THE IDENTIFICATION AND ASSESSMENT OF YOUNG CHILDREN WITH MOVEMENT DIFFICULTIES

By

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The candidate confirms that the work submitted is her own and that appropriate credit has been given where reference has been made to the work of others.

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ABSTRACT

The focus of this research study is the identification and assessment of children aged 3 to 5 years with movement difficulties. It is concerned with the construction of the Early Years Movement Skills Checklist, which is an assessment instrument designed to be used flexibly by teachers and parents to identify and assess young children with movement difficulties. The Checklist is in five sections: four sections contain activities which are functional in nature relating to the child's everyday life. The thinking behind this involves a belief supported by the relevant literature that both assessment and intervention should be as close as possible to the child's daily experiences and interests. A fifth section considers movement-related behaviours.

The collection of data involved Checklists being completed by teachers in 34 randomly selected schools for 420 3 to 5 year old children. Analysis reveals that the Early Years Movement Skills Checklist identifies movement difficulties in this age group and significant differences are found between children who display movement difficulties and those who do not. A reliability study involving measures for interrater and test-retest reliability was completed. The overall interrater reliability correlation coefficient for the Checklist was 0.96 and the overall test-retest reliability correlation coefficient for the Checklist was 0.94; both highly significant. A validity study focusing on the predictive validity compared data collected from the Checklist with data from a normative motor skills test from the Movement Assessment Battery for Children (Henderson & Sugden, 1992). A significant correlation coefficient value of 0.76 was returned for the whole of the selected sample.

The relationship between movement skill difficulties and movement-related behaviours was investigated. Children with movement difficulties were found to display a higher incidence of social and affective disorders than children without movement difficulties. This finding is in line with current views on movement difficulties and associated or concomitant difficulties.

The Early Years Movement Skills Checklist was found to be an efficient, speedy and accurate assessment instrument to aid in the identification of young children with movement difficulties.

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CHAPTER 1

Introduction and Research Aims

Movement Difficulties in Young Children

Movement is a fundamental component of human life; the ability to make precise controlled movements is so much part of daily living that the conduct of countless acts becomes so automatic that they scarcely intrude upon consciousness - so much so that we often forget their diversity, richness and functional importance. The development of movement skills is such that by the time children reach school age they have built up a repertoire of skills that, it is hoped, will be sufficient to function effectively in the classroom. However, some children arrive at school obviously lacking in the movement skills necessary for them to cope with the demands of the school environment. For some, this could be a direct result of lack of experience, while for others it could be a far more complex problem with potential long-term consequences (Cantell, Smyth, & Ahonen, 1994; Losse, Henderson, Elliman, Hall, Knight, & Jongmans, 1991). Indeed, these children not only lack the movement skills necessary to function effectively in the classroom, they also lack motor competencies necessary to cope with the demands of every day living.

Children lacking in these movement skills have been variously described, but, as noted by Sugden and Wright (1998), the descriptors used often reflect the emphases of the researchers' interests and also shed light on the difficulties experienced by children with movement problems. For example, terms such as *clumsy children, coordination problems* or *difficulties, motor coordination problems* or *difficulties, movement skill problems, movement problems* or *difficulties, perceptuo-motor dysfunction* and *dyspraxia* have all been used.

The most recent and formal term used to describe these children is *Developmental Coordination Disorder* (DCD). It appears in both the American Psychiatric Association (APA) *Diagnostic and Statistical Manual for Mental Disorders* (DSM-III-R, 1987; DSM-IV, 1994) and the World Health Organisation (WHO) *International Classification of Diseases and Related Health Problems* (ICD-10, 1992a; 1992b; 1993). This term has been used by researchers such as Henderson (1992, 1994); Hoare (1994); Missiuna (1994); Mon-Williams, Pascal and Wann, (1994) and Sugden and Wright (1995, 1996, 1998). The fact that DCD now has a specific entry and is regarded as a separable developmental disorder of movement skills means that it requires diagnostic, etiological, and remedial attention in its own right (Henderson, 1994).

While it is acknowledged that there is much variation in the way movement skill difficulties manifest themselves, some common characteristics have been identified. The overall picture of children with DCD shows that the basic fundamental skills of sitting, standing, walking, running, reaching and grasping always emerge even though they may be delayed. However, although these skills can be performed at a rudimentary level, the necessary development to competent functional skills has not occurred (Henderson, 1992; Keogh & Sugden, 1985; Sugden & Henderson, 1994). This lack of development means that, by comparison, children with DCD fall behind their peers in some or all of these functional skills, resulting in a detrimental effect on their progress at school.

For a considerable number of children, the movement difficulties experienced during their early years continue to have an effect into teenage years (Cantell et al., 1994; Geuze & Börger, 1993; Losse et al., 1991). Parents of children described as *clumsy* are frequently told that their children will grow out of the problem and that the physical signs associated with DCD will disappear with maturation. However, the picture that emerges is not encouraging and the persistence of DCD into later life is a topic that reveals differing and sometimes conflicting results.

The period from 2 to 7 years of age is generally recognised as a time of acquisition of a number of fundamental motor skills leading to the development of a large repertoire of movement skills (Keogh & Sugden, 1985). With age children's movements become more continuous and appear to be easier and smoother; they are more consistent, efficient and effective. Simple observations of changes of walking, running, and many manipulation movements illustrate these general descriptions of change, as do the analyses of many movement skills. Young children also become able to do more things simultaneously and to achieve intended outcomes in many different ways. The period from 3 to 5 or 6 years of age is a crucial one because children develop those skills which are fundamental to daily living (Keogh & Sugden, 1985). If the fundamental skills are not developed in these years, problems may occur later. We have information on these, yet there is a lack of detailed research on the children in this age group who fail to acquire the skills necessary to function effectively in daily life.

Sugden and Keogh (1990) note that considerable individual variation in rate and level of development is expected, but some children will have serious and pervasive problems that are well beyond the boundaries of normal variation. Thus, although these skills may be performed at a rudimentary level, development into competent functional skills which enable children to manipulate and control their environments has not occurred. Consequently, on entry into school the child with DCD may not have mastered the skills necessary for them to participate fully in classroom and playground activities.

Since the early 1980s there has been a number of longitudinal studies on the early development of children with mild to moderate motor impairment (Bax & Whitmore, 1987; Drillien & Drummond, 1983; Hadders-Algra, Touwen & Huisjes, 1986; Kalverboer, Hopkins, & Geuze, 1993; Silva & Ross, 1980). These studies all showed that a proportion of children identified with difficulties as infants, continued to display a variety of problems, including motor difficulties, at 5 years of age. However, most of these studies are somewhat limited, in that they were not specifically designed to document the natural history of motor difficulties in children. Rather, their main objectives were to investigate the consequences of particular perinatal events - the effects of being exceptionally low birth weight, premature, and so on.

In addition to the need for further information on the course of motor development among children who are noticeably impaired in the early years, there is also a need for further information on how these problems affect other aspects of development. Various studies have identified a number of associated problems including underachievement at school (Henderson, May, & Umney, 1989), lack of concentration (Lyytinen & Ahonen, 1989), behaviour problems (Gillberg & Gillberg, 1989; Losse et al., 1991), low self esteem (Schoemaker & Kalverboer, 1994), poor social competence (Knight, Henderson, Losse, & Jongmans, 1992) and lack of physical hobbies (Cantell et al., 1994; Hall, 1988). While these studies do not specifically address the progression of motor difficulties experienced by young children, they give an indication of the course that their movement difficulties may take in later years showing why early identification of problems may help prevent later, more pervasive difficulties.

Earlier work concerning the identification of children with developmental coordination disorder has concentrated upon school age children and how the disorder manifests itself through difficulties related both to daily living and to school related tasks. The long-term prognosis for children with DCD who do not receive help is not good in general, although some children do catch up with their peers (Cantell et al., 1994; Losse et al., 1991). To date, the evidence thus far shows that those children who receive help can make gains in their motor skills and associated behaviours (Polatajko, Macnab, Anslett, Malloy-Miller, Murphy, & Noh, 1995; Revie & Larkin, 1993; Sims, Henderson, Hulme, & Morton, 1996a; Wright & Sugden, 1998). In addition, Cantell et al. (1994) have shown that those who catch up soonest fare better academically and socially than those whose recovery is delayed until adolescence. This would seem to suggest that the earlier the intervention the better the outcome.

For this work to continue and progress, it is necessary for young children with movement difficulties to be consistently and effectively identified and assessed such that the nature of these difficulties can be determined leading to appropriate intervention strategies where necessary.

The Research Project

In an attempt to address the problem of movement difficulties in young children, this research study focuses on the identification and assessment of movement difficulties in children, aged 3 to 5 years. Specifically, the research can be broken down into a number of areas.

To identify and assess movement difficulties in young children and the relationship to movement-related behaviours

A central aim of identifying children with movement difficulties is to be able to provide appropriate management and intervention at the earliest opportunity. One advantage of identifying young children is that most children younger than six years of age are still acquiring, as well as refining, their motor skills (Keogh & Sugden, 1985).

To construct a checklist (known as the Early Years Movement Skills Checklist) to identify and assess movement difficulties in young children, aged 3 to 5 years

The first step in providing appropriate intervention and management is to consistently and effectively identify children experiencing movement difficulties. The central theme of this study is to design and construct an efficient, speedy and accurate instrument to aid in the identification and assessment of young children with movement difficulties.

To assess movement skills in young children, using the Early Years Movement Skills Checklist and thereby identify those children who display movement difficulties

The Early Years Movement Skills Checklist is an instrument which has been designed to be used flexibly by teachers, parents and other professionals involved with children displaying movement difficulties. The focus of the Checklist is how a child performs a task on a daily basis and therefore the Checklist contains items which can be observed by teachers and/or parents as part of the child's daily routine.

To assess the nature of movement difficulties in individual children identified as displaying movement difficulties

The Early Years Movement Skills Checklist is constructed so that the motor activities are organised into 4 sections, with each section focusing on a specific area of movement skills. This will give an indication of the type of movement problems a child is experiencing and the specific context in which the difficulties occur.

To compare the data collected from the Early Years Movement Skills Checklist with data from a normative motor skills test from the Movement Assessment Battery for Children (Henderson & Sugden, 1992)

By comparing the data collected from the Early Years Movement Skills Checklist with data from the Movement ABC Test (Henderson & Sugden, 1992), a measure of the predictive validity of the Checklist will be obtained.

To combine the data from the Early Years Movement Skills Checklist and the Movement Assessment Battery for Children (Henderson & Sugden, 1992) to further assess the nature of the difficulties seen in the identified children

Wright and Sugden (1996b) propose a two step procedure for accurate identification and assessment of children with movement difficulties. In this study the data obtained from both the Early Years Movement Skills Checklist and the Movement ABC Test (Henderson & Sugden, 1992) will be studied in order to gain a more accurate picture of the difficulties experienced by a child.

To investigate the relationship between motor skill behaviour and movement-related behaviours in young children with and without movement difficulties

One of the sections of the Early Years Movement Skills Checklist examines movement-related behaviours; it is concerned with aspects of behaviour which may influence the child's achievement in motor activities. This section is taken from the Movement ABC Checklist (Henderson & Sugden, 1992). The observations from this section will provide information relevant to the evaluation of observations from Sections 1 to 4 and the relationship between motor skills behaviour and movement-related behaviours in children with and without movement difficulties will be investigated.

CHAPTER 2

Motor Development

Introduction

The study of motor development has had a renewed interest during the last decade not only in describing children's behaviour in more detail and with greater accuracy than previously, but also because new ideas have led to exciting theoretical concepts underlying the explanations of why and how children develop. During this century, the changes children make in their progression toward competence in motor development have been chronicled in great detail. This detail has amounted to descriptions of changes that have taken place in the various phases of the child's development. However, explanations as to how and why these changes take place have been insufficiently explored.

Maturational models, such as those proposed by Shirley (1931), Gesell (1945/1988) and McGraw (1963) were popular for a long time. During the 1970s and 1980s, models from cognitive theories were popular, particularly information processing approaches involving cognitive concepts, such as attention, memory, processing capacity and feedback. Although this helped popularise motor behaviour as a field of study, these models did not provide totally satisfactory explanations for either the performance or the development of motor behaviour (Sugden & Wright, 1998). More recently, the focus of attention has moved away from these models toward those that are more dynamic and ecological in nature. Explanations have been offered by those who are promoting dynamic systems as the theoretical underpinnings for how babies and infants perform, learn, and change in their motor behaviour (Thelen, 1995; Turvey & Fitzpatrick, 1993). A dynamic systems approach examines the interaction between the demands made by internal constraints, such as body mechanics, and the external environmental requirements and, as noted by Clark and Phillips (1993), it is a theory that specifically offers a set of principles for studying the emergence and evolution of new forms and one that seeks to explain change.

The term development refers to the process by which children change during the lifespan, and motor development has been described as adaptive change towards competence (Keogh & Sugden, 1985). Changes occur in biological, physical and social environments to enable individuals and their surroundings to become congruous. Behaviour, including motor behaviour, is the culmination of many influences. These influences - psychological, sociological, biological, physiological, cognitive and mechanical - and their interaction are the basis on which the understanding of behaviour is made (Haywood, 1993). The understanding of motor development is based on the integration of many behavioural changes that take place within and across phases of development.

Keogh and Sugden (1985) consider motor development not only the development of motor control over body movements, but they inextricably link it to the development of the mover's resources. Their stance is explained by considering the demands of the task as it relates directly to the resources the mover has at that moment in time. The more difficult an individual finds a task, the less efficient they are in dealing with it and the more errors they make, so contributing to the higher task demands because of their lack of resources at the time. The interaction of the mover-environment interplay as a transactional relationship is basic to Keogh and Sugden's (1985) view of motor development.

