25	31

It is evident from the information presented above that most of those students who stayed at the Stanine 2 and Stanine 3 levels in 1982 and 1986, and those students who regressed from the Stanine 3 level to the Stanine 2 level made no improvement in their motor skills despite being involved in three or more activities and also being involved in at least one activity for three or more years. It is beyond the scope of this research work to pinpoint why these students did not make any significant progress but it seems possible that at the Stanine 2 / Stanine 3 motor skill level an integration of separately learned

motor skills may need to take place before further motor skill advancement is achieved. This notion could explain why some students showed improvement and others did not when involved in a similar number of sport and recreation activities and when affiliated to a particular activity for similar periods of time.

Only ten students in the Retested 1982 Low Performance Group (i.e. 28% of this group) indicated involvement in an organised leisure activity in the four years between testing. Eight of these students (22% of the Retested 1982 Low Performance Group) had received tuition for a musical instrument and three (8%) were still continuing such pursuits in 1986.

Information about the role schools play in providing sport and recreation opportunities for students with impaired motor skills was collected in the questionnaire administered to students in the Retested 1982 Low Performance Group. Six students (17%) said that they had not been involved in any organised sport or recreation activity either at school or in the community between 1982 and 1986. Twenty-three students (64%) had been involved in at least one sport or recreation activity which had been organised by the school while seven students (19%) had relied on clubs exclusively as providers of their sport and recreation activities between 1982 and 1986.

An overall analysis of the reported student involvement by the Retested 1982 Low Performance Group in organised sport and recreation activities between 1982 and 1986 showed that over the four years between testing, schools had provided 58% of the opportunities for involvement while clubs provided 42% of the opportunities.

Students were asked on the questionnaire to indicate who got them involved in the sports and recreation activities they participated in. Fifty-six percent (56%) of the students involved in activities said that they themselves had made the decision to participate while 13% said that they were encouraged by friends to join particular activities. A further 16% of the students who were involved in activities said that their parents had played a major part in influencing their

involvement in a sport or recreation activity while some 16% of the students stated that the school had played a significant role in getting them involved in an activity.

The above results show that schools are important providers of sport and recreation opportunities for students with significantly impaired motor skills. Schools are also important actual and potential sources of encouragement to these students in their participation in sport and recreation opportunities. It is not possible to show from this study (or perhaps any other study in New Zealand) that had schools not provided the opportunities for these students to participate, that considerably less involvement would be recorded. It is likely however that students who have motor skill problems will be less motivated to actively seek out and join clubs on their own initiative. Four of the seven students with motor skill impairment who played exclusively in the club setting did so as a result of parent influence. It can be seen that overall parents were not the major determiners of student participation in sport and recreation activities for this group (parents were acknowledged as influencing only 16% of the students who participated in sport and recreation activities).

Stanine 1 Group

At the time of testing in 1986 only two students in this group were actively involved in an organised sport or recreation activity - one girl had been attending gymnastics classes at school for two terms and First Aid classes for a year, and the other girl was currently learning flute at school and had been playing for just over a year. Two other students had over the last four years been involved in a sport and one of these students had also learnt the violin for a year but both had by 1986 given up these pursuits. None of the students in the group had been involved in any organised sport or recreation activity for much more than a year. Two students indicated that they did activities on their own at home - one said he went running occasionally and the other enjoyed roller skating.

It was evident that all but one of the activities these students had been involved in had been offered by the school they attended and that they themselves had made the choice to become involved rather than being influenced by parents or friends. Only one of the students indicated that they had joined an activity because their friends and family were already involved.

The comments recorded by students at the Stanine 1 level - when completing the questionnaire - showed that their lack of motor skill ability significantly affected their participation in sport and recreation activities. Two students said that they had become "spectators" for the last two years as they had missed out on playing netball because their skills were not good enough to make a team. Another student said he had stopped being involved in scouts because "they kept on testing me - and I couldn't do it" and had got frustrated. Yet another student expressed doubt about how long she would continue to participate in the school gymnastics club because she had already failed her first badge twice.

Clearly the opportunities for students at the Stanine 1 level to learn and to practice motor skills through involvement in sport and recreation activities were very limited. This situation for some was by choice not to be involved, but for others was the result of not having motor skills at the level needed to be selected into teams and to participate successfully. Their lack of involvement in clubs which could provide the opportunity for the teaching and practice of motor skills, combined with the lack of physical education instruction which focussed on the mastery of motor skills in the school setting, has meant that few realistic opportunities for motor skill improvement have existed for these students with significantly impaired motor skills.

Retested Stanine 4 Group

All Stanine 4 students completed the questionnaire. In a effort to identify whether participation in sport and recreation activities may have had an effect on the motor skill improvement or regression of students in the Retested

Stanine 4 Group this group has been divided into three subgroups - the 'Stanine 4 Regressors' (those whose lowest stanine score has dropped from Stanine 4 to Stanine 3), those who stayed at the Stanine 4 level ('Stanine 4 same') and those who had improved significantly to progress to the Stanine 5 or Stanine 6 level ('Stanine 4 Improvers').

Table 27 shows that in 1986 14 of the 17 students (82%) in the Retested 1982 Stanine 4 Group were involved in some form of recreation or sport - 76% were participating in sports activities. Three students (18%) were not participating in any sport or recreation activity - one student in the 'Stanine 4 improvers' group was not involved in a sports team because he had after school and weekend employment.

Table 27 : Retested 1982 Stanine 4 Group Involvement in Sport and Recreation Activities

Stanine Level 1986	Number	Involved in Sport 1986	Involved In Sport or Rec 1986	Not Involved In Sport or Rec 1986	Never Been Involved in Sport or Rec	Never Been Involved in Sport
Stanine 4 Regressors	6	5	6	-	-	-
Stanine 4 Same	4	3	3	1	-	-
Stanine 4 Improvers	7	5	5	2	-	-
Total	17	13	14	3	-	-
Percentage Total		76	82	18	-	-

All six of the students in the 'Stanine 4 regressors' group were participating in a sport or recreation activity in 1986 Three of the four students in the 'Stanine 4 same' group were participating in a sports activity and five of the seven 'Stanine 4 improvers' were also playing a sport.

Table 28 records the number of activities students had tried between 1982 and 1986. All students had tried at least one sport or recreation activity over the four years and 11 students (64% of the Retested Stanine 4 Group) had tried two or more activities during this time. It is evident however from the data on this table that the greater number of activities students tried did not relate directly to the improvements or non-improvement shown in their motor skills.