A child's motor development can be traced through an account of their physical growth patterns and the monitoring of the increasingly complex skills that are acquired. One can record the changes in height and weight of a baby, the disappearance of primitive reflexes, and the appearance of new features such as the ability to smile and react to the mother's presence. These changes mark the growth and development of a child as they physically mature. The information offered by this form of assessing development is essential in charting what is considered normal, healthy development. Children change dramatically in the years preceding schooling, and the motor milestones that they achieve, in what order and at what level of competence, are used as indicators in the process known as motor development.

Motor development has such obvious and dramatic changes that it is easy to overlook the subtle changes, such as the developing adaptability of reaching and grasping and the emerging ability to react to a moving environment. Keogh and Sugden (1985) note that there are two basic questions in developmental psychology: the first concerns describing change and how children differ at different phases of their lives; the second, asked less frequently, is the causal one involving identifying the agents of these changes. This chapter considers the different theories that have been proposed in an attempt to identify the agents of these changes and to understand motor development in general.

Historical perspective

A historical view of the study of motor development includes the domination by two approaches over the last 50 years. The first approach involved maturational concepts espoused, amongst others, by Shirley (1931), Gesell (1945/1988), and McGraw (1963) who explained motor development in terms of the natural biological unfolding of behaviours. The second approach is known as information processing, emerging from the field of cognitive psychology. In this approach children were viewed as systems which processed information and various stages of processing were identified for the input, transformation, storage and production (Keogh & Sugden, 1985). This approach differed greatly from the maturational approach, having a much greater emphasis on the interaction of the individual and the environment. However, it was still concerned with within-child variables and regarded motor development as being heavily reliant on cognitive processes.

Maturation

Long before developmental psychologists became interested in the mental lives of infants, there was a rich tradition of careful descriptive and quasi-experimental study of how the bodies of infants grow and change. The scientific study of motor development can be traced back to the 1920s when pioneer developmental scientists such as Shirley (1931), Gesell (1945/1988) and McGraw (1963) spent many years observing and reporting on how infants gain control of their movements. Shirley (1931) compiled individual movement biographies cataloguing the movements of 25 babies from birth to two years of age through regular home visits. The child's movements were recorded and the detail amounted to an intensive, longitudinal study of early walking development. Gesell and Armatruda (in Knobloch & Pasamanick, 1974) also collected observations of child development, so much so, that their data was used to produce developmental scales on which a diagnosis of development could be based.

A large number of child development textbooks reflect the enormous influence of the early pioneers in motor development. Their legacy was twofold: First, the assumption that motor development was sequential, rule-based, and inevitable - a series of 'milestones' by which to judge developmental progress, and, second, that this progress directly reflected changes in the central nervous system. Thus, the impression left by many textbook accounts was that motor development is the 'biological' background for vastly more interesting 'psychological' changes in perception, cognition, and social behaviour. Thelen (1995) notes that at a time when most developmentalists were discovering the active, competent infant and child, in terms of motor development, children still passively "matured".

Although no exact definition of maturation has been universally accepted, the term is most frequently used to describe the changes which develop in an orderly fashion without direct influence of known external stimuli but which are almost certainly, in part at least, a product of the interaction of the organism and its environment (Espenschade & Eckert, 1967). With respect to higher organisms, it is certainly true that no adaptive function is at its optimum of perfection from the moment of its inception. For example, at a certain stage in the development of the child it becomes possible for him to attempt to walk. The common expression, learning to walk, recognises the need for practice to perfect this function.

Essential characteristics of maturation are usually listed as the sudden appearance of new patterns of growth or behaviour, the appearance of particular abilities without benefit of previous practice, the consistency of these patterns in different subjects of the same species, the orderly sequence in the manifestation of different patterns and the gradual course of physical and biological growth toward the attainment of mature status.

As pointed out by Thelen (1995), Gesell and McGraw were more than just observers and describers; they were also important theorists, interested in why infants universally pass through a series of motor milestones. Thelen (1995) notes that " . . . these early workers concluded that the regularities they saw as motor skills emerged reflected regularities in brain maturation, a genetically driven process common to all infants" (p. 79). Gesell was particularly clear in assigning primacy to autonomous changes in the nervous system and only a secondary and supporting role to infants' experience. Thelen (1995) observed that some researchers claimed that this maturational urge was so strong that even restricting infant movements on cradleboards, a practice of the Hopi people, did not deflect this timetable.

It can be argued that, in some ways, these pioneers did their jobs too well. Their descriptions of motor milestones and stages were incorporated into all the textbooks. Their age norms became the bases of widely used developmental tests, and their maturational explanation was widely accepted and, in some areas, is still widely believed today. It would appear that, as a result, researchers knew all they needed to know about motor development; it provided the universal, biological grounding for the more psychologically interesting aspects of early development. However, the deficiencies in the neuromaturational account have been well summarised by Thelen and Ulrich (1991), and while they question the neuromaturational explanations of causation and privilege accorded the developing nervous system, they claim the central problem for this perspective is that it ignores the richness inherent in developing behaviours arising from many subsystems and processes.

To the maturationalists, motor development was a series of naturally unfolding structures in the nervous system driven internally, although, Manoel and Connolly (1997) note that McGraw (1963) recognised that the structure - function relationship could be bidirectional. This argument is further considered by Lockman and Thelen (1993) who suggest that the issue is not whether we can reduce behaviour to mechanisms in the nervous system or partition some aspect to genetic inheritance, but whether we can make current levels of explanation harmonious and congruent. "What goes on in the nervous system *must* be reflected in behavior, but it is equally true that what goes on as behavior must sculpt and mold the nervous system" (p. 958).

Information Processing

A deeper understanding of the cognitive involvement during the performance and learning of motor skills has been made possible with the evolution of information processing models of behaviour. This has enabled a change from a product approach where attention is given to the motor performance, to a process approach, where the antecedents of the response outcome are considered.

Many models have been formulated to represent individuals' processing activities. Information enters through one or more of the sensory systems and can come from external sources, and from internal sources, which include body knowledge of muscle tension and limb position and information generated internally through ideas and feelings. Information is transformed in many ways to make input meaningful to the individual and to make the decisions needed to act upon the existing conditions as perceived by the individual. The effector system produces a movement within the processing system's information constraints, and an action takes place within the context of the existing environment.

Two topics within the area of information processing characterise the research: mode of control and response organisation. The mode of control is how the motor system functions in relation to if and when feedback information is used. The idea of an open-loop mode is that a movement is preprogrammed and executed without ongoing correction. A closed-loop mode has a processing loop to bring information into the motor system while movement is occurring, rather than waiting until the movement is completed. A closed-loop mode uses feedback to generate error information which can be acted upon to reduce error during the movement. The motor control system functions in the same way during open-loop control, except that error information is not acted upon or is not useful until the movement is completed.

Arguments for and against both modes of control have been presented and discussed extensively (Keogh & Sugden, 1985). Supporters of the closed-loop mode of control point to the deterioration of performance when feedback is withdrawn and the lack of evidence for motor programming in humans. Those favouring an open-loop mode of control note that movements can take place without feedback and present evidence of motor programming in animals. The issue is not that only one or the other mode exists but when each functions.

One general developmental concern is the changes in the motor system's mode of control. Movements initially are made in a more discontinuous or discrete manner before the mover can put the pieces together to make a more continuous and unified movement. The mode of control can change in several ways depending on the movement's need for ongoing regulation and the mover's capability to organise larger movement programs that can be performed in an open-loop mode. The more experienced mover will be able to use both modes of control flexibly in order to adapt to environmental conditions and task requirements.

Beginning with a single and reasonably simple reaching movement, younger babies function in an open-loop mode to make corrections after a reach is completed, whereas older babies can correct during a reaching movement indicating that they are using a closed-loop mode of control. This is evidence that babies soon have the capability of using both modes of control; however, it does not mean that babies or young children can easily adjust to environmental conditions and task requirements by using the more effective mode of control. Hay (1979) reported that young children performed reaching movements in a ballistic or discrete manner, suggesting open-loop control, in contrast with older children who seemed to use selectively a combination of open- and closed-loop control. Hay also noted that children in the middle years seemed to overuse closed-loop control to overcorrect, as if not able to take in error information without immediately using it. Hay's three stages demonstrate that children become capable of using both modes of control selectively.

The second area of concern is how a movement is organised for execution; the fundamental question here is how can a movement decision be translated into a movement? After a mover reads a movement situation and selects a solution to whatever is perceived to be the movement problem, how is the motor system commanded and guided in carrying out the action plan?

Keogh and Sugden (1985) note that one line of research has concentrated on preprogramming to consider the extent to which a movement can be organised before it is executed. If the subjects know the movement to be performed, they presumably can prepare a motor program while waiting to move. Their reaction time will not be different for different movements, because they know what they must do and have a motor program selected and repackaged, if necessary. When the subjects do not know which movement will be required, their reaction time increases to indicate that programming is taking place.

Another important concern is the impact of preparation time when an unknown or uncertain situation is encountered, so that a movement must be selected and organised during the reaction time interval. Younger children presumably will need more time, but they may need proportionately more time for more difficult movements.

Many of the subcomponents of information processing were brought together in schema theory, as put forward by Schmidt (1975); this involved the development of generalised motor programs with invariant features that determine a class of movements or actions. Schmidt's (1975) schema theory of generalised motor programs is organised around rules called recognition schemas and recall schemas. The general sense of schema theory is that a mover has rules defining the relationships among the information involved in the production and evaluation of a movement. Schmidt (1975) recognises four pieces of information as stored or retained when an individual makes an intended movement: initial conditions that exist before movement, response specifications for the motor program, sensory consequences of the movement, and outcomes of the movement. When several similar movements have been attempted, the mover can abstract the relationships among these four sources of information in order to formulate the recognition schemas and recall schemas.

A fundamental proposition in schema theory is that the variability of experience will lead to the establishment of stronger schemas. The logic is that the variability of experience offers more information to the mover, who can extract from this information a more complete rule about means-ends relationships. It follows that a more complete schema allows the mover to organise movements better in unfamiliar or novel situations that involve the class of movements covered by a general motor program.

The information processing approach did not emerge in response to questions concerning motor behaviour but, once applied to some fundamental issues, became the dominant paradigm in the 1960s and 1970s and is still used today. Although the approach as a holistic theoretical explanation of motor behaviour is now not favoured, microcomponents of the approach are still prevalent in many studies.

Sugden and Wright (1998) note that this approach has allowed researchers to investigate in detail the processes involved in motor behaviour, has generated a vast amount of data describing and explaining motor actions, and, most of all, has generated debate by involving a larger and more diverse group of researchers examining the motor domain. From this group, criticism of the approach has also emerged, and new ways of examining motor actions leading to new explanations of motor development have been proposed.

Dynamic Systems and Ecological Psychology

Background

During the 1960s interest in the motor field waned as developmentalists moved toward Piaget, behaviour modification, and ethological theories of social attachment. Now after 30 years the cycle has again shifted, and the field is experiencing a renewed and revitalised interest in motor development. Motor development researchers are learning more and more about how infants come to control their limbs and bodies and, as a result, the field of motor development may again provide theoretical leadership for understanding human development in general. Thelen (1995) proposes theoretical concepts derived from the work of Bernstein (1967), J. J. Gibson (1979) and E. J. Gibson (1982, 1988), and notes that, taken together, these theories lead to a very different picture of the developing infant than that imagined by Gesell or Piaget.

Nicolai Bernstein, a Russian movement physiologist, was the first to examine in detail the problems of the brain-to-behaviour causal link, such as that propounded by the pioneer developmental scientists. He was the first to explicitly define movement in terms of coordination, the cooperative interaction of many body parts and processes to produce a unified outcome. The issue is usually stated as Bernstein's 'degrees of freedom' problem: How can an organism with many muscles and millions of nerves and cells ever figure out how to coordinate these into a single smooth and efficient movement without involving some homunculus which has the directions already stored? (Bernstein, 1967).

Rejecting the idea that a movement reflects a one-to-one relationship between the neural codes, the precise firing of motorneurons, and the actual movement pattern, Bernstein (1967) recognised that movements could come about from a variety of underlying muscle contractions. He also noted that a particular set of muscle contractions does not always produce identical movements, indicating that movements are not programmed in detail but are planned at an abstract level and refined by the task. "This type of organization allows the system greater flexibility to meet the demands of the task within a continually changing environment, while maintaining a movement category suited to the goal in mind" (Thelen, 1995, p. 81).

Bernstein (1967) also helped motor development researchers recognise that such an organisation has the ability to exploit the natural properties of the motor system and the complementary support of the environment. For example, limbs have springlike properties, due to the elastic qualities of muscles and the anatomical configuration of the joints and, as such, greatly simplify motor control. This means that when a limb is stretched and released the mover only has to set the parameters of the limb spring to reach the final resting position and need not be concerned with the detail of how the limb gets there; the pathway has self-organised from the properties of the components.

In light of Bernstein's insights, the picture of the infant waiting for the brain to mature and then executing the brain's demands is clearly untenable. These observations, surely, cast doubt on any explanation that relies heavily on simple nervous system maturation as the process by which infants develop motor coordination. For infants, as well as adults, movements are always a product of not only the central nervous system but also of the biomechanical and energetic properties of the body, the environmental support, and the specific demands of the particular task. Thelen (1995) notes that the relations between these components is not hierarchical, in that the brain commands and the body responds. Rather, it is profoundly distributed, "heterarchical", self-organising and nonlinear. "Every movement is unique; every solution is fluid and flexible" (p. 81).

Multicausal Development

The ideas of Bernstein have been elaborated by a number of researchers, including Kelso and Tuller (1984), Kugler and Turvey (1987), Thelen (1995) and Turvey (1990), and have been an influential force behind ideas that have become to be known as a dynamic systems approach. These researchers proposed models in which development is dynamic, and patterns of movement emerge from particular constraints with preferred patterns of behaviour that are self-organised.