Table 28 : Number of Sport or Recreation Activities Tried by Retested 1982 Stanine 4 Group between 1982 and 1986

Stanine Level	Number in Group	Number of Activities Tried 0	1	2	3	4+
Stanine 4 Regressors	6	-	3	-	3	-
Stanine 4 Same	4	-	-	3	1	-
Stanine 4 Improvers	7	-	3	2	2	
Total	17	0	6	5	6	-
Percentage Total		-	35	30	35	-

Table 29 identifies the greatest length of time students have been involved in an activity. Eight students (47% of the Retested Stanine 4 population) had been involved in one particular sport for four or more years. This continued involvement in one sport does not however appear in itself to have led to a significant improvement in motor skills - shown by the fact that three of the 'regressors' as well as four of the 'improvers' had been involved in at least one activity for four years or more.

A check was made to see if a combination of factors may have facilitated a significant improvement in motor skills - that is being involved in three or more activities and being involved in one of these activities for four or more years. Four students met this criteria - two students came from the 'Stanine 4

improvers' group and two from the 'Stanine 4 regressors' group. This result infers that there are other factors which influence the development of motor skills.

Table 29: Most Number of Years Involved in Same Activity by Retested 1982 Stanine 4 Group

Stanine Level	Number in Group	Number Years Involved Same Activity 0	1	2	3	4+
Stanine 4 Regressors	6	-	2	1	-	3
Stanine 4 Same	4	-	1	2	-	1
Stanine 4 Improvers	7	-	2	1	-	4
Total	17	0	5	4	0	8
Percentage Total		-	30	23	-	47

Students in the Retested Stanine 4 Group, like the Retested 1982 Low Performance Group, had over the four years relied on schools to provide the majority of their sport and recreation opportunities. Fifty-nine percent (10 students) of this group had relied on their school to provide all their sport and recreation pursuits. Twenty-three percent (4 students) of the Stanine 4 Group had been involved in pursuits offered by both the school and the community and 18% had relied on clubs alone to provide their sporting activities.

Forty-five percent of the students from the Stanine 4 Group said that they themselves had made the decision to participate in the chosen activity. Parents had influenced involvement in 25% of the activities and friends had also influenced involvement in 25% of the chosen activities.

Overall Comments

The results presented in this section show that there is no direct correlation between involvement in sport and an improvement of motor skills between 1982 and 1986 for students in either the Retested 1982 Low Performance Group or the Retested 1982 Stanine 4 Group. These results are in agreement with those found by Magill and Ash (1979).

There is however some evidence in the results which shows that participation in a particular sport or in particular sports may bring about improvement in specific motor skills. For example those students who got involved in swimming in a club situation showed significant improvement in Bilateral Co-ordination skills, as did those involved in Tai Kwon Do. A number of students involved in several sports which used small balls (such as hockey, cricket, tennis, and squash) also showed significant improvement in their fine motor skills. This possible correlation between particular sports involvement and specific motor skill improvement was suggested by Ulrich (1987).

Magill and Ash (1979) recorded a 59% participation level in sport in their study of elementary school students in Texas. This level of involvement is comparable to that of the Retested 1982 Low Performance Group which was at 58% though the participation in sport of the Retested 1982 Stanine 4 Group was considerably higher at 75%

It is evident from the responses to the questionnaire that parents and friends were a greater influence on participation in sport and recreation activities for the Retested 1982 Stanine 4 Group than for the Retested 1982 Low Performance Group - that is parents influenced participation for the Retested 1982 Stanine 4 Group in 25% of the cases whereas parents only influenced those in the Retested 1982 Low Performance Group in 16% of the cases; friends influenced participation in 25% of the cases for Retested 1982 Stanine 4 Group compared to 13% of the cases for Retested 1982 Low Performance Group. It is of note that parents and friends had little influence on the

participation in sport and recreation activities of those in the Retested 1982 Stanine 1 Group which may be a reason why so many in this group were not involved in sport and recreation pursuits.

This study shows that schools currently provide a conducive setting to encourage students between the ages of 10-14 years, especially those with significantly impaired motor skills, to take up the opportunities that are offered to them to participate in sport and recreation activities. Schools are also in the best position to foster the development of motor skills based physical education programmes which may, in time, significantly improve student motor skill levels, and in turn improve these students self confidence. Clearly schools have an important role to play in encouraging students with significantly impaired motor skills to become involved in sport and recreation activities.

SPECIAL CLASS STUDENTS

Abstract: These students were identified as having special learning needs in academic subject areas. Not all 'special class' students tested in 1982 demonstrated significantly impaired motor skills - two students (boys) demonstrated a high level of motor skills. Only three of seven students were able to be retested - high attrition rate. Staff were unaware of the extent of significantly impaired motor skill levels exhibited by these students.

Nine 'special class' students were in the original group of 335 students tested in the 1982 South Auckland Perceptual Motor Dysfunction Survey. These students had been identified as having special learning needs in academic subject areas. These special needs were being met in a 'special class' setting for part of each school day. These students were included in the South Auckland Perceptual Motor Dysfunction Survey (SAPMDS) testing schedule in 1982 because they were integrated part-time into the class groups chosen for testing. The number of special class students tested was representative of the number of these students attending school in the Hamilton area (i.e. 3%).

Table 30 identifies the lowest Gross or Fine Motor Composite stanine level of the special class students in 1982. Seven students were classified in the Low Performance Group (at the Stanine 1 and Stanine 2 levels) while two students demonstrated high levels of motor skill ability.

All five students in 1982 at the Stanine 1 level were low on both Gross Motor and Fine Motor Composite scores. Three of these students (two females and one male) scored at the Stanine 1 level for both Gross Motor and Fine Motor Composite scores.

The two students at the Stanine 2 level in 1982 (both females) had low Fine Motor Composite scores with Gross Motor Composite scores at the Stanine 4 level.

Table 30 : 1982 Special Class Students Distribution by Lowest Motor Composite Stanine Score

Lowest Stanine Level	Number Students	Males	Females
Stanine 1	5	3	2
Stanine 2	2	-	2
Stanine 5 plus	2	2	-
Total	9	5	4

1986 Results

The two Special Class boys with scores of Stanine 5 or above were not selected for retesting in 1986. From Table 31 it can be seen that two students were known to have left the area and one other was not traced. One student was in Social Welfare custody. She was not regularly attending school and so was not retested.

Two of the three special class students retested in 1986 (one male and one female) were attending different intermediate school special classes in the Hamilton area. The other student was attending secondary school and was placed in a special class in this setting.