A definitive leap forward in the understanding of motor development was, perhaps, marked in August 1993 by the publication of a special section of *Child Development*, a leading developmental journal, entitled 'Developmental Biodynamics: Brain, Body, Behavior Connections" (Lockmann & Thelen, 1993). The title captures the multiple influences that have come together to spark this new interest; dramatic advances in the neurosciences, in biomechanics, and in the behavioural study of perception and action. But, Thelen (1995) argues that, perhaps, most important, have been new theoretical and conceptual tools that have swept away old ways of thinking and brought the promise of a developmental synthesis closer to realisation (Bushnell & Boudreau, 1993; Sporns & Edelman, 1993; Turvey & Fitzpatrick, 1993).

At birth, a baby is completely reliant on adults and its movements are dictated by gravity. There are reflex mechanisms seen in the early months which are referred to as involuntary movements. In addition to these involuntary movements, Thelen (1979) also noted the seemingly random leg kicks, arm waves and body rolling of young babies; these movements, known as spontaneous movements, are not reflexes or involuntary movements, yet apparently serve no purpose or use in the goal-directed sense. However, researchers have viewed both reflexive movements and spontaneous movements as possible precursors to later voluntary movements. Thelen and Fisher (1983) measured the spontaneous movements seen in young babies and noted that the kinematics of the spontaneous kicking movements resemble the spatial and temporal components of mature walking patterns. In a later study of three-month-old infants, Thelen (1994) found that babies were in fact able to direct movement towards a novel task; in this case moving an overhead mobile. Her study suggests that even at this early stage in life learning processes are in place, supporting the view that new movements seen in infants are not simply the result of autonomous brain maturation. An important consequence of these ideas of motor organisation on motor development was to direct attention to the multicausality of action.

A good example of multiple systems in motor development is the so-called stepping reflex of the newborn infant. Newborn infants, when held upright with their feet on a support surface, perform alternating, steplike movements. Newborn stepping is intriguing because it is surprising to see such well-coordinated patterns at an age when infants are motorically immature and also because within a few months, these movements disappear. Thelen (1995) points out that regressive patterns such as this are of great interest to developmentalists because they raise questions about continuity and the nature of ontogenetic precursors as well as about the function of behaviours that disappear. Some researchers also believe there is a link between these subcortical reflex behaviours, such as crawling, primary stepping and swimming reflexes, and later cortically processed voluntary movements such as actual walking, swimming and climbing (Thelen, 1995; Zelazo, 1976).

As noted above, the reflexive movements seen in the stepping reflex disappear with time, but the spontaneous kicking of a child laid on his or her back remains. It has been suggested by Gallahue (1982) that early and regular stimulation of reflexive behaviours may bring forward the onset of the corresponding voluntary movement. It is also thought that as the cortex matures it is able to store information from the involuntary actions, and that this may aid the infant in the performance of later voluntary stepping or grasping. The same observation of using information from previous behaviours could well be made of the spontaneous movements. Certainly the preservation of a reflex beyond a certain age or the absence of a reflex would possibly indicate damage to the central nervous system. For this reason alone, information about early involuntary movements has a very important role to play.

McGraw (1963) explained the stepping response as single-causal: Maturation of the voluntary cortical centres first inhibited subcortical or reflexive movements and then facilitated them under a different and higher level of control. Naturally, this explanation came into question when motor development was seen in a different light. In their study of the spontaneous kicking in infants, Thelen and Fisher (1982; 1983) found that kicking and stepping appeared to have the same movement patterns. They compared the kinematics of the joint movements and the underlying muscle activation patterns in stepping and kicking in the same infants and found no substantial difference; they were the same movements performed in two different positions. It seemed incredible that the cortex would inhibit movements in one posture but not in another.

According to the dynamic systems approach, movement arises from a confluence of processes and constraints in the organism and the environment. A change in posture is a change in the relationship between the mass of the body and the gravitational field. It requires more strength to lift a leg to full flexion while upright than while supine, where after a certain point gravity assists in the flexion. Thelen and Fisher (1982) also noted that in the first two or three months, when the stepping reflex disappears, infants have a very rapid weight gain. This weight gain is mostly subcutaneous fat rather than muscle tissue and, as a result, their limbs get heavier but not necessarily stronger. Thelen and Fisher (1982) thus speculated that the 'disappearing' reflex could arise from the confluence of increasingly heavy legs and a biomechanically demanding posture.

As primitive and postural reflexes begin to decline, the poorly defined and seemingly random spontaneous movements move into a period of practice and mastery, and the actions seen during the first year develop more control and precision. Jensen et al. (quoted by Thelen, 1995) have found that infants show a progressive ability to move their leg joint independently rather than as a whole unit, so allowing finer control of forces through the knee and hip. This decoupling of the two legs occurs by increasing, or by freeing, the degrees of freedom and so provides the child with more flexibility to explore and discover new patterns of movement for their limbs.

Thelen and Smith (1998) discuss the fact that developmental change is not planned but arises within a context as the product of multiple, developing elements. Each component has its own trajectory of change; some elements may be fully formed early in life but remain unseen because the supporting subsystems and processes are not ready. Other components may be comparatively delayed, and one element may act as a “rate limiter,” preventing the cooperative self-organisation of the other component. Only when all the components reach critical functioning and the context is appropriate does the system assemble behaviour.

Hidden Skills

An especially intriguing aspect of a multicausal view of development is understanding precocial components of a behaviour. Thelen (1995) notes that these are aspects of a functional activity that are normally hidden but can be elicited, usually under special experimental conditions, long in advance of the fully formed action.

Thelen and Ulrich (1991) demonstrated a clear instance of precocial components with respect to human motor development in infant treadmill stepping; they conducted an experiment in which infants as young as one month were held supported under the armpits so that their legs rested on a small, motorised treadmill. Thelen and Ulrich (1991) found that the infants all performed coordinated alternating stepping movements that share many kinematic patterns with adult walking. They also noted that treadmill stepping is sensitive to external conditions such as the speed or direction of the belt and they further observed that infants were able to maintain excellent alternation of their legs on a split-belt treadmill, when one leg was driven on a belt moving twice as fast as the other leg. Thelen and Ulrich (1991) comment that treadmill stepping is truly a hidden skill because without the facilitating effect of the treadmill, such patterns are not seen until the end of the first year, when babies begin to walk on their own. Treadmill stepping is not a simple reflex, but a complex, perceptual-motor pathway whereby the dynamic stretch of the legs provides both energetic and informational components that allow the complex pattern to emerge.

Thelen (1995) believes that the discovery of such precocial components of later-appearing skills raises an important point for development in general. It is attractive to think that treadmill stepping is somehow the true "essence" of the later behaviour, that the experimentally elicited components show that the ability is there all along and that further development merely enhances performance factors. In contemporary developmental psychology there has been great interest in finding such underlying competencies, abilities or rules as if they hold a more privileged causal role. As a result there has been a trend to look for the earliest possible age at which infants have knowledge about objects, or physical laws, or language rules. Further development is then judged of lesser interest because all that develops are the factors that limit full expression of the inborn or innate knowledge.

Surely, the lesson from looking at motor skills is that there is no "essence" of a behaviour; it is impossible to isolate disembodied instructions to act from the actual performance of the act itself. All behaviour is always an emergent property of a confluence of factors. Thelen (1995) believes that "Just as each movement is the on-line product of complex, multiple processes, so it is that we can make no distinction between the center and the periphery, the inside and the outside, the "biological" and the experiential, the genetic and the environmental. Focusing on these dualisms diverts attention from questions of developmental process" (p. 83).

Dynamics and Development

The dynamic systems explanation of development emphasises that the infant explores and finds solutions to new environmental demands. It is not simply a matter of maturation driving the infant; it is the task that motivates the infant, interacting with the child's resources and producing the driving force for change (Sugden & Wright, 1998). Preferred patterns (attractors) are those that the system wants to perform and only moves out of with difficulty. In dynamic systems theory, specific propositions are made about stability and the loss of stability: If a system is unstable, for example, it is said to be in transition. As a dynamic system loses stability, it has the possibility of evolving into another stable attractor state or returning to its original state.

Dynamic change, then, can been seen in dynamic terms as a series of stability, instability and phase shifts in the attractor landscape, reflecting the probability that a pattern will emerge under particular constraints. From dynamic principles, one can predict that change occurs with the loss of stability. When the system is stable, it is performing the preferred patterns and change is brought about by a disruption of the stable position. Some changing components in the system must disrupt the current stable pattern so that the system is free to explore and select new coordinative modes. For instance, growth or biomechanical factors may be important in early infancy, whereas experience, practice, or environmental conditions may become dominant later on. Once new configurations are possible and discovered, they must also be progressively tuned to become efficient, accurate and smooth. Thus, Thelen (1995) believes that for any particular task, a dynamic view predicts an initial high variability in configurations representing an exploration stage, a narrowing of possible states to a few patterns, and a progressive stability as patterns become practiced and reliable. Clearly, theory predicts that times of instability are essential to give the system flexibility to select adaptive activities.

A number of authors have used Waddington's (1957) epigenetic landscape to reflect how development takes place (Connolly, 1986; Thelen, 1995). Thelen (1995) notes that as a ball runs through the landscape a deep narrow fissure is characterised by stability while at the same time having a limited number of options, whereas when the landscape has no fissures it is essentially unstable and has many options. Thelen believes that instability is necessary for any flexible system to select adaptive activities and is therefore necessary for change and development.

The work of Clark and Phillips (1993) examined stability and instability using a dynamic systems strategy by analysing collective variables for the leg's segmental motion over a one year period in infants. They examined the notion of instability and how long it lasted and what happened when the system was perturbed. They found that from the very onset of independent walking, the infant is attracted by the same dynamic solution as the adult, but, as predicted by the dynamics of systems in transition, the solution is unstable. In addition, the infants refused to walk when a weight was attached to the ankle. However, within three months the system had stabilised. Similarly, this also occurred with the thigh and shank limit cycle systems, with an adult like pattern appearing after three months of walking. Their results indicate that certain aspects of intralimb coordination became increasingly stable with development, and that, overall, the development of upright locomotion can be modelled in terms of the behaviour of a dynamic systems approach.

By the time a child has reached their second birthday they will more than likely have developed their motor skills to such a degree that they have basic control of their movements in a stable environment. This phase represents a time when the infant is attempting to gain mastery over the elementary stability, locomotor and manipulative tasks that will form the basis of future fundamental movements. Postural control is imperative to all movements. The young infant progresses from keeping its head steady when moved, to sitting with support, to adopting an independent sitting position, to changing body positions and finally to standing without support. To a limited extent, dynamic stability is being acquired by this age too and is seen in the faltering steps of toddlers. This motion stability is something that is seen to improve from year one to year two as the child tries to control a continuous sequence of changes. Locomotion develops from rolling over and moving forward to walking without support. Although by two years of age a child may walk with reasonable control and poise, that level of control disappears when either the momentum becomes too great or the environmental conditions become variable. With regard to manual control, the infant is seen to reach and grasp initially with a palmer grasp using both hands, progressing to using one hand in a similar fashion, and finally to using a pincer grip to pick up small objects. This digital dexterity is achievable in the first year while the second year consists of refining these achievements by trying out more functional tasks such as self-feeding (Gallahue, 1982; Haywood, 1986; Keogh & Sugden, 1985).

Children interact with their environments primarily through skilled actions and through these they are able to solve problems set by the environment and devise new interactions. Thus, it is a fundamentally important issue to know how skilled actions are organised. Sugden and Wright (1998) note that this has rarely been studied, yet this continuous reorganisation is a fundamental requirement to meet the increasingly complex environmental demands. The development of motor skills necessarily involves a succession of changes in which the action becomes more refined. These changes illustrate a movement from a state of low organisation or relative disorder to a state of higher organisation or greater order and stability (Kugler, 1986).

Exploration and Selection

The new views of motor development emphasise strongly the roles of exploration and selection in finding solutions to new task demands. This means that the infant must assemble adaptive patterns from modifying their current movement dynamics. The first step is for the baby to discover configurations which the task demands – a tentative crawl or a few shaky steps; then, infants must "tune" those configurations to make them appropriately smooth and efficient. This tuning is discovered through repeated cycles of action and perception of the consequences of that action in relation to the goal.

These views differ sharply from the traditional maturational accounts by proposing that even the so-called "phylogenetic" skills such as crawling, reaching and walking, are learned through a process of adapting and refining current dynamics to fit a new task through exploration and selection of a wider space of possible configurations. The assumption here is that infants are motivated by a task and that the task, not prespecified genetic instructions, is what constitutes the driving force for change.

Experimentally, this process of change is best seen when infants are given novel tasks and actually observed adjusting their current dynamics to solve problems (Thelen, 1995). Task novelty is important as the aim is to demonstrate a process where the outcome could not have been anticipated by phylogeny or neural codes. Goldfield, Warren and Kay (1993) monitored the development of an infant learning to use a ‘baby bouncer’, and found that they adjusted their kicking to gain optimal bounce. This has also been demonstrated by Thelen (1994) who observed the refinements infants made to make an overhead mobile move. In this experiment three-month-old infants lay supine under a mobile. Experimenters attached one of the baby’s legs to the mobile with a ribbon tied around the ankle, such that the infant’s spontaneous kicking movements made the mobile move. Very quickly the infants learned the contingency - that the mobile moved and created a noise in direct relation to how frequently and vigorously they kicked. Thelen (1994) was also interested in whether, in addition to learning to kick more, infants could also learn a novel pattern of interlimb coordination. Normally, three-month-old infants rarely use a simultaneous double kick, but, in an attempt to induce the infants to use a simultaneous in-phase pattern, Thelen (1994) tethered their legs together. This allowed the infants to move their legs independently, but also made it much more efficient to use both legs together to get vigorous activation of the mobile. As predicted, infants whose legs were tethered during the reinforcement phase of the experiment learned to shift their predominant pattern to in-phase kicking. As in the experiment by Goldfield et al. (1993), the infants began with a few tentative simultaneous kicks, and seeing the consequences, gradually replaced other configurations with the new form. In dynamic terms, the tethering disrupted the stability of the old attractors, allowing the infant to explore and discover a more efficient leg-coupling attractor.