The two students attending intermediate school scored at the Stanine 1 level in 1982 and still had skills at this level four years later in 1986. These two students most impaired motor skill was Balance - both were functioning at pre-school levels (i.e. at a 4 years 2 month level) in this motor skill area. Each student's motor skill subtest scores were functioning at a level five years below their chronological age.

Both students at the intermediate school level had changed their writing hand dominance in the intervening years between testing; both had changed from being left-handed to right-handed. They had also changed their dominant sports hand to the right hand for throwing though in several fine motor skill tasks one student preferred to use his left hand while the other student resorted to alternating the use of her hands in one task and was unsure about which hand to use on another task and tried both. These students were left eye dominant which meant they displayed cross hand-eye dominance features.

Table 31: Retesting of Special Class Students in 1986

	Number of Students	**Males**	**Females**
Retested	3	2	1
Left the Area	2	1	1
No Trace Found	1	-	1
Social Welfare	1	-	1
Total	7	3	4

The other special class student tested - now at secondary school - showed an improvement in Gross Motor Composite scores between 1982 and 1986 of two stanine levels to reach the Stanine 4 level. This was achieved through big gains in Strength, and Running Speed and Agility motor skill subtests. Further gains in gross motor scores were hampered by a six year deficit in Bilateral Co-ordination skills. This student's Fine Motor Composite stanine score remained at the Stanine 2 level from 1982 to 1986. Close examination of individual fine motor skill subtest scores shows a big improvement in Visual Motor Control skills but a matched decline in Response Speed skills.

The student who showed improvement indicated ongoing involvement of over three years in several sports activities in clubs (rugby, soccer and cricket) while the two students who made no improvement over the four years were not

involved in any activity and gave no indication of any past involvement in recreation activities or sports. Such non-involvement is likely to have had both a physical and social impact on these students.

None of the special class students tested said that they participated in daily physical education programmes. The staff involved in teaching these students were unaware of the actual degree of impairment shown by the students tested. With physical motor skills at the levels exhibited by these special class students a focus on specific ways to accelerate motor skill learning is clearly indicated if these students are to cope adequately in the future with daily living tasks. Guided daily practice of motor skills in varied situations to achieve mastery in basic motor skill tasks is a pattern of learning worth pursuing with these students.

PROJECTION AND COMPARISON OF STUDY RESULTS

Abstract: Projection of results from this time series study design to the original 1982 sample population shows that in 1986 17.3% had significantly impaired motor skills at the form three secondary school level compared to 18.5% determined at the primary school level in 1982. These results can be compared to the cross-sectional research design results gained in 1982 which showed that 21.3% of students at the secondary school level had significantly impaired motor skills. The incidence results do not support the existence of a maturational effect on significantly impaired motor skill development. Differences are also evident in the changes of motor skill characteristics between the primary and secondary school levels in the time series and cross-sectional study results.

The students tested in this study in 1986 were originally part of a much bigger sample group which was tested in the South Auckland Perceptual Motor Dysfunction Survey (SAPMDS) in 1982.

The students tested in this study in 1986 - in the Retested 1982 Low Performance Group - were representative of the 1982 Low Performance Group in the SAPMDS. The students tested in the Stanine 4 Group in 1986 in this study, were drawn from the Stanine 4 Group of the 1982 SAPMDS and were representative of this group in respect to sex composition but were not truly representative in respect to Fine and Battery Composite stanine scores (refer to discussion on page 65 for a more detailed explanation).

Bearing in mind the identified difference in representation of the Stanine 4 Group in 1986, it is still possible to make projections (with accuracy) from the results recorded in this study which are relevant to the larger group of students tested in 1982. It is possible to calculate the percentage of students from the original 1982 sample who would have shown significant motor skill impairment in 1986.

Von Eye (1985) reported that there was evidence to show that growth curves based on cross-sectional research differed in part from those based on time series research. The results of the incidence level and motor skill trends from

the primary to secondary school levels in the cross-sectional research format of the 1982 SAPMDS are thus able to be compared to those gained from the time series research format of this study to ascertain if there are any differences and the determine the extent of these differences.

It needs to be reiterated that the 1982 SAPMDS primary school sample and the 1982 research sample in this study are drawn from the same sample population. A comparison of results therefore underlies the differences between the secondary school samples used in each study. That is the 1982 SAPMDS compared different sample groups at the primary, intermediate and secondary school levels, whereas this study has drawn from the same sample population at both the primary and secondary school levels.

Projection of 1986 Test Results

The South Auckland Perceptual Motor Dysfunction Survey in 1982 tested 335 students at the primary school level. The results showed that at the Standard Three level 62 students (18.5%) had significantly impaired motor skills (the Low Performance Group) and that 37 students (11%) made up the Stanine 4 Group who were deemed to be just above the significant level of impaired motor skill performance.

The results of this 1986 study show that many of the students in the Low Performance Group in 1982 continued to have significantly impaired motor skills in 1986. Twenty-seven (27) of the 37 students retested from the 1982 Low Performance Group (i.e. 73%) still had significantly impaired motor skills in 1986. The projection of this result to the original group tested indicates that 45 students of the original 62 identified in the 1982 Low Performance Group (i.e. 73%) would still have significantly impaired motor skills in 1986 at the secondary school Form Three level. This figure translates to 13% of the originally tested primary school population in 1982 still having significantly impaired motor skills in 1986 (i.e. 45 out of 335 = 13%) .

The results of the 1986 study also showed that a number of the primary school students at the Stanine 4 level in 1982 did not continue to improve their motor skills in the ensuing four years. In 1986 six students out of the seventeen 1982 Stanine 4 students retested (35% or one in every three students in this group) demonstrated significantly impaired motor skill levels and were now categorised in the Low Performance Group in 1986. When this result is applied to the original primary group tested in 1982, thirteen students (13) from the original Stanine 4 Group of 37 students (i.e. 35%) would be identified as having significantly impaired motor skills in 1986.

The above projected calculations show that had all those in the Low Performance Group and the Stanine 4 Group at the primary level in 1982 been able to be retested in 1986, some 58 students - 45 from the Low Performance Group and 13 from the Stanine 4 Group - would have demonstrated motor skill levels which are considered to be significantly impaired. This means that 17.3% of the 335 students tested at the primary level in 1982 would, four years later, in 1986 be categorised in the Low Performance Group.

This result of 17.3% of the students at the secondary level with significantly impaired motor skills when compared to the 18.5% incidence of those with significantly impaired motor skills at the primary level in 1982 shows a decrease of just over one percent (1.2%). These results do not indicate the presence of maturational effects on the development of motor skills in school students between the Standard Three primary school level and the Form Three secondary school level.

N.B. These calculations do not include any students who may have been at the Stanine 5 level or above in 1982 and whose motor skill levels deteriorated over the intervening four years to be in the Low Performance Group in 1986. This premise was considered unlikely and was not examined in the 1986 retesting schedule.

Comparison of Cross-sectional and Times Series Approach to Determination of Incidence of Significant Motor Skill Impairment

The 1982 South Auckland Perceptual Motor Dysfunction Survey (SAPMDS) adopted a cross-sectional research design and tested 150 students (using the Bruininks-Oseretsky Test of Motor Proficiency) at each of the intermediate and secondary school levels in addition to the 335 students tested at the primary school level. This testing was carried out to gauge whether the incidence of those with significantly impaired motor skills was similar to that identified at the primary school level, or whether the incidence at the intermediate and secondary school levels showed a marked increase or decrease. The number of those tested and the percentage of those identified in the 1982 SAPMDS Low Performance Group at each of the school levels in 1982 is shown in Table 32.

Table 32 : Number Tested/ Percentage in Low Performance Group In The 1982 South Auckland Perceptual Motor Dysfunction Survey.

School Level	Number Tested	Percentage in Low Performance Group
Primary	335	18.5
Intermediate	150	13.8
Secondary	150	21.3

(From Table 11 1982 South Auckland Perceptual Motor Dysfunction Survey - Donaldson and Maurice 1983).

The 1982 SAPMDS results (as shown above) indicate a slight increase (2.8%) in the incidence of those with significantly impaired motor skills from the primary to secondary school level (i.e. 18.5% to 21.3%). These results are however only able to give an indication of what actually occurs because in such cross-sectional designed research studies different population groups are tested at each school level.

The 1986 test results projected to relate to the original 1982 primary level group of students tested (as shown above) can be regarded as a more accurate indicator of the comparative incidence of significantly impaired motor skill performance at the primary and secondary level because the students tested at each level were drawn from the same population. These projected 1986 results showed that 17.3% of the original sample population had significantly impaired motor skills at the secondary level.

The different research design methods of calculating the incidence of those with significantly impaired motor skills at the secondary school level shows a discrepancy of four percent (4%) - that is 21.3% in the 1982 SAPMDS cross-sectional study and 17.3% as calculated from the results gained from this time series 1986 study.

Despite the different research methods adopted both these studies show a high incidence level of those with significantly impaired motor skills identified at both the primary and the secondary school level.

Comparison Between the Cross-sectional and Time Series Research Approach in Determining the Motor Skill Trends from the Primary to Secondary School Level.

A comparison of results in this section is made to highlight the differences evident between the motor skill characteristics shown from the primary to secondary school level in the cross-sectional 1982 SAPMDS, and those characteristics found in this time series research study of those in the Low Performance Group in 1982 and 1986.

The 1982 SAPMDS showed that at the primary school level the incidence of students in the Low Performance Group with gross motor skill impairment was 84% and at the secondary school level 94% of the 1982 Low Performance Group showed gross motor skill impairment. The times series research results

of this study show that a greater percentage of students at the secondary school level had gross motor skill impairment - that is 97% of the 1986 Low Performance Group had gross motor skill impairment.

Thirty-five percent (35%) of the 1982 SAPMDS primary school Low Performance Group demonstrated fine motor skill problems while only 15% of the 1982 Low Performance Group at the secondary school level showed impairment in these motor skills. These results highlight a considerable reduction in the number of students with fine motor skill problems from the primary to secondary school level. The current time series study results also show a reduction in the number of students with fine motor skill problems at the secondary school level but not to the same extent. Twenty-seven percent (27%) of the 1986 Low Performance Group have fine motor skill problems - that is a decrease of 8% from the primary school level, compared to a decrease of 20% from the primary to secondary school levels in the 1982 SAPMDS.

Another area of contrast between the results of the cross-sectional research of the 1982 SAPMDS and this time series longitudinal study can be made in relation to the number of students at the secondary school level who had both low gross and low fine motor skills. Twenty-two percent (22%) of the 1982 Low Performance Group at the primary school level of the SAPMDS had both low gross and low fine motor skills while only 9% of the 1982 Low Performance Group at the secondary school level displayed this motor skill impairment. The 1986 Low Performance Group (secondary level students) contained 24% of students with both low gross and low fine motor skill impairment - that is an increase in those with these motor skill characteristics rather than a decrease.

One other comparison between the results of the cross-sectional research design of the 1982 SAPMDS and the time series design of this present study can be drawn. In 1982 97% of the students in the 1982 Low Performance Group at the secondary level demonstrated a three year deficit in Balance motor skills with a -5 year 10 month average deficit recorded for this group.

The 1986 Low Performance Group in this study presents an even more grave picture with all students at the secondary level showing a three year deficit in Balance motor skills and an average impairment for the group of -7 years 1 month.

Summary

Differences in the research results of times series and cross-sectional studies in determining the incidence of motor skill impairment and the motor skill characteristics of groups with impaired motor skills are evident. This outcome was predicted by Von Eye (1985). The results of the cross-sectional research approach of the 1982 SAPMDS when compared to the time series results of this study tended to over estimate the incidence of motor skill impairment and to underestimate the extent of the motor skill impairment shown at the secondary school level.

SUMMARY OF FINDINGS

At the beginning of this study a number of goals were outlined and four hypotheses were formed to maintain a clear picture of the significance of this research and to direct the discussion of results. It is necessary now to review these statements and to confirm or refute the hypotheses that were made.

A primary goal of this study was to identify the motor skill levels and the motor skill patterns of a group of school students at the form 3 level who four years previously had been identified as having significantly impaired motor skills. Hypothesis 1 and hypothesis 2 were formed as a prediction of what would be found in this investigation.

Hypothesis 1 stated that -
The majority of students who were in the standard three 1982 Low Performance Group of the South Auckland Perceptual Motor Dysfunction Survey and who were retested in this study in 1986 will continue to have significantly impaired motor skills.