This has also been noted by Adolph, Eppler and Gibson (1993) who watched how toddlers altered and adjusted their locomotion to deal with varying degrees of steepness of a slope. In these experiments, all the children demonstrated an awareness of their environment, its constraints and an ability to link their perceptions with their actions and develop solutions. The children's motor activities provided the means to explore their environment and the opportunity to learn about its properties. As each new solution was gained, it opened up other opportunities for further perceptual motor explanation, and so the children built on their knowledge from the demands of the tasks.

Sporns and Edelman (1993) propose a theory of selection as providing the basis for movement development, noting that development must initially involve a basic movement repertoire, the ability to sense the effect of the movement on the environment, and it must include a mechanism by which those movements are selected that satisfy both environmental demands and internal constraints. Thus, selection is a key aspect of change in motor coordination, and successive selection will involve progressive modification of a given movement repertoire. As noted by Sugden and Wright (1998), this alleviates the need to solve a problem by computational or processing means and replaces it with the organism selecting purposeful movement synergies from a wide range that have adaptively developed to solve environmental and mechanical problems.

Perception and Action

A central theme in the dynamic systems approach to motor development is the inseparable coupling of perception and action in the generation and improvement of new skills. The action-perception coupling research has been directly inspired by the theories of E. J. Gibson (1982; 1988) and J. J. Gibson (1979) on perception and perceptual development. These studies have demonstrated that, from the beginning, infants are continually coordinating their movements with concurrent perceptual information to learn how to maintain balance, reach for objects in space and locomote across various surfaces and terrains.

The classic line of research in this area stems directly from Gibson's (1979) concept of affordances. According to Gibson, an affordance is the reciprocal relation between the actor and the environment that is necessary to perform functional activities. Adults know immediately when a chair is appropriate for sitting or a surface for walking or when an object is within reach. People directly and accurately perceive these relations by sensing information from the environment and from their own bodies through receptors in the muscles, skin, and joints. The developmental question is how these relations are acquired: How do infants come to know whether they can successfully execute particular actions on the world?

Evidence of infants' growing abilities to detect such affordances was reported by Adolph et al. (1993). They presented crawlers and toddlers with a novel task, that of locomoting over a sloping surface of various degrees of steepness. The research focused on two issues: Would the children know when they could successfully go up or down the slope without falling? and Would they be able to adjust their patterns of locomotion to the steepness of the slope? Going up the slope posed no problems for either group; both groups tried even the steepest slope without hesitation. However, going downhill was another matter, and as the slope steepness increased, the toddlers became increasingly wary, often refusing to go, sometimes scooting backward, but rarely falling, suggesting that they understood something about how their locomotor abilities fit the task. In contrast, the crawlers did not appear to perceive this fit; they plunged downhill indiscriminately. Although they evidenced some wariness in hesitating and exploring the steep slopes, many crawled down anyway, unsuccessfully. Although the specific factors contributing to this difference are as yet unknown, the authors specify that it is likely that the process involved the infants' own continuing exploration of their action capabilities in relation to the slopes and learning and remembering about the consequences of their activities.

The primary thrust of research from a Gibsonian approach has been to understand how perception guides action. Thelen (1995) points out that motor activities are particularly critical because they provide the means for exploring the world and for learning about its properties. During development each motor milestone opens new opportunities for perceptual discovery. Bushnell and Boudreau (1993) have provided a particularly enlightening example of how important developmental accomplishments are paced by motor skills. They found that infants could perceive object properties only as their manual activities permitted appropriate haptic exploration.

Recent evidence makes it seem likely that infants, from the start, understand the world from time-integrated multimodal perception. Every waking moment includes sensations not only from vision, hearing, taste, smell, and feeling but also from receptors in muscles, joints and skin that detect position, force and movement changes in a continually active organism. What is important here is that the nervous system is built to integrate these streams of information; multimodal information is bound together frequently and in multiple sites along the processing stream and that there is no single localised area in the brain where perceptual binding occurs (Thelen, 1995).

Thelen (1995) believes that it may be exactly this continual bombardment of real-life, multisensory but coherent information that creates developmental change as infants learn to act in social and physical worlds. The key elements are the dynamic processes of exploration and selection: the ability to generate behaviour that provides a variety of perceptual-motor experiences and then the differential retention of those correlated actions that enable the infant to function in the world.

Brain Development

A fundamental process in movement dynamics is that of brain development that is consistent with the process approaches of behavioural development. Traditionally, developmentalists have assumed that the causal link is mainly one way; the brain matures and allows new behaviours to develop. But the question must be asked as to what causes the brain to change? The notion of exploration and selection as processes involved in development include a view of the brain as a changing, developing organism that is itself moulded through experience. An ever increasing field in contemporary neuroscience deals with brain plasticity, that is, how the brain itself is moulded through experience – individual perception and action. Kessen and colleagues (1970) found that the histological characteristics of a two year old child's brain are barely discriminable from an adult brain. Likewise, neuroscientists have found astounding plasticity not only in infants but also in adults. This work makes it likely that experience is the driving force for changes in the brain, which in turn create new opportunities for experiences (Thelen, 1995).

To illustrate the plasticity of the brain, the example of the baby developing efficient movements from its spontaneous movements to kick the mobile with two legs 'in phase' rather than one leg at a time is used. As the infant engages in different types of kicking he/she discovers that when vigorous kicks occur close together the mobile moves for longer and makes more noise; the correlated features of leg movement and sight and sound of the mobile are reciprocally strengthened so that a higher level association emerges. The process has been self-organising. The nervous system is learning to recognise and categorise sensory signals as a dynamic, self-organising process (Thelen, 1995). This process continues throughout life and is not seen merely as an explanation for new behaviours in babies, but also explains new behaviours at any time in life.

Overall, accepting this new approach to motor development, one would regard infant crawling for instance, not as an inevitable stage in development, but as a temporary solution to the problem of getting from A to B, at this particular level of strength and postural control. The thrust of this view is that through repeated cycles of perception and action, new behaviours emerge that are not explained by a pre-existing genetic plan. The notion that there is a relationship between cognition and action is not new; this was the basic assumption Piaget made in the 1950s, but he linked his ideas of development more closely to physical or mental growth patterns. This new synthesis of development views the growing human as a true dynamic system, rejecting the dualism of structure and function (Thelen, 1995). However, it is still possible to outline the types of motor skills that growing humans gain over time, for although we are all individuals we have much in common too; given normal development, we all discover walking rather than jumping as a more efficient means of locomotion most of the time. As the infant explores its environment, the movements that they use change from simply explorative to more refined and purposeful movements that result in an efficiency not seen earlier. It is this idea that repeated cycles of perception and action give rise to emergent new forms of behaviour without pre-existing mental or genetic structures that is the link between the simple activities of the young infant and the growing life of the mind.

Thus, in a dynamic systems approach, great emphasis is placed on the role of exploration when explaining changes in skilled actions, and development is seen as exploring the dynamics of action leading to a stable state. Sporns and Edelman (1993) suggest that a baby's spontaneous exploratory movements are the key elements in motor development, with sensory and motor neurons becoming increasingly linked as a motor problem is consistently solved. It follows that exploration leads to selection that, in turn, leads to optimal solutions to environmental problems constrained by internal qualities. However, as noted above, children interact with their environment primarily through skilled actions, and it is a fundamentally important issue to know how skilled actions are organised. "How this selection is ultimately linked with emergence, breakdown, and reorganisation of structures necessary for skilled behaviour remains a basic issue" (Sugden & Wright, 1998, p. 32).

Summary

Explaining motor development necessarily goes beyond mere descriptions and involves an examination of the processes that drive the changes seen in children. The maturational and information processing approaches to motor development have dominated explanations of change for many years, but, as noted above, these models did not provide satisfactory explanations for either the performance or the development of motor behaviour. The information processing approach has provided the field of study with a number of insightful ways in which to examine and remediate motor difficulties. Descriptions of what children need to know as well as do when performing a motor skill have led directly to the development of intervention programmes (Sugden & Wright, 1998). However, more recently maturational and information processing approaches have been challenged in new and exciting ways.

The dynamic systems approach has been the driving force behind the renewed interest in motor development and has contributed to new insights in theory and methods to the field as a whole. There are several ways in which the approach has had wider impact.

Firstly, the dynamic systems approach illustrates a strong emphasis on process, rather than the more traditional performance variables. Process accounts provide explanations of not just what behaviours are performed, but how they are assembled for perceiving and acting and how they change over time. The studies of Thelen et al. (1982; 1983) and Goldfield et al. (1993) are especially clear process accounts of how infants learn to make increasingly appropriate actions. Motor development is particularly appropriate for process-orientated research because behaviour can be directly observed and recorded in continuous and fine detail. Lockman and Thelen (1993) suggest that the processes by which infants and children acquire motor skills may yield general developmental principles, which may be applied to other domains.

Secondly, the approach illustrates the benefits of addressing developmental questions from multidisciplinary perspectives and from several levels of organisation. Action can not be separated from perception, from the biomechanics of the limbs and from the nervous system which generates and controls movement. The studies mentioned above address the body, brain, behaviour relations, focusing particularly on babies and infants.

Finally is the promise for grounding human development in biologically plausible processes, without resorting to the genes versus environment or structure versus function debate (Lockman & Thelen, 1993). Surely, the issue here is not whether we can reduce behaviour to mechanisms in the nervous system or partition some aspect to genetic inheritance, but whether it is possible to make the explanations offered above harmonious and congruent. What goes on in the nervous system must be reflected in behaviour, but it is equally true that behaviour must sculpt and mould the nervous system. "Understanding these tightly interwoven links remains a formidable challenge to the field as a whole" (Lockmann & Thelen, 1993, p. 958).

Sugden and Wright (1998) comment on the attractiveness of the dynamic systems approach for analysing the nature of coordination disorders, the assessment in context, and for developing principles into practice for intervention. The essence of causality from a dynamic systems approach is behaviour being the result of multiple subsystems that change over time in a nonlinear fashion. "Our knowledge is presently limited, but the approach offers such exciting opportunities through a diversity of paradigms examining real-life actions rather than fragments of movements" (p. 33).

Movement Development in 2 to 6 year old Children

New behaviours are seen in abundance in children from 2 to 6 years of age. Many developmentalists refer to the skills emerging during this period as fundamental movements (Cratty, 1986; Gallahue, 1982; Haywood, 1993; Smoll, 1982) and include activities such as running, hopping, jumping, skipping, climbing, throwing, catching, kicking, striking, rolling, twisting, turning and balancing, plus the manual grips needed for writing and drawing. During this phase, motor control improves drastically and the child's repertoire of skills increases substantially. By six years of age children have not only acquired the above skills but can also use them in combination.

Between the ages of two and six years children acquire and, in the case of some skills, refine these so-called fundamental skills. For example, skipping and hopping are acquired while walking and running become more efficient and graceful as the child's experiences increase. Despite more smoothness and consistency being evident in some of the normal six-year-old's motor skills, there is still much to learn concerning the constraints that fast movements, lack of time or complex movements can exert. There are also difficulties with movements in unpredictable and variable conditions (Keogh and Sugden, 1985).

Taking the dynamic systems approach to motor development these fundamental skills do not follow a predetermined plan of occurrence, rather they develop from the child finding new solutions to new tasks as their human resources affords them. Using the example of throwing, a baby soon learns how to get rid of an implement held in their hands. This develops into transporting hand-held objects to destinations further away rather than simply dropping them. As these developments take place, the child is learning categories of movements which can be applied to a task under certain constraints. These constraints can be seen in how a young child freezes the degrees of freedom used in the act of throwing and how those degrees of freedom are freed as their experiences and resources expand.

The two-year-old child tends to limit the throwing action to one mainly from the elbow with little rotary movement. The child's body weight is not really transferred into the throw and the feet tend to remain stationary. If the same child attempted to use a more adult technique to throw they would probably fall over, so the child freezes the degrees of freedom in order to keep control of the movement. This self-organising system is demonstrating the resources the child has at this moment in time and how they are adapting to the constraints upon them. As the child learns that moving more of the arm is beneficial to the throw, and that the non-throwing arm can be used to stabilise the increased movement, so more rotation is evidenced and a definite shift of body weight supports the additional movements. The child is freeing some degrees of freedom as their resources now enable them to. Thelen (1995) indicates that a new category of movements makes a higher level association. As the throwing action becomes more dynamic, the arm movements more extensive, there is a greater awareness of how these additional degrees of freedom can be controlled and used to produce a more efficient throw in a variety of contexts. The child's movements are being tuned to their ever evolving resources.

The six-year-old child normally uses many more degrees of freedom when throwing than the two-year-old would, but this is not always the case. The six-year-old can return to the status of the two-year-old when the constraints of the environment are such that the many degrees of freedom developed would lead them to an inaccurate or inefficient movement. For example, if a child was running fast to throw a ball in an atmosphere of much excitement and tripped en-route, he/she would be very likely to revert to the pattern of throwing seen in the two year old. So, although the child learns to free their many degrees of freedom in order to produce more efficient movements, they also become aware of what conditions demand the freezing of them.

During the motor development of young children, gender differences in the performance of fundamental skills have been documented. These differences have been partially explained by the differing physical growth patterns of boys and girls (Eckert, 1973). It has been suggested that as boys tend to have longer limbs, they are able to throw further than girls, and boys also tend to be taller and heavier, with the exception of the early adolescent phase. These physical attributes could be said to afford or not afford the emerging fundamental movements from two to six years of age. In some tasks boys are superior performers with regard to technique and performance measures than girls, in other tasks girls are superior performers. Keogh and Sugden (1985) cite the example of hopping in which girls out perform boys. Not only do girls acquire the skill of hopping sooner than boys, they also perform the movement more gracefully and with a greater degree of control. Hopping demonstrates one of the most distinct gender differences in motor development, according to Keogh and Sugden (1985).

Eckert (1973) believes that society and culture can influence the gender differences seen in motor performances. The new synthesis of motor development might explain these gender differences by suggesting that the tasks presented to the child will afford them opportunities for action, and in time, the selection of efficient solutions. If either gender is not often presented with certain tasks, then it will be difficult for the child to develop highly attuned movements, as exploration needs opportunities, and opportunities develop higher level associations.

The study of motor development has been seen to move away from phylogenetic and ontogenetic explanations and into a process orientated approach, where self-organising dynamic systems are tuned to the constraints of the environment and the resources of the mover through individual action and perception. The growing child is regarded far more as a thinking being involved in the relationship between affordance and development of motor skills and not simply as a product of a predetermined genetic map.

CHAPTER 3

Developmental Coordination Disorder

Introduction

In 1962 an article entitled "Clumsy Children" appeared in the *British Medical Journal* which discussed behaviour seen in young school children that could mistakenly be attributed to naughtiness or low intelligence but was, according to the authors, more likely to be a consequence of poor motor control. This disorder, found not uncommonly in primary school aged children, resulted in a marked impairment in the performance of functional skills required to succeed at school. Impaired motor performance by this age group had been noticed prior to the publication of the paper in the *British Medical Journal*, but, as observed by Sugden and Wright (1998), this paper possibly marked the beginning of published works that adopted a scientific approach to the study of what is now recognised as *developmental coordination disorder* (DCD). The paper called for concerted study to be undertaken to widen awareness of the condition, to diagnose precisely and thus to maximise opportunities to help these children.

Perhaps most notable of the early studies is that of Orton (1937); he described children who displayed strikingly similar characteristics to those children who are nowadays described as having DCD and noticed that inaptitude of motor activity often involved movements of the body as a whole, including such factors as balance and gait, and not merely manual dexterity.

In 1962, Walton, Ellis and Court observed a syndrome in 5 children in which the principle feature was described as "severe clumsiness". They noted that these children displayed clumsiness to such a degree that many motor activities essential to everyday life were distinctly impaired. In an attempt to determine causality, Walton et al. (1962) reported that they could find no trace of defects in the pyramidal, extrapyramidal or cerebellar pathways that control volitional motor activity. They hypothesised that the difficulties seen in these children occurred because of a defect in cerebral organisation and not from an acquired pathological lesion of the brain. They also noted that distinguishing the cause of this syndrome was not simple, and they argued against the notion that the difficulties evidenced by these children was a consequence of abnormal maturation that could be corrected with the passing of time. Walton et al. (1962) concluded that apraxic and agnosic disorders, although known in children with cerebral palsy, could also occur as isolated difficulties without other signs of neurological disturbances.

A number of other earlier studies report similar finding to Walton et al. (1962) (Brenner & Gillman, 1966; Brenner, Gillman, Zwangill, & Farrell, 1967; Dare & Gordon, 1970; Gubbay, Ellis, Walton, & Court, 1965). In general, school performance was found to be poor, the children had been slower in attaining milestones in their development of motor skills, and a high proportion of them presented definite indications of clumsiness, speech defects or poor motor coordination.

As a clearer picture of the motor difficulties faced by children with DCD has emerged, interest and research in the subject has spread from medical personnel to psychologists, educationalists, and therapists. Sugden and Wright (1998) note that these professionals are united not only in their quest for an understanding of the condition but also in how to deal with and help children overcome their difficulties.

Terminology

As noted earlier, many terms have been used to describe the condition and, as noted by Sugden and Wright (1998), the descriptors used often reflect the emphases of the researchers' interests and also shed light on the difficulties experienced by children with movement problems.

The most common of the terms used is *clumsy children* (Dare & Gordon, 1970; Geuze & Kalverboer, 1994; Henderson, 1994; Keogh, Sugden, Reynard, & Calkins, 1979; Lord & Hulme, 1987a; Losse et al., 1991). Other terms used include *clumsy child syndrome* (Gubbay, 1975a); *coordination problems* or *difficulties* (O'Beirne, Larkin, & Cable, 1994; Sugden & Henderson, 1994); *motor coordination problems* or *difficulties* (Maeland, 1992; Roussounis, Gaussen, & Stratton, 1987); *movement skill problems* (Sugden & Sugden, 1991); *movement problems* or *difficulties* (Henderson et al., 1989; Sugden & Keogh, 1990; Wright, Sugden, Ng, & Tan, 1994); *perceptuo-motor dysfunction* (Laszlo, Bairstow, Bartrip, & Rolfe, 1988a); *dyspraxia* (Iloeje, 1987; McGovern, 1991; Walton et al., 1962).

The most recent and formal term used to describe these children is *developmental coordination disorder* (DCD). It appears in both the American Psychiatric Association (APA) *Diagnostic and Statistical Manual for Mental Disorders* (DSM-III-R, 1987; DSM-IV, 1994) and the World Health Organisation (WHO) *International Classification of Diseases and Related Health Problems* (ICD-10, 1992a; 1992b; 1993), and was first classified as such in DSM-III-R (1978). The classification in these manuals represents a very positive step forward, not only in terms of recognition of the disorder but also because of the credibility these manuals offer. Henderson (1994) notes that the fact that DCD now has a specific entry and is regarded as a separable developmental disorder of movement skills means that it requires diagnostic, aetiological, and remedial attention in its own right. The term *developmental coordination disorder* has also been used, amongst others, by Henderson (1992, 1994); Hoare (1994); Missiuna (1994); Mon-Williams et al. (1994) and Sugden and Wright (1995, 1996, 1998).

Core Characteristics

While it is acknowledged that there is much variation in the way movement skill difficulties manifest themselves in the early years of life, some core characteristics have been identified.

The American Psychiatric Association (1994) describes DCD as

> ". . . a marked impairment in the development of motor coordination (Criterion A). The manifestations of this disorder vary with age and development. For example, younger children may display clumsiness and delays in achieving developmental motor milestones (e.g., walking, crawling, sitting, tying shoe laces, buttoning shirts, zipping pants). Older children may display difficulties with the motor aspects of assembling puzzles, building models, playing ball and printing or handwriting."
>
> APA (pp. 53-55).

The World Health Organisation (ICD-10, 1992a) describes the features of Specific Developmental Disorder of motor dysfunction as

> "A disorder in which the main feature is a serious impairment in the development of motor coordination that is not solely explicable in terms of general intellectual retardation or any specific congenital or acquired neurological disorder. Nevertheless, in most cases a careful clinical examination shows marked neurodevelopmental immaturities such as choreiform movements of unsupported limbs or mirror movements and other associated motor features, as well as signs of impaired fine and gross motor coordination."
>
> WHO (1992a, F82).

The extent to which the earlier noted descriptors differ is a testament to the heterogeneity of the difficulties experienced by children with DCD. Wright and Sugden (1996a) note that not only are the differences in children revealed in their range, but also the pervasiveness of the problem differs from child to child. For some children, their difficulties may only be evident in fine motor tasks or in gross motor tasks. For some, the difficulties they experience may be due to the environment, in that it limits or affords the child's movement control. For other children, their lack of motor control is evident in every area, and, as noted by Hoare (1994) and Wright and Sugden (1996b), variability of severity is evident in this situation also. These difficulties could arise from poor planning of motor tasks, a lack of understanding, or a cognitive difficulty with the task and how it fits in with other movements.

The overall picture of children with DCD shows that the basic fundamental skills of sitting, standing, walking, running, reaching and grasping always emerge even though they may be delayed. However, although these skills can be performed at a rudimentary level, the necessary development to competent functional skills has not occurred (Henderson, 1992; Keogh & Sugden, 1985; Sugden & Henderson, 1994). Henderson and Sugden (1994) suggest that this lack of development means that, by comparison, children with DCD fall behind their peers in some or all of these functional skills, resulting in a detrimental effect on their progress at school.

Prevalence

According to DSM-III-R (1987) and DSM-IV (1994) a prevalence of DCD as high as 6% has been estimated for children of 5-11 years of age. Other studies from around the world lend weight to this estimation. Gubbay (1975a) found up to 6.1% of a population of almost a thousand school children to be *clumsy*. Keogh et al. (1979), using multiple procedures, identified 9% of 6-year-old boys as *clumsy*. Later studies have also found similar percentages. Henderson and Hall (1982) found 5% of a sample of 400 children displaying *developmental clumsiness*, Iloeje (1987) found a prevalence rate of 5.9% of Nigerian children with *developmental apraxia*. Henderson, Rose and Henderson (1992) reported that it has been estimated that up to 10% of school age children may suffer from DCD, exhibiting *clumsiness* that is not due to an intellectual deficit or identifiable physical disorder. Wright et al. (1994) identified 4.72% of children in Singapore as having definite movement problems and a further 10.85% classified as being at risk.

However, in spite of the apparent agreement of prevalence, these figures are subject to definitional difficulties and the use of different instruments to identify children with DCD. When prevalence figures are published it is not simply a question of whether they agree with other figures, but also whether the same children are being assessed. This often varies according to how and for what purpose children are being assessed. For example, Maeland (1992) pointed out that although three different assessment methods identified about the same amount of children (5-5.6%), each procedure identified a different set of children.

Sugden and Henderson (1994) observe that in most studies the prevalence of boys is higher than that of girls, with some showing a slight difference while in others the ratio is as high as 3:1. Wright and Sugden (1996a) found similar prevalence rates amongst 6 to 9 year old children in Singapore. The reasons for the higher prevalence rate among boys are unclear, but Sugden and Henderson (1994) point out that similar ratios are reported for children who suffer from other specific learning difficulties such as dyslexia.

Nature

The knowledge gained over the past 30 years or so has been extensive, but the exact nature of DCD from the literature has not as yet reached the point where a totally clear picture is presented (Sugden & Wright, 1998). Individual aspects of the disorder have been researched highlighting distinctive behaviours; however, reports can be seen to reveal the perspective and interest of the author, and it is generally believed that the assessment and testing procedures influence what is found. Not only can the assessment procedures bias the findings in a certain direction, but the methods chosen to report the findings may also have an effect.

Two procedures have been used to investigate the nature of DCD. The first and most common is to compare the behaviours of children with DCD with those of children classified as not experiencing DCD. This method follows a long-established tradition of intergroup analysis, and distinctive aspects of DCD investigated in this way are well documented. However, an underlying question when performing intergroup analysis involves the concept of a syndrome; are differences found between DCD and non-DCD children clear, consistent, and reliable enough to constitute a recognisable syndrome? This involves the issue of homogeneity and whether children with DCD form a homogeneous group. Sugden and Keogh (1990) and Sugden and Sugden (1991) observed that, far too often, children with DCD are treated as a homogeneous group with respect to characteristics and remediation. However, recent research has shown that these children do not form a homogeneous group, and various attempts have been made to discover the exact nature of DCD. Wright and Sugden (1996a) demonstrated that there are two distinct methods of assessing the nature of DCD; *intergroup characteristics*, in which children with DCD are clearly different from a control group, and *intragroup characteristics*, where difficulties seen within the DCD group are not common to all the children.

Differences between children with and without DCD

Studies that describe differences between children with and without DCD range from general summaries to documentation of specific behaviours attributed to the disorder. The *British Medical Journal* (1962) lists many traits of children they refer to as clumsy; being in trouble at school, bad behaviour, experiencing difficulties with self-help skills and being awkward in their movements. In the study by Walton et al. (1962), the children's development is followed and observations are made about the delays of motor milestones in comparison with normally developing children. The authors found that the clumsy children displayed "excessive clumsiness of movement, poor topographical orientation, inability to draw, to write easily and to copy" (p. 610).

In the study by Gubbay (1975b), *clumsy* children and matched controls were both assessed on a screening test consisting of eight motor skills tasks and a questionnaire completed by the children's teachers. He found that the *clumsy* children differed significantly from the matched controls on nearly all the motor skills tasks and all the areas dealt with by the questionnaire, such as poor handwriting, low sporting ability, poor academic performance, bad conduct, clumsiness, and unpopularity.

During the 1970s and early 1980s, papers were produced that continued to demonstrate the difficulties that children with DCD experienced in comparison with other children. These papers demonstrated a sophistication not seen before, and provided information gained in a scientific manner. One such study is that by

Keogh et al. (1979), who considered whether different teachers and educators would identify clumsiness with any consistency. The study was part of a two year project to study clumsiness in a non-clinical sample of young school children, using a teacher rated checklist, classroom observations and a motor skills test. The study by Roussounis et al. (1987) describes the poor results on a standardised test of motor performance that children with DCD achieved in relation to their general abilities. Both these papers used standardised tests and the inclusion of control subjects with which to compare results.