A detailed look at the motor skill development of the Retested 1982 Low Performance Group has been undertaken. The results of this section of the study show that only ten students (27%) from the Retested 1982 Low Performance Group of 37 students made sufficient improvement in their motor skills between 1982 and 1986 to no longer be classified in the Low Performance Group in 1986. Thus two out of every three students identified in the 1982 Low Performance Group still had significantly impaired motor skills in 1986. This variation in results supports Henderson's comments when she stated that some students appear to grow out of their difficulties and some do not (Henderson 1987). These results mean that Hypothesis 1 is supported because the majority of students, that is 73% of the Retested 1982 Low Performance Group, continued to have significant motor skill problems four years after their initial identification at the standard three primary school level.

Hypothesis 2 stated -

That gross motor skills particularly balance skills, will continue to be the main area of significant motor skill impairment in those students classified as having significantly impaired motor skills in 1982 and who were retested in 1986.

The 'non-improvers' from the Retested 1982 Low Performance Group showed a significant deterioration in all four gross motor skills (i.e. Balance, Bilateral Co-ordination, Strength, and Running Speed and Agility). They also demonstrated a decline in Upper Limb Co-ordination and the fine motor skills of Response Speed and Upper Limb Speed and Dexterity. The 'non-improvers' continued to maintain only Visual Motor Control skills at their age level between 1982 and 1986.

Thirty-one students (31) in the Retested 1982 Low Performance Group (84% of the group) had low Gross Motor Composite scores in 1982. Eight of these students made significant improvement in their Gross Motor Composite scores to no longer be classified in the Low Performance Group in 1986. The motor skill characteristics of several other students in the Retested 1982 Low Performance Group changed between 1982 and 1986 so that in 1986 26 students, 70% of the Retested 1982 Low Performance Group, displayed low Gross Motor Composite scores.

In contrast to the 'non-improvers' in the Retested 1982 Low Performance Group ten students demonstrated a significant improvement in their motor skills to no longer be in the Low Performance Group in 1986. These ten students showed big gains in the gross motor skills of Bilateral Co-ordination, Strength, and Running Speed and Agility. They also maintained their fine motor skills of Visual Motor Control and Upper Limb Speed and Dexterity at their age level. This group however also showed significant declines in the gross motor Balance subtest skills, in Upper Limb Co-ordination, and the fine motor Response Speed motor skill subtest areas.

Balance skills were the most impaired motor skill subtest for the Retested 1982 Low Performance Group in 1982 with 23 students (62%) being two or more years below their average age level in 1982. By 1986 all of the Retested 1982 Low Performance Group (including those who progressed out of the Low Performance Group) were on average three or more years behind in their Balance motor subtest skills.

The above results support hypothesis 2, but not in every respect. Although gross motor skills of the 'non-improvers' were the most impaired motor skills, this group also showed a deterioration in Upper Limb Co-ordination and the fine motor skills of Response Speed and Upper Limb Speed and Dexterity. Balance subtest motor skills were, as predicted in hypothesis 2, the most impaired of the eight motor skill subtest areas for all those in the Retested 1982 Low Performance Group.

Another goal outlined at the outset of this study was to determine the extent of the motor skill development in 1986 of students identified in 1982 as having the most impaired motor skills - the 1982 Stanine 1 Group. Hypothesis 3 was a prediction of what conditions were considered to be necessary for students in the 1982 Stanine 1 Group to improve significantly and to no longer be classified in the Low Performance Group in 1986.

Hypothesis 3 stated -

That without involvement in remedial physical education programmes or consistent involvement in at least one sport those students in the most impaired motor skill group - the Stanine 1 Group - will not improve their motor skill levels significantly and will continue to be in the Low Performance Group in 1986.

Three students in the 1982 Stanine 1 Group made at least a one stanine improvement in their lowest Gross Motor Composite score by 1986. In contrast five students made no improvement in the intervening four years with three

students recording both Gross and Fine Motor Composite scores at the Stanine 1 level. All students in the 1982 Stanine 1 Group had Balance and Bilateral Co-ordination motor subtest skills three or more years behind their age level.

No students in the Retested 1982 Low Performance Group received structured remedial physical education instruction between 1982 and 1986. Only one student from the Retested 1982 Stanine 1 Group maintained involvement in a club for three years or more and although this student made a one stanine level improvement, this improvement was not sufficient to be promoted out of the Low Performance Group. Thus all students from the Retested 1982 Stanine 1 Group remained in the Low Performance Group in 1986 which was predicted by Hypothesis 3.

One further goal which was established at the outset of this study was to look closely at the motor skill patterns of a group of students at the form 3 level whose motor skills four years previously were considered to be just above the level of significant impairment. Hypothesis 4 was developed to pre-empt the results gathered from this group.

Hypothesis 4 stated -

That some of the students whose motor skills were just above the level of significant impairment at the standard three level in 1982 will show a significant deterioration in their motor skill levels four years later at the form three level in 1986.

Six of the 17 students in the Retested 1982 Stanine 4 Group (35% of the group) did show a deterioration in their motor skills by 1986 to be classified in the Low Performance Group. These six students showed a deterioration in all gross motor skills with Balance subtest skills showing the greatest decline. These results support Hypothesis 4.

Several others goals of this study were outlined to maintain a clear picture of the significance of this research and to direct the discussion of results. One such goal was to investigate student involvement in sport and recreation activities as possible reasons for identified changes in motor skill levels. The results presented in this study relating to the sport and recreation involvement of students with significant motor skill impairment and those just above this cut-off point, failed to find a direct correlation between involvement in sport and motor skill improvement or regression. However it was evident that most of those at the Stanine 1 level in 1986 had, by choice or by circumstance, few opportunities in which to practice and further develop their motor skills due to limited or no involvement in sport and recreation pursuits and to a dearth of physical education programmes in schools which focussed on the practice and mastery of motor skills.

An interesting point was highlighted in the results of the questionnaire which was completed by students in this study. It was evident that schools played a significant role in providing sport and recreation opportunities for students to pursue - they provided at least 60% of the sport and recreation activities for students tested in this study.

This study has not attempted to make direct links between student academic ability and significantly impaired motor skill ability. However a number of students tested in this study had 'special class' status which meant that they were receiving remedial help in some academic study areas. A goal of this study was simply to record the motor skill development of those 'special class' students retested in this study.

The 1982 results showed that not all 'special class' students had significantly impaired motor skills. Two of the nine 'special class' students displayed a high level of motor skills. In contrast in 1986 two 'special class' students were still attending intermediate school, had only recently determined their writing and sports hand dominance, and had all motor skill subtest levels operating more than five years behind their chronological age.

Finally two goals were set to compare the results of this time series design longitudinal study with those found in the 1982 South Auckland Perceptual Motor Dysfunction Survey (SAPMDS). One goal was to compare the incidence of those with significantly impaired motor skills as found in each study. The other goal was to compare the motor skill trends identified from the primary to secondary school levels in each of these studies.