Sugden and Wright (1998) observe that testing procedures not only became more sophisticated but also more comprehensive. Henderson and Hall (1982) used a battery of tests to determine the characteristics of *clumsy* children compared with matched controls. The battery of tests included scores on a motor impairment test, neurodevelopmental examinations, ratings of children's drawings, and an IQ and reading test. One area of focus within the study was to explore the possibility of subgroups existing within the DCD group. Henderson and Hall (1982) used the term *subgroup* to describe distinct behaviours seen within the DCD group, such as those children whose motor impairment was an isolated problem from their IQ, reading and number work. Another group included children whose motor impairment was associated with a number of other problems, such as low academic attainment, social immaturity, and negative attitudes toward school. Research continues to use matched controls to draw out the differences between DCD children and non-DCD children, but it has now moved on to isolate behaviours in a laboratory setting with greater control of confounding variables to assess aspects of DCD.

Sensory/Perceptual Functioning

Attempts have been made to identify the underlying causes of DCD, while at the same time highlighting specific deficits in children's motor performance. Some researchers have looked at the differences between a sample of *clumsy* children and a matching control group on their ability to process sensory/perceptual information. In a series of studies, Hulme and his colleagues (Hulme, Biggerstaff, Moran & McKinley, 1982a; Hulme, Smart, & Moran, 1982b; Hulme, Smart, Moran & McKinley, 1984; Lord & Hulme, 1987a; 1987b; 1988) investigated the processing of visual and kinaesthetic information in children with DCD. The children with DCD made poorer visual and kinaesthetic judgements than control children and, in addition, Hulme and his colleagues found that the children's poor performance on the visual tasks correlated with their poor movement skill. This led them to suggest that a deficit in visual processing is a causal factor in children with DCD.

In a follow-up study, Lord and Hulme (1987a) presented results that indicated a wide-ranging and serious impairment in perceptual processing in DCD children. Visual acuity was tested to rule out visual-sensory impairments using eye charts and sensitivity tests. These tests showed that the children with DCD were not hindered in this respect. Visuospatial perception was measured, and in each of the tests administered there were significant differences between the control children and those with DCD.

More recently, Mon-Williams et al. (1994) studied ophthalmic function in children with DCD, exploring the possibility that visual impairments might contribute to DCD. Results indicated that there were no significant abnormalities within the DCD group. This led them to suggest that motor problems can exist even with perfect retinal image clarity and, conversely, adequate motor behaviour can occur with poor binocular control. However, they point out that visual processing consists of much more than the provision of a clear retinal image and a deficit may lie elsewhere within the visual processing system. These results, as observed by the authors, lend weight to Abernethy's theory (1986) that ophthalmic factors play only a minor role in the control of perceptual-motor actions. The authors conclude that simple ophthalmic problems do not cause the motor difficulties experienced by a large number of the population with DCD.

Dwyer and McKenzie (1994) studied the contribution of visual memory to the development of motor coordination and suggest that children with DCD are unable to employ efficient rehearsal strategies to maintain a visual image in a form that would enable them to act upon it. In a follow-up study, Skorji and McKenzie (1997) examined the capacity of children with DCD to reproduce short sequences of simple movements. Their findings for immediate recall replicated those of Dwyer and McKenzie (1994). However, when interference dimensions were introduced in the recall tests, children with DCD only differed from the control children when visual interference with a high spatial involvement was presented. They suggest that children with DCD are more dependent on visuospatial rehearsal than control children when attempting to memorise modelled movements.

Kinaesthetic Functioning

Laszlo and colleagues (Laszlo & Bairstow, 1985; Laszlo et al., 1988a; Laszlo, Bairstow, & Bartrip, 1988b) adopted a process orientated approach to investigate the nature of DCD in respect to diagnosis and treatment. Much of their work has centred on the contribution of kinaesthesis to motor control and the Kinaesthetic Sensitivity Test (KST) (Laszlo and Bairstow, 1985). Their work emphasised the poor results seen in children with DCD on tasks that included kinaesthetic acuity, perception, memory, and velocity discrimination. After kinaesthetic training, the children with DCD made significant improvement in motor skill performance, and, according to the authors, so demonstrating the significant role that kinaesthetic sensitivity plays in motor control (Laszlo et al., 1988a; 1988b).

The most recent work emanating from the work of Laszlo and colleagues is reported by Sims and colleagues (Sims et al., 1996a; Sims, Henderson, Morton, & Hulme, 1996b). In the first study, Sims et al. (1996a) found no differential effect between two groups of children with DCD, when one group received kinaesthetic training and the other group was offered no treatment. In the second study, Sims et al. (1996b) compared three groups; one receiving kinaesthetic training, one receiving a program of treatment specifically designed to avoid any reference to kinaesthetic training, and one group who received no intervention. Children who received no treatment failed to improve their performance, whereas both groups of children receiving help improved significantly; however, neither group improved more than the other.

Other researchers have found contrary evidence to that reported by Laszlo et al. (1988a; 1988b). Sugden and Wann (1987) and Polatajko and colleagues (1995) did not find a significant relationship between the KST (Laszlo & Bairstow, 1985) and a normative based test of motor impairment, finding that children who received KST training did not perform any differently from other groups of children. Both these studies suggest that increased kinaesthetic acuity does not immediately translate into increased motor performance, nor into generalising new found skills.

Information Processing and Motor Programming

The theme of investigating and assessing DCD using an information processing model is seen not only in studies that explore the perceptual or input stage of the model, but also in studies concentrating on the role of feedback and motor programming. Lord and Hulme (1988) found that although patterns of movements between two groups of children on a rotary pursuit tracking task were similar, children with DCD were poorer performers when time on target was considered. Lord and Hulme (1988) concluded that although the children with DCD were not limited by an ability to develop a motor program for the rotary pursuit task, they were restricted by impaired visual feedback control. They suggested that although children with DCD have a representation of what needs to be done, they are slow in processing information that affects other aspects of motor control, such as responding to errors.

Smyth and Glencross (1986) suggested that children with DCD are deficient in speed of processing kinaesthetic information but not in speed of processing visual information. Using chronometric techniques, their findings suggested that DCD is associated with a dysfunction in proprioceptive information processing but not with an impairment in the response selection process. Smyth and Mason (1997) found differences between children with DCD and a control group on their ability to use proprioceptive information to match postures and to map between visual and proprioceptive space and between targets defined by the felt positions of their two arms. However, the same children displayed no differences in planning for end state comfort. Smyth and Mason (1997) conclude that inability to carry out simple motor tasks predicts difficulties with proprioceptive matching and aiming, but does not predict performance on action planning.

van der Meulen, Denier van der Gon, Geilen, Gooskens, and Willemse (1991) supported the findings of Smyth and Glencross (1986) and found only small and insignificant differences between children with DCD and their matched controls in their abilities to process visual feedback. van der Meulen and colleagues (1991) suggested that the increased time delay the children with DCD showed when trying to track a target was a consequence of a strategy they employed to deal with their difficulties in motor performance, and not due merely to impaired information processing. Similarly, Wann (1987) found that children experiencing problems with handwriting employed movements that allowed greater visual control during movement execution. Again, this can be seen as a strategy used to compensate for difficulties in motor performance, with a need to rely more heavily on visual feedback from the writing movements.

Rösblad and von Hofsten (1994) assessed the role of vision in the guidance of movement; they explored the possibility that children with DCD may be more dependent on vision than other children. Although all children were affected by removal of vision, the children with DCD did not appear to be especially disturbed. However, Rösblad and von Hofsten (1994) found that in all conditions, time taken for the children with DCD was slower than for the controls. This suggests that the children with DCD were no more or less reliant on visual feedback to control their movements than the control children; both groups merely slowed down the movement to maintain their accuracy level. The initial slower and more variable movements of the children with DCD is not then attributable to visual information but could possibly result from poor forward planning. If a child finds it difficult to plan ahead or anticipate and prepare for difficulties, then errors have to be dealt with as they occur, which interrupts the smoothness and efficiency of movement. Rösblad and von Hofsten (1994) see this strategy as being the result of anticipatory monitoring being replaced with feedback monitoring, which is both slower and more variable. The impaired capacity for anticipatory control is seen as a limiting factor for children with DCD.

These papers appear to agree that children with DCD have slower movements than their matched controls, but each paper offers slightly different explanations for this slowness. The explanations range from regarding perceptual aspects of the information-processing model as impaired to aspects of processing that link the input of information to the cognitive aspects of information processing. The intertwined role of these two features of information processing, input and decision making, appears to be significant.

Other studies have considered the central decision-making capacity of children with DCD. van Dellen and Geuze (1988) found that children with DCD were slower to respond to stimuli but not inaccurate in their movements, and concluded that the slowness was largely localised in the cognitive decision process response selection. In a second study, van Dellen and Geuze (1990) found that when the movement accuracy demands were relatively high, children with DCD were slower than controls in executing simple, goal-directed hand movements. This finding was substantiated by Vaessen and Kalverboer (1990) who found that motor tasks requiring greater accuracy constituted a heavier load for children with DCD than those with time pressures. Sugden and Wright (1998) suggest that it is possible that children with DCD underestimate the requirements of the higher movement accuracy demands and as a result, need more time to adjust their inappropriate movements. This could be due to inaccuracy in the perception of the accuracy demands or inaccuracy in the planning or programming of such movements.

Henderson et al. (1992) found that children with DCD did not perform as well as control children in tasks with both cognitive and motor load. Henderson et al.

(1992) found that it was not the motor loading that caused the decrement in performance but rather the cognitive loading in terms of the increased accuracy demands made by the reaction time task.

The findings of the experiments concerning DCD and information processing suggest that there is evidence of visual and kinaesthetic deficits in children with DCD concerning the input aspect of the information-processing model, leading to difficulties in error detection and movement correction during execution. These perceptual difficulties result in less efficient motor programming in children with DCD, particularly when accuracy and anticipation is required. As the complexity and spatial uncertainty of tasks increases, children with DCD find more and more difficulties with motor control.

These studies have all used matched controls to highlight the differences between two groups of children, and it is widely believed that detailed, pertinent information can be gained about impaired processes from research using this experimental design. Henderson (1992) notes that each separate study advances the knowledge and understanding of what underlies DCD, but whether it will ever be possible to produce a cohesive theoretical account from such divergent sources remains unclear.

Differences within the DCD group

An inherent presumption in the above method of investigation is that children with DCD all demonstrate the behaviours in question. Experimental designs including control children that have made group-based findings on a variety of characteristics of children with DCD appear to concur and, in some papers, there is a suggestion that the nature of DCD is such that the impairments seen in some children are not evident in others. This section attempts to show that children with DCD differ sufficiently from within their own groupings to warrant *intragroup* analysis of this disorder.

A number of studies exist which identify children with DCD as forming a heterogeneous group, in that the movement patterns they display are different in different children (Barnett & Henderson, 1992; Cantell et al., 1994; Dare & Gordon, 1970; Dewey and Kaplan, 1994; Gubbay, 1975b; Henderson & Hall, 1982; Hoare, 1994; Sugden & Sugden, 1991; Wright, 1996; Wright & Sugden, 1996a, 1996b, 1996c).

The extent to which the children experience movement difficulties is the factor that is most commonly used to discriminate one subgroup of children from another. Sugden and Sugden (1991) use the notion of children *at risk* and children with *movement problems* when referring to the severity of the disorder. The cut-off points in norm-referenced tests, such as the Movement Assessment Battery for Children (Movement ABC) (Henderson and Sugden, 1992), offer indications of the severity by reference to percentile charts. It is possible, however, to place children with DCD in subgroups from within the group on the basis of severity and on the nature of the disorder.

Subtypes of DCD

The most comprehensive reports detailing subgroups of children with DCD are those by Dewey and Kaplan (1994), Hoare (1994), and Wright and Sugden (1996a). Hoare (1994) reported on subgroups of children with DCD by examining the results of the children's performance on kinaesthetic, visual, cross modal (kinaesthetic and visual), and fine motor and gross motor tasks. Using cluster analysis she was able to confirm heterogeneity within the DCD group, and was able to define five patterns of dysfunction. From these patterns of dysfunction, Hoare (1994) was able to isolate five subgroups of children with DCD. One group found motor tasks difficult in the absence of perceptual problems, while another group had difficulties across both motor and perceptual domains. A third group had difficulties with both kinaesthetic and visual tasks, suggesting a generalised perceptual dysfunction. The children in the fourth group were characterised by their particularly good kinaesthetic processing but displayed a large difference between their performance on the visual and kinaesthetic tasks.

A fifth group had a mixed profile, suggesting some separation of inability within the gross motor domain.

Hoare (1994) concluded that these results demonstrate that while the children with DCD all experienced difficulties with their movements, there were examples of where specific difficulties were far more evident within one subgroup than another. Although Hoare (1994) does not claim to have discovered consistent subgrouping of the disorder, she demonstrates the heterogeneity of children with DCD.

In the study by Dewey and Kaplan (1994) four subgroups were identified, including a control group showing no motor problems. The four subgroups included one group with deficits in balance, coordination, and gestural performance; one with deficits in motor sequencing; one with severe deficits evident in all areas, and one with no difficulties compared with the others. Of particular interest in this study is the distinction between the first two groups; one displaying difficulties in the execution of motor skills with planning apparently remaining intact, and one group showing difficulties in the planning.

The work of Hoare (1994) has been supported by Wright and Sugden (1996a); they found four clusters of children who, whilst all experiencing difficulties generally, had specific problems areas: The children in the first cluster demonstrated the most even profile of all the clusters and represented the least impaired of the DCD children; they needed help in all areas but their difficulties were not as severe as some of the other DCD children. The second cluster of children scored poorly on the factor indicating that help was needed to perform throwing, aiming, and receiving. The third cluster needed most assistance when the environment was changing, but they also exhibited difficulties in the *control of self* factor. The children in the forth cluster demonstrated the most obvious difficulty; they recorded the highest score on manual tasks and the highest score for *dynamic balance*.

The clusters found by Wright and Sugden (1996a) matched some of those found by Hoare (1994), who also identified one group of children with a specific difficulty concerned with visually loaded tasks. Hoare (1994) also isolated a group of children who showed great difficulty with manual dexterity and with static and dynamic balance.

The cluster analysis used by Hoare (1994) found clusters of children with DCD who, although being equally impaired overall, demonstrated deficits that generalised across modalities and deficits that were highly specific. All the children in the Wright and Sugden (1996a) study were assessed using the Movement ABC (Henderson & Sugden, 1992) and failed either or both the checklist or test, placing them in the DCD category. However, the factor and cluster analysis has shown that although they may be equally impaired according to test scores, they do not all demonstrate impairments in the same problematic motor behaviours.

The study by Wright and Sugden (1996a) also reveals some patterns of associated behaviours. Those children in cluster 3, considered to be the group with many difficulties, show the clearest pattern of associated behaviours related to their movement difficulties; they are seen to be easily distracted, lacking in persistence, disorganised, and confused about their school tasks. As this group of children scored poorly on the *changing environment* factor, the associated behaviours would interact to make adjustments to a changing environment difficult. Cluster 4 also shows a profile of being easily distracted, looking around and responding to noise and movement outside of the classroom environment. This may add to the causes of the poor performance in manual dexterity tasks done under a time constraint.

Prognosis

When examining origins and development, there are a number of age-related issues that need consideration. Stanley & Alberman (1984) noted that if there is a cohort of children with low birth weight and a short gestational age, there will be a higher incidence of children with cerebral palsy. However, the question arises about the remainder of the cohort who do not develop cerebral palsy; if these children are examined on entry into school, at around 5 years of age, will there be a higher incidence of general motor disorders? Sugden and Wright (1998) consider this and comment that an investigator can begin by identifying and assessing children for motor difficulties at 5 or 6 years of age and follow them longitudinally to monitor their development over the next few years. Are the same children identified at, for example, 12 or 16 years of age as those who were identified at 5 or 6 years of age? For those who remained the same, were there any experiences that they missed during childhood that may have contributed to any lack of improvement? Of equal importance is to examine children who were having problems at one age and yet these problems seemingly disappear a few years later.

There are two bodies of literature that deal with these questions. The first often concerns antecedents in the early years, such as birth factors, the status of the young infant, and development in the early years. The second body of literature examines the relationship between early school age motor disorders and the progression during the school years into adolescence.

Development in the early years

The relationship between neurological examinations and fundamental units early in life and later behavioural signs at school age has long been a concern of investigators. Several large-scale longitudinal investigations have detailed the first 5 years of life, examining the progression of those showing at-risk signs at birth to determine the predictive value of certain antecedent conditions.

A major study examining longitudinal data on young children was provided by a developmental screening programme conducted by Drillien and Drummond (1983) in Scotland. They examined the course and occurrence of neurodevelopmental disabilities during the first three years of life in relation to educational and behavioural problems during the first two years of schooling. The incidence of movement disorders as the primary problem was 1.8% from a population of 3,667 children, with additional information available on 100 children who were referred for displaying movement disorders. Of these, when specialists made detailed assessments of the primary disorder, almost 40 could be placed in categories other than the primary disorder. Thus, if the Drillien and Drummond data are typical, prevalence of motor disorders based on screening assessments will be overestimated. It is interesting to note that 80% of movement disorders were identified between 8 and 20 weeks, whereas only approximately 30% of other problems were identified early. Sugden and Keogh (1990) comment that in the early years, movement behaviours are the prevalent response mode with the result that movement problems are more likely to be noted, often as indicators of other conditions. In the Drillien and Drummond (1983) study, many children with movement disorders also had minor abnormal neurological signs in the first three years but because there was an overall high proportion of children with minor abnormal neurological signs in the first year, having movement difficulties was too common a problem to be a predictor of other problems.

One way to examine aetiological factors is to take specific groups of children identified for risk factors and then compare prevalence rates with a control group. This method was used by Hall, McCleod, Counsell, Thompson, and Mutch (1995) who looked at motor function of children at 8 years of age in a population of children who had very low birth weights. Using the Movement ABC (Henderson & Sugden, 1992), the authors found significant differences between both low birth weight groups and control groups. In the group of children with birth weights below 1000g, 50% scored below the 10th percentile on the Movement ABC. In the control group, this figure was 8%. In the group of children with birth weights between 1,000g and 1,499g, 34% scored below the 10th percentile, whereas in their control group, the figure was 11%. Similar results were found by Roth, Baudin, Pezzani-Goldsmith, Townsend, Reynolds, and Stewart (1994) who examined neurodevelopmental status at 1, 4, and 8 years of age and found that neurodevelopmental difficulties at 1 year of age are good predictors of outcome at 8 years of age.

Some children identified at birth or shortly afterwards will continue to have motor problems later on. However, individual prediction is difficult. Group data will support the contention that a greater proportion of those with early problems will persist in showing them later in childhood. However, the data are not strong enough to take individual cases and make accurate predictions about future performance. This is made more complex by the measures that are taken at birth. From a group of children with neurological signs at birth, some may not survive, while others will develop recognised biological disorders, such as cerebral palsy. From the remainder, there will be a higher incidence of coordination disorders that persist through to school entry, and may possibly continue through childhood into adolescence.

Development from early school years to adolescence

There are two types of studies that provide information about development and progression from 6 or 7 years of age onward, and it is from these that trends and principles can been drawn out. There are longitudinal studies which focus on general development, examining a number of variables including motor behaviour. There are also studies that have specifically targeted motor behaviour, usually starting around 6 or 7 years of age and examine a group over a period of time.

Follow-up Studies

The studies in this section examine the motor domain as the primary dependent variable with other variables related to the core motor disorder.

A study entitled ‘Clumsiness in Children – Do they grow out of it?’ was published by Losse et al. in 1991, in which the authors investigated the long-term prognosis for children with DCD. Essentially, the study was a 10-year follow-up of a sample of 32 children, 16 of whom were originally described as *clumsy* and 16 children matched for age, gender, and intelligence. 10 years later, the authors carried out a series of assessments on all 32 children, including a neurodevelopmental test battery, The Henderson revision of the TOMI, Weschler

Intelligence Scale for Children, a Perceived Competence Scale for Children, school records and an interest questionnaire and interview.

One of the questions addressed by this study concerned the changes within the DCD group over time. The data collected suggest that the children as a group do tend to have pervasive problems in most areas, although there are many individual differences. The scores on the motor assessment instrument show a general lack of proficiency, which were further substantiated by comments from the pupils concerning their experiences. The authors reported that the academic and social competence scores are more variable; some were adequate, but overall they were more negative than they had anticipated. The authors presented results as case studies, one of which showed a child who was fairly successful at an early age but at 16 had a very low self-concept with plummeting IQ scores, achievement in school was very low, and had a serious emotional and behavioural difficulty. Another child from the DCD group still appeared to have motor difficulties, but he had supportive parents and teachers and was still highly motivated to learn new skills. This child did not have a low self-concept, his behaviour was good, and he was confident. Although his academic achievements were not high, he had many friends and appeared to be a well-adjusted teenager.

Losse et al. (1991) discussed the fact as to whether children grow out of this condition. While noting that some earlier studies investigating this same question reveal difficulties, they concluded from their own study that motor coordination disorders are not confined to early childhood, as most of the children in the DCD group still had coordination difficulties as teenagers. Losse et al. (1991) also concluded that the problems associated with clumsiness at age 6 are still present at the age of 16, appearing to be true both for academic attainment and for social and emotional adaptation. However, they were cautious in interpreting these associated difficulties as being a direct consequence of motor coordination difficulties. Overall, Losse et al. (1991) noted that minor motor difficulties in early childhood should not be ignored; the effects of being clumsy are evident into the teenage years and manifest themselves not only in the motor domain but also in other areas, affecting other aspects of the child's functioning.

Another follow-up study was reported by Cantell et al. (1994) who examined Finnish children at 15 years of age, having originally been diagnosed as motor delayed at 5. At 15 years of age, the children were assessed on motor abilities, educational performance, social and emotional development including self-image, and leisure activities. The original cohort consisted of 106 children classified as motor delayed and 40 control children. For this study 10 years later, a total of 81 of the motor delayed children and 34 control children were found. Of the 81 motor delayed children, 53 were still classified as motor delayed and thus labelled the *stable clumsy group*, while 28 were found to be no longer different from the controls, and reclassified as the *intermediate group*. Of the children identified at 5 years of age, 46% were still significantly different from the control group at 15. The intermediate group had some residual problems, being different from the control group on some tasks and not on others, but their overall performance was better than that of the stable *clumsy* group.

The *clumsy* group was found to have lower achievement, but it was noted that this did not alter during the course of the study. They also displayed lower aspirations for their future, and were also fairly accurate in their estimations of their performance at school. This group did not perceive their social status to be any different from the other groups, but they took part in fewer social activities. The intermediate group continued to have some difficulties with motor tasks at 15, although these were less extreme than those found in the stable *clumsy* group. The intermediate group appeared to have adjusted to their difficulties and were succeeding in school and took part in sports and other social activities. Cantell et al. (1994) commented that the differences between this group and the stable *clumsy* group suggest that social and educational outcomes are poorest for those with the most extreme motor difficulties at 5 years of age or for those with motor difficulties associated with lower intellectual abilities. Cantell et al. (1994) conclude that "Some children do 'grow out of it;' some do not" (p. 127).

In a series of studies, Gillberg and Gillberg and colleagues identified a condition they have termed DAMP – deficits in attention, motor control and perception (Gillberg, 1983; Gillberg & Rasmussen 1982a; 1982b; Gillberg, Rasmussen, Carlstrom, Svenson, & Waldenstrom, 1982; Gillberg, 1985; Gillberg & Gillberg, 1983; 1989; Gillberg, Gillberg & Groth, 1989). In Sweden, children are screened for DAMP at 6 years of age and many of these children have been followed through a number of longitudinal studies. From these studies the concept has been shown to be a pervasive disorder with both attention and behaviour deficits remaining with the children (Gillberg & Gillberg, 1983; Gillberg et al., 1989).

In their longitudinal study, Gillberg et al. (1989) found that from the age of 7 to 13 years of age 70% of the original cohort of children with *motor perception dysfunction* (MPD) no longer displayed any characteristics. However, Gillberg and Gillberg (1989), reporting on the same cohort of children, found that 84% of the children still classified as having MPD had either behavioural or school achievement problems at 13 years of age.

Using the same children, Hellgren, Gillberg, Gillberg and Enerkskog (1993), examined general physical and psychosocial health 10 years after the original study, when the children were 16 or 17 years of age. They found that children diagnosed as having DAMP at 7 years of age continue to show health problems at 16, over and above those of the general population. The DAMP group had more febrile seizures, more substance abuse, more accidents, longer visual reaction times, and a higher rate of gross and fine motor problems. However, although group data showed a higher proportion of problems in the DAMP group, a number of individuals in the group did relatively well. The authors comment that these results indicate that DAMP is a neorodevelopmental disorder with changing clinical landmarks, which in some cases continues to cause difficulties throughout childhood and adolescence. They present this data in support for the proposition that motor problems persist throughout childhood and argue against the notion that children will grow out of it. Michaelson and Lindhal (1993) reached a similar conclusion that even if some children do improve with age, there is still a large number whose motor problems continue well beyond childhood.

It has sometimes been suggested that a distinction can be made between children whose early motor problems are a relatively isolated phenomenon and children whose difficulties are more extensive. The long-term prognosis for the former group is thought to be much better. For example, Bax and Whitmore (1987) noted that the intelligent *clumsy* children they identified at 5 years of age had fewer problems at 7 and 10 years of age than those whose other learning difficulties were already evident at 5. Gillberg and Gillberg (1989) suggested that children whose motor problems are accompanied by attentional problems do less well in school than those with isolated motor problems.

However, Losse et al. (1991) maintain that a categorical distinction between isolated clumsiness and clumsiness with other difficulties is too simplistic. The main difference between the Losse study and those of Bax and Whitmore (1987) and Gillberg and Gillberg (1989) is that the Losse study extends well into the secondary school years. Results from the study show that minor motor difficulties in early childhood should not be ignored. The effects of being *clumsy* are evident into the teenage years and manifest themselves not only in the motor domain but also in other areas.

These longitudinal studies which examine a number of developmental variables are important; they provide invaluable descriptions of children with difficulties over long periods of time, allowing researchers to examine mediating variables that influence the individual's development and, in addition, they place motor attributes in the context of other development and allow complex interactions across different attributions to be examined. As noted by Sugden and Wright (1998), if only motor variables had been measured in the DAMP studies, the information that we now have concerning difficulties that seemingly disappear but re-emerge in other areas would have been lost.

The results of the studies concerned with long-term prognosis of DCD are still somewhat equivocal although, as noted by Sugden and Wright (1998), there is a clearer picture developing as research in the area becomes tighter and re-examines previous work. What is evident is that there are children who do not spontaneously grow out of the condition and there are children who literally suffer from the effects of DCD for considerable periods of their childhood. The long-term prognosis of DCD is an important question for research to answer but, even if DCD is a temporary difficulty for some children, the anxiety felt by the children and the poor motor skills exhibited are crucial issues to be dealt with at any time.

Associated Difficulties

The features associated with DCD are many and are not confined to the more noticeable motor skills. There are also social and affective concomitants which can all combine to detract from the child's academic progress (Losse et al., 1991).

Many studies bear witness to the varied problems displayed by children with DCD. Gubbay (1975a) found that children were rejected by their classmates; Keogh and colleagues (1979) found that children with DCD attempted to cover up their difficulties by exhibiting disruptive behaviours in class. Kalverboer (1988) found that children with DCD were also considered to be withdrawn, submissive, and self-conscious, while Henderson et al. (1989) showed that children with movement difficulties were unrealistic in the way they set goals for themselves, had lower self esteem and were less inclined to accept responsibility for what might happen to them.