When testing a different sample at each level (primary and secondary) as in the 1982 SAPMDS an incidence level of 18.5% was determined at the primary school level and 21.3% was determined at the secondary school level. This present study - which used a time series research approach - enabled a determination of the incidence of students with significant motor skill impairment at the secondary level through the retesting of a representative group of the original 1982 SAPMDS primary school sample in 1986. This calculation of the incidence level showed that 17.3% of students had significantly impaired motor skills at the secondary school level. A four percent difference in the incidence level is apparent from these different calculations, however it is evident that regardless of the method used to determine the number of students with significant motor skill impairment, the results fail to give support to the notion of a maturational effect on motor skill development.

Different motor skill characteristics were determined for groups of students with significantly impaired motor skills as identified in the 1982 SAPMDS cross-sectional research approach and this time series research approach. This variation in results was anticipated by Von Eye (1985). The results of the cross-sectional research approach of the 1982 SAPMDS when compared to the time series results of this study showed that the cross-sectional research design tended to over estimate the incidence of motor skill impairment and to underestimate the extent of the motor skill impairment shown at the secondary school level.

CHAPTER SIX:
CONCLUSIONS, IMPLICATIONS AND RECOMMENDATIONS

The conclusions which can be drawn from the results of this study have implications for scholarly understanding and professional practice. The results of this study suggest the need for further research in several areas and the need to modify or at least question theoretical constructs which have in the past hindered the development of programmes and practices which could facilitate the learning and mastery of motor skills. The comparison made in this study between the results gained in this time series longitudinal research design study and the cross-sectional study design of the 1982 South Auckland Perceptual Motor Dysfunction Survey has implications for research practice.

To date there has been little research or professional debate as to the existence of a maturational effect on the development of motor skills after infancy. In a small number of references in the literature (as discussed in this study) there has been the suggestion that such a theoretical premise exists but the literature yields no research in the physical education field to support this notion. Physical education professionals have it seems failed to 'grasp the nettle' on this issue. This is evidenced by a failure to actively seek to improve motor skill teaching practices and provide opportunities for motor skill improvement as a means of reducing the number of students in the school setting who have significantly impaired motor skills.

This longitudinal study has been conducted in an effort to determine the possible effect of maturation on the motor skill development of students between 10 and 14 years of age. The results of this study showed that 27% of those identified as having significant motor skill impairment in 1982 at the standard three level (9 to 11 years approximately) improved their motor skills sufficiently over the following four years to no longer be considered as having significantly impaired motor skills in 1986 (13-15 years approximately) A maturational effect is indicated by the improvement that these students made. However in contrast 73% of students (that is two out of every three students) identified as having significant motor skill impairment in 1982 still had

significantly impaired motor skills in 1986 - a result which indicates that a maturational effect has not been an influence on these students motor skill development.

The fact that six students who had motor skills that were just above the level of significant motor skill impairment in 1982, had by 1986 shown a significant deterioration in these skills is further evidence that there is not a maturational effect evident in the development of motor skills for this student age group.

These research results are not definitive in providing evidence to refute the existence of maturation and clearly the effects of maturation are not complete at 14 years of age. However these results provide enough evidence for physical educators to at least question the accepted theoretical construct of maturation that they have unwittingly supported over the years.

This study has identified that there is a significant number of students who have motor skill problems in the school setting and provides information about which motor skills are most affected. Several practical lines of enquiry are indicated from these results. There is a need to determine whether this lack of motor skill development is the result of inadequate teaching practices or due to the lack of practice of these motor skills, or a combination of these factors. Such investigation necessarily requires a critique of the current physical education curriculum in terms of its adequacy in meeting the developmental motor skill requirements of students at all levels in schools. The interpretation of the physical education curriculum by teachers and the ability of teachers to teach what is contained in the syllabus also needs to be investigated as these may be sources of misunderstanding and inadequacy.

To date worldwide there has been little published work on the efficacy of different types of intervention programmes in assisting students with significantly impaired motor skills. Losse et al. (1991) report that an intervention programme took place over a year for most of the 'clumsy' students identified in the Henderson and Hall (1982) study. Significant progress was made by many of the students at that time but these gains were

not maintained after the programme was completed and support was withdrawn (Losse et al. 1991; p.65). Clearly greater professional application is required in this area to develop and record the outcome of intervention programmes and strategies designed to help students with significantly impaired motor skills.

The lack of improvement over a four year period shown by 73% of the students (two out of every three students) with significantly impaired motor skills in this study clearly shows that there is no room for complacency in physical education lessons when faced with students who have not mastered basic motor skills such as balance and bilateral co-ordination. The motor skills tested in this study are the foundation skills on which more complex motor skill tasks necessary for employment are based. The results of this research study shows that the cost of doing nothing to help students with significant motor skill problems means that some 13% of the student population at each grade level will continue to display motor skill problems in later life.

The fact that 76% of all the students retested in this study at the primary school in 1982, and 93% of this same group of students in 1986 at the secondary school level displayed problems in the Balance motor skill subtest is of significance. It was acknowledged at the beginning of this study that there were limitations in determining the reason for trends evident in the data collected because research into possible connections were beyond the scope of this study. However the writer considers that it is worth noting that there could be a causal link between the high percentage of students with balance motor skill problems as shown in this study and the number of students in schools who are reported to be suffering from "glue ear" (17% in Dunedin Multidisciplinary Child Development Study- Silva and McGee 1984). This possible linkage of factors would need further investigation to be verified.

The degree of participation in sport and recreation activities and the reasons for student non-involvement in activities have been briefly discussed in this

study as it relates to motor skill development. This is an area where more detailed investigation may provide interesting insights into the factors which influence student participation in sport and recreation activities in New Zealand.

This study highlights the important role schools in New Zealand currently play in providing opportunities for involvement in sport and recreation pursuits for their students. This is not the case in many other countries and the advantages of this type of involvement has as yet not received close scrutiny.

The comparison made between the results of this time series longitudinal research design and the cross-sectional study design of the 1982 South Auckland Perceptual Motor Dysfunction Survey study serves to remind researchers that different results are obtained from these different research approaches and therefore the information gained from each method must be interpreted judiciously.

This study provides a benchmark in the physical education field from which future studies to determine the incidence of students with significant motor skill impairment in New Zealand and overseas can be judged. It is hoped this study of students with significant motor skill impairment, the so called 'clumsy', is successful in drawing attention to the fact that a sizeable number of students attending our schools are in need of special consideration, especially by the physical education profession, if they are to develop a full repertoire of motor skills on which can be built a successful career and lifestyle.