Although, as pointed out by Sugden and Henderson (1994), bright and well adjusted *clumsy* children do exist, they are in the minority; it is far more common to find children whose poor movement skills are accompanied by educational or behavioural problems. "Although a causal relationship has not been clearly established between DCD and school achievement, there is good evidence to suggest that there is a strong correlation" (Sugden & Henderson, 1994).

Sometimes the fact that children with movement difficulties do less well academically than would be expected from their cognitive ability can be directly explained by problems with handwriting, poor presentation, slowness to complete work and disorganisation. At other times, low self-esteem, difficulties in concentrating, unhappiness because of bullying or rejection, will ultimately mean that these children will fail to show their true potential in the classroom. A study carried out by Schoemaker and Kalverboer (1994) found some children whose lack of competence in the motor domain contrasts sharply with their academic and social success. However, far more common are those whose movement difficulties are accompanied by lack of confidence, poor motivation, low self-esteem, depression, and social isolation. In a study by Smyth and Anderson (*in press*) it was found that, as a group, children with coordination disorders spent longer alone in the school playground, more time watching other children play, and at some ages spent more time moving around the playground without being engaged in any game or structured activity. In agreement with Schoemaker and Kalverboer (1994), Smyth and Anderson (*in press*) suggest that exclusion or withdrawal is already operating and some children with coordination problems are isolated from social play by the age of 6 years.

It is often assumed that the emotional problems experienced by children with DCD are simply a secondary consequence of their movement difficulty. However, Sugden and Henderson (1994) suggest that a more useful way of understanding the relationship is to view them as being in continuous interaction with each other. It is easy to see how being poorly coordinated from an early age can have negative effects; even at a very early age social rejection by peers may occur as the child with DCD is seen as an unpopular playmate. Such rejection marks the beginning of a cycle of lack of participation, reluctance to learn new skills, resistance to practice, declining confidence, lack of self-esteem and social isolation. "If such a cycle is not broken, then the consequences for some teenagers can be severe" (Sugden and Henderson, 1994).

Summary

Earlier work concerning the identification of children with DCD has concentrated upon school age children and how the disorder manifests itself through difficulties related both to daily living and to school related tasks. A number of studies have investigated the outcome of this disorder in adolescence, noting that appropriate intervention and management strategies play a crucial part in the successful resolution of the difficulty.

The ramifications of having DCD are seen in poorly coordinated living skills, and those motor skills needed for progress in the formal and informal learning environment of school. Motor competency is an important determinant of a child's educational progress as well as more general development. In most cultures, for example, learning in the early years is based on exploratory play, which in turn involves movement. As the child gets older, the ability to write legibly and with adequate speed becomes a prerequisite for note taking and examination performance as well as being a component of more general literacy skills. In addition, lack of movement skills may exclude a child from playground activities, leading to social isolation, loneliness, and even depression (Gillberg & Gillberg, 1989; Hellgren, Gillberg, Bagenholm, & Gillberg, 1994; Losse et al., 1991; Smyth & Anderson, *in press*).

The long-term prognosis for these children is not good in general, although some children do catch up with their peers (Cantell et al., 1994; Geuze & Börger, 1993; Losse et al., 1991; Lyytinen & Ahonen, 1989). The evidence thus far shows that those children who receive help will make gains in their motor skills and associated behaviours (Polatajko et al., 1995; Revie & Larkin, 1993; Sims et al., 1996a; 1996b; Wright & Sugden, 1998). In view of this, it is necessary that young children with movement difficulties are consistently identified and assessed in order that the nature of their difficulties can be determined and, where necessary, appropriate management and treatment of the disorder may ensue.

CHAPTER 4

Development of the Early Years Movement Skills Checklist

Introduction

The focus of this study is the movement skill problems children may experience within their everyday situation. It is important, therefore, that the assessment instrument can be used flexibly by teachers/parents/carers as part of everyday activities, and not within an artificially created testing situation. The issue is how they perform on a day-to-day basis and not on a one-off specific motor skill or task. This is in keeping with the American Psychiatric Association's DSM-IV (1994), which states that in order for a diagnosis of Developmental Coordination Disorder to be made a child must experience movement problems which significantly interfere with academic success or activities of daily living. However, the diagnosis cannot be made if the disturbance is due to a medical condition such as cerebral palsy or muscular dystrophy. If a child has mental retardation, the diagnosis of Developmental Coordination Disorder can only be made if the movement difficulties are in excess of those usually associated with mental retardation.

Diagnostic criteria for 315.4 Developmental Coordination Disorder

A. Performance in daily activities that require motor coordination is substantially below that expected given the person's chronological age and measured intelligence. This may be manifested by marked delays in achieving motor milestones (e.g., walking, crawling, sitting), dropping things, "clumsiness", poor performance in sports, or poor handwriting.

B. The disturbance in Criterion A significantly interferes with academic achievement or activities of daily living.

DSM IV (1994, pp. 54-55).

Performance inadequacies on movement assessment tests will provide an initial indication of movement skill problems, but detailed and systematic observations of children with movement problems are also needed to fully identify the nature of a child's problems. The inability to perform a movement adequately is a general indication of movement difficulties; how a child attempts a movement can provide further insight into the problems that a child has. An additional consideration in measuring movement problems is movement-related behaviours which are important when moving and participating in movement activities (Keogh et al., 1979). Movement-related behaviours are difficult to separate from movement skills when measuring movement difficulties, and therefore need to be considered in any assessment of movement problems.

It is acknowledged that methods of identification and assessment are inextricably linked to the nature and characteristics of any disorder and, indeed, often determine what the central features are (Sugden and Wright, 1998). A major concern when examining assessment processes and instruments is why the test is being used, and for what purpose will the results be used. Very often the questions run in tandem with who is using the test. At a fundamental level, one can regard some assessment regimes as being purely for screening purposes so that a large population can be reduced to a smaller sample identified as being at some kind of risk. Motor behaviour is frequently assessed as part of a larger battery of overall development and gives a professional an overview of a child's profile of abilities. Examples of tests such as these include the Bayley Scales of Infant Development (Bayley, 1993) and Griffiths Mental Development Scales for testing babies and young children from birth to eight years of age (Griffiths, 1967). However, Sugden and Wright (1998) point out that for a more detailed examination of motor behaviour, tests which directly address motor aspects of a child's functioning are required.

Henderson (1987) undertook a critical analysis of types of assessment instruments and methodology. In her review of assessment types, Henderson (1987) divides tests into those which she labels traditional and have formed the basis of assessment by psychologists, paediatricians, therapists and teachers, and those she labels as alternative and have emerged as a result of the criticisms aimed at the traditional approaches. Henderson divides the traditional approaches into descriptive tests, diagnostic tests and neurodevelopmental test batteries. Descriptive tests are usually aimed at assessing functional performance in everyday activities, producing a quantitative measure of the child's performance. These tests use chronological age as the measure against which performance is judged and composite scores are used in a normative manner to compare child against child.

Henderson (1987) questions the usefulness of chronological age as a yardstick against which development should be judged. She quotes Connolly and Prechtl (1981) who noted that models of development which emphasise regularity and do not sufficiently acknowledge variation have been seen to be inadequate. Consequently, some doubt has been expressed about the use of age-related measures in testing. Furthermore, there is concern about tests standardised on populations of normal children being used on children with disabilities; if a test is designed to encompass the entire range of performance then the 'grain' of the test has to be so coarse that it fails to register small differences between impaired children. It is also clear, according to Henderson (1987), that such tests do not identify changes in performance resulting from intervention. However small these changes might be when seen in the context of the spectrum of performance across all individuals as far as a particular child is concerned they may represent major progress.

Although the Checklist includes items which are believed to be age-appropriate, it is not a standardised test with norms; rather, it is an instrument designed to be used flexibly by teachers or parents to describe more accurately the difficulties some children are experiencing in the motor area. It provides some detail about an individual child's performance with respect to functional competence in realistic everyday situations. The Checklist is based on the theoretical framework that recognises that an individual always performs a task in a contextual setting. By constructing the Checklist in this way it is possible to use the profile of a child's score in a diagnostic manner to address specific concerns that the Checklist highlights. For example, a child's performance may be seen to be weighted in one of the areas only, thus pointing to the specific area of need. This will then give specific guidelines for intervention.

The integral nature of assessment and management follows a number of guiding principles. It has been noted that a system of assessment and identification of movement skill problems needs to be based firmly on the developmental progression of children, the interaction with the task to be completed and the context in which it is being performed (Keogh and Sugden, 1985). The identification of children with movement problems should involve an assessment of movement performance in relation to some general expectations of what is adequate movement skill. Another principle guiding the work is that activities within the movement skill domain should be organised into a framework so that a class of activities can be identified, with remediation aimed at that class (Sugden and Sugden, 1991).

CONSTRUCTION OF THE CHECKLIST

Theoretical foundations of the Checklist

Establishment of vocabulary of functional movement skills

The available literature on movement development was studied in detail to establish the movement skills of 3 to 5-year old children. From the ages of two to seven years children are constantly modifying and elaborating earlier achievements, leading to the development of a large repertoire of movement skills during the early years of childhood. At the end of this period, children should have good enough control of body movements to perform many fundamental play-game skills and many functional hand skills, although Keogh and Sugden (1985) point out that they will not use them very well in open movement situations. Children will continue to improve their control of body and limb movements beyond this age by increasing their level of performance and their repertoire of movement skills to cope with personal desires and situational requirements and conditions.

By the time young children have completed the early school years they have developed a large repertoire of movement skills, particularly self movements, movements in which the child has control of it own movements. Their movements become more continuous and appear to be easier and smoother, they make fewer extraneous movements and go through a fuller range of motion and their movements are more consistent, efficient and effective. Simple observations of changes in core movement skills, such as walking, running and many manipulation movements, illustrate these general descriptions of change. Young children also become more able to do things simultaneously and to achieve intended outcomes in various different ways.

Between the ages of two and seven years, young children become more proficient at modulating and varying force production in movements. They can make more precise and more delicate movements and can adjust to task and situation requirements, such as needing to move slowly. They become more proficient at generating force more effectively by using movements to summate and transmit force, for example, in throwing. They also improve their postural control to control the forces generated in movements, which has the reciprocal effect of enabling more forceful movements. This also leads to some movements being less difficult because additional speed provides motion stability.

Manual control improves markedly during the preschool and early school years. At age 7 years, children have a good repertoire of manual movements, including grip variations and numerous ways to combine arm and hand movements. The intrinsic movements of each hand provide dexterous control in handling objects. Older children can make power and precision movements with the same tool, whereas younger children often are limited to power movements. Functional asymmetry is well established to provide a wide range of collaboration between the hands. Much of what a young child learns is acquired through using the hands in various ways. Activities that occur in the early years class provide evidence that the child with poor manual dexterity is considerably disadvantaged: drawing, painting, using construction toys, pouring, stirring, kneading dough or rolling pastry, using toy tools such as hammers, screwdrivers and saws are all examples of activities that typically occur in early years classes (Sugden & Henderson, 1994). The child who cannot participate in these activities is missing out on important learning experiences. Manual tasks involving the use of both hands can be classified in various ways. For example, a broad distinction can be drawn between those in which one hand has a primary function and the other adopts a supportive role, such as writing with one hand and holding the paper with the other, and those in which the hands coordinate by performing two separate aspects of the same task, such as in buttoning and unbuttoning.

The following sources were used in order to generate a list of functional activities seen in 3 to 5-year old children (List 1). Cohen and Volkmar (1997), Cratty (1986), Espenschade and Eckert (1967), Gallahue (1982), Goldfield (1995), Griffiths (1967), Haywood (1993), Kalverboer et al. (1993), Keogh and Sugden (1985), Klin, Carter, Volkmar, Cohen, Marans and Sparrow (1997), Knobloch and Pasamanick (1974), Koegel and Koegel (1996), Prizant, Schuler, Wetherby and Rydell (1997), Schuler, Prizant and Wetherby (1997), Schmidt (1991) and Wetherby, Schuler and Prizant (1997). These activities are derived from the movement skills typically seen in this particular age group: body control such as that seen in walking, running, jumping, hopping, throwing and balancing; manual control such as self-help skills including dressing, washing and feeding, construction skills, holding grips for writing and drawing, and bimanual control; and control of limb movements.

LIST 1

Movement for self

- Put on and take off articles of clothing (sweater, T-shirt, coat)
- Unbutton accessible buttons or undo zip
- Wash and dry face and hands, and brush teeth
- Feed self using cutlery (e.g. use knife and fork to cut fish finger)
- Use cup/beaker competently
- Demonstrate good posture when sitting or standing
- Copy/trace simple figures (circle, cross, square)
- Pick up and manipulate small objects (Duplo, Lego, Megablocks)
- Plan and construct models from Duplo, Lego, Megablocks
- Walk around the classroom/school avoiding collision with stationary objects/persons
- Name/recognise body parts (wrist, elbow, ankle)
- Use playground equipment competently (climbing frame, slide)
- Demonstrate an understanding of directional commands (forward/backward; over/under; in/out)
- Throw ball to hit a stationary target
- Hop 1-3 times on preferred foot
- Run and jump over low stationary object
- Balance for 5 seconds on one leg

Movement with others

- Move around the classroom/school avoiding collision with other moving persons
- Move around tracking/staying with a person in the playground e.g. tig/tag
- Move to intercept and stop a moving object (ball, toy car)
- Ride moving vehicles (pedal car, tricycle)
- Clap hands/tap feet in time to a musical beat
- Catch a large approaching bouncing ball with two hands

The activities listed above are those which are typically seen in early years classes, and those which are within the developmental boundaries of 3 to 5-year-old children.

As noted above, one of the guiding principles underpinning the construction of an assessment