APPENDIX A : Background Questionnnaire -Administered Verbally to Students in 1986

Name ..... Number .....

School .....Date .....

Intermediate School Attended.....

Teachers - F1 ..... F2 .....

1. What sport and leisure activities do you participate in? (include music)

Activity	Times/week	How Long Been Doing ?	Club/School	Who got you Involved?

2. What sport and leisure activities did you do but don't do any more (between Std 3 and Form 3)

3. Why did you give these activities up?

4. How often did you do physical education/fitness programmes at Intermediate School?

Less than 2 times/week
2 times/week
Other (state)
3 - 4 times/week
Daily

5. What did you do in these physical education periods?

6. Do you enjoy your physical education classes? Yes / No
Why / Why not ?

APPENDIX B: Summary of the Selection of the 1982 South Auckland Perceptual Motor Dysfunction Survey Test Sample.

Twelve schools were chosen for testing. They were selected to provide a balanced geographical, socio-economic, sex, and racial sample of the Hamilton area. The two special schools in the region were excluded from selection.

All the schools selected for testing followed a non-streaming policy which negated a possible streaming bias of the sample.

Students were not selected for testing at schools in a totally random manner. Complete class groups were tested in order to evaluate teacher perception in identifying students with significantly impaired motor skills. Where there was more than one Standard Three class in a school, a random selection of class was made.

A number of subjects were selected for testing from open plan schools. The method of selecting students at these four schools varied somewhat but each followed a random selection process.

Special class students who were integrated on a part-time basis into the classes chosen for testing were included in the survey.

Further details regarding the selection and testing of pupils in the South Auckland Perceptual Motor Dysfunction Survey can be obtained from the report of this study (Donaldson and Maurice 1983, p.16-17)

APPENDIX C: Criteria of Low Performance Group Determined In the South Auckland Perceptual Motor Dysfunction Survey 1982

The fixing of a criteria to determine the incidence of students with significantly impaired motor skill development (Low performance Group) was a difficult task. The Stanine 3 level for any one of the composite scores - Gross, Fine and Battery was initially considered a realistic cut-off point in determining the Low Performance Group.

To further investigate whether this cut-off point was realistic those scoring at the Stanine 3 level and below were stratified into subgroups according to each student's lowest recorded composite score ie. Stanine 1, Stanine 2 and Stanine 3. The degree of impairment evident at each of these levels was then determined using age equivalent scores calculated from Bruininks-Oseretsky Test results. Several different skill impairment patterns were identified within each Stanine level and at the three different age levels (Primary, Intermediate, and Secondary) which are shown in the South Auckland Perceptual Motor Dysfunction Survey (Table 4 page 39) and replicated here on Table 33.

The degree of impairment identified in students at the Stanine 3 level for all age levels (as shown in Table 33) was considered sufficiently low to warrant their inclusion in the Low Performance Group. This confirmed the initially selected cut-off point for the Low Performance Group at Stanine 3 for one or more of the Composite scores.

Table 33 Degree of Impairment for the Primary, Intermediate and Secondary Levels at Stanine Three, Two and One

	Primary	Intermediate	Secondary
Stanine Three	(a) Behind chronological age on all Fine or all Gross subtests. ie - 2+ years behind chronological age on two subtests or - 1+ years behind chronological age on two or more subtests. (b) Behind chronological age 3+ years on one subtest and 1+ years behind chronological age on two or more subtests. (c) Behind chronological age 4+ years on one subtest. NB: All subjects are 2+ years behind chronological age on at least one subtest.	(a) Behind chronological age on four or more subtests. ie - 3+ years behind chronological age on three subtests or - 4+ years behind chronological age on two subtests. (b) Behind chronological age 6-8 years on one subtest. NB: All subjects are 4 1/2+ years behind on at least one subtest.	(a) Behind chronological age on all Gross subtests ie - 3+ years behind chronological on one subtest and 1+ year on three or more subtests. (b) Behind chronological age 3+ years on three or more subtests. (c) Behing chronological age 5+ years on one subtest and 2 years behind chronological age on one other subtest. NB: All subjects are 3+ years behind chronological age on at least one subtest.
Stanine Two	(a) Behind chronological age on all Fine or all Gross subtests ie - 1 + years behind chronological age on all subtests. (b) Behind chronological age 4+ years on one subtest and 1+ years behind chronological age on two or more subtests. NB: All subjects are 2 1/2+ years behind chronological age on at least one subtest.	(a) Behind chronological age on five or more subtests ie - 4+ years behind chronological age on four subtests or - 5+ years being chornological age on two subtests. (b) Behind chronological age 8+ years on one subtest. NB: All subjects are 5+ years behind chronological age on at least one subtest.	(a) Behind chronological age on all Fine or all Gross subtests ie - 2+ years behind chronological age on three or more subtests. (b) Behind chronological age 3+ years on three or more subtests. (c) Behind chronological age 5+ years on one subtest and 2+ years behind chronological ageon three other subtests.
Stanine One	(a) Behind chronological age on all Fine or all Gross subtests ie - 3+ years behind chronological age on three or more subtests. (b) Behind chronological age 5-6 years on one or two subtests or - 5+ years behind on one or more subtests. NB: All subjects are 3+ years behind chronological age on	(a) Behind chronological age on all Fine and all Gross subtests ie - 3+ years behind chronological age on five or more subtests. NB: All subjects are 7+ years behind chronological age on at least one subtest.	(a) All behind chronological age on all Fine or all Gross subtests ie - 1+ years behind chronological age on five or more subtests. (b) All behind chronological age 2+ years on three or more subtests. NB: All subjects are 4+ years behind chronological age on at least one subtest.

APPENDIX D: Levels of Significance

Sex Differences: Chi-Square Tests

Chi-Square tests were used to determine whether there was a significant difference between the sex composition of those retested and those not retested in both the Low Performance Group and the Stanine 4 Group. Any statistical significance ($p < 0.05$) means that those retested in 1986 are not representative of these groups in 1982.

Low Performance Group: Chi-Square = 0.31638, p= 0.5738

StanIne 4 Group: Chi-Square = 0.23197, p= 0.6301

The levels recorded above are not significant.

Differences in Gross, Fine and Battery Scores: Two Tailed T-test

A two tailed T-test was used to identify any significant differences between the Gross, Fine and Battery scores of those retested and those not retested in the Low Performance Group and the Stanine 4 Group. The 1982 test results were used for this comparison.

Low Performance Group:

Gross Composite Scores: t= 0.64 p = 0.528

Fine Composite Scores: t=-0.58 p = 0.562

Battery Composite Scores: t= 0.16 p = 0.877

Stanine 4 Group:

Gross Composite Scores: t= -0.08 p = 0.937

Fine Composite Scores: t= -2.57 p = 0.016 *

Battery Composite Scores: t= -2.90 p = 0.007 *

* These scores are significant ($p< 0.05$). There is a significant difference between the Fine and Battery Composite Scores of those retested and those not retested in the Stanine 4 Group.

APPENDIX E:

Table 34 : Gross and Fine Motor Skill Characteristics of Retested 1982 Low Performance Group as Percentages by Sex

	←1982→			←1986→		
Characteristics	**Total**	**Male**	**Female**	**Total**	**Male**	**Female**
Low score gross/ high score fine	23	8 (50)*	15 (71)	19	6 (38)	13(62)
Low score fine/ high score gross	5	4 (25)	1 (5)	1	1 (6)	-
Low score gross/ low score fine	8	4 (25)	4 (19)	7	4 (25)	3(14)
Low score battery only	1	-	1 (5)	-	-	-
No longer in LPG (Stanine 4 plus)	-	-	-	10	5 (31)	5 (24)
Total	37	16	21	37	16	21
Total low score gross	31	12 (75)	19 (90)	26	10 (63)	16 (76)
Total low score fine	13	8(50)	5(24)	8	5 (31)	3(14)
Percentage in 1986 LPG						
Total Number					11	16
Total low score gross					10(91)	16(100)
Total low score fine					5(45)	3 (19)

APPENDIX F

Table 35: Degree of Impairment of the Retested 1982 Low Performance Group Subtest Skills in 1982

	-1 year	-2 years	-3 years	-4years
GROSS MOTOR SKILLS				
Balance	31 (84)	23 (62)	18 (49)	14 (38)
Bilateral Co-ordination	27 (73)	15 (41)	11 (30)	6 (16)
Strength	26 (70)	17 (46)	5 (14)	2 (5)
Running Speed and Agility	26 (70)	12 (32)	4 (11)	3 (8)
Upper Limb Co-ordination	13 (35)	10 (27)	6 (16)	5 (14)
FINE MOTOR SKILLS				
Response Speed	15 (41)	10 (27)	8 (22)	2 (5)
Visual Motor Control	11 (30)	6 (16)	4 (11)	1 (3)
Upper LImb Speed and Dexterity	18 (49)	17 (46)	3 (8)	2 (5)

( ) - percentage scores rounded to the nearest one percent

Table 36: Degree of Impairment of the Retested 1982 Low Performance Group Subtest Skills 1986

	-1 year	-3 years	-5 years	-6 years	-7 years
GROSS MOTOR SKILLS					
Balance	36 (97)	36 (97)	32 (86)	23 (61)	16 (42)
Bilateral Co-ordination	20 (54)	18 (49)	9 (24)	4 (10)	3 (8)
Strength	28 (76)	18 (49)	8 (22)	2 (5)	2 (5)
Running Speed And Agility	22 (59)	19 (51)	11 (30)	7 (18)	6 (16)
Upper Limb Co-ordination	25 (68)	15 (41)	2 (5)	2 (5)	2 (5)
FINE MOTOR SKILLS					
Response Speed	25 (68)	15 (41)	4 (11)	10 (26)	8 (21)
Visual Motor Control	7 (19)	6 (16)	3 (8)	3 (8)	1 (3)
Upper Limb Speed and Dexterity	26 (70)	14 (38)	4 (11)	2 (5)	2 (5)

( ) - percentage scores rounded to the nearest one percent

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Table 33: Degree of Impairment for the Primary, Intermediate and Secondary Levels at Stanine Three, Two and One

	Primary	Intermediate	Secondary
Stanine Three	(a) Behind chronological age on all Fine or all Gross subtests. ie - 2+ years behind chronological age on two subtests or - 1+ years behind chronological age on two or more subtests. (b) Behind chronological age 3+ years on one subtest and 1+ years behind chronological age on two or more subtests. (c) Behind chronological age 4+ years on one subtest. NB: All subjects are 2+ years behind chronological age on at least one subtest.	(a) Behind chronological age on four or more subtests. ie - 3+ years behind chronological age on three subtests or - 4+ years behind chronological age on two subtests. (b) Behind chronological age 6-8 years on one subtest. NB: All subjects are 4 1/2+ years behind on at least one subtest.	(a) Behind chronological age on all Gross subtests ie - 3+ years behind chronological on one subtest and 1+ year on three or more subtests. (b) Behind chronological age 3+ years on three or more subtests. (c) Behing chronological age 5+ years on one subtest and 2 years behind chronological age on one other subtest. NB: All subjects are 3+ years behind chronological age on at least one subtest.
Stanine Two	(a) Behind chronological age on all Fine or all Gross subtests ie - 1 + years behind chronological age on all subtests. (b) Behind chronological age 4+ years on one subtest and 1+ years behind chronological age on two or more subtests. NB: All subjects are 2 1/2+ years behind chronological age on at least one subtest.	(a) Behind chronological age on five or more subtests ie - 4+ years behind chronological age on four subtests or - 5+ years being chornological age on two subtests. (b) Behind chronological age 8+ years on one subtest. NB: All subjects are 5+ years behind chronological age on at least one subtest.	(a) Behind chronological age on all Fine or all Gross subtests ie - 2+ years behind chronological age on three or more subtests. (b) Behind chronological age 3+ years on three or more subtests. (c) Behind chronological age 5+ years on one subtest and 2+ years behind chronological ageon three other subtests.
Stanine One	(a) Behind chronological age on all Fine or all Gross subtests ie - 3+ years behind chronological age on three or more subtests. (b) Behind chronological age 5-6 years on one or two subtests or - 5+ years behind on one or more subtests. NB: All subjects are 3+ years behind chronological age on at least one subtest.	(a) Behind chronological age on all Fine and all Gross subtests ie - 3+ years behind chronological age on five or more subtests. NB: All subjects are 7+ years behind chronological age on at least one subtest.	(a) All behind chronological age on all Fine or all Gross subtests ie - 1+ years behind chronological age on five or more subtests. (b) All behind chronological age 2+ years on three or more subtests. NB: All subjects are 4+ years behind chronological age on at least one subtest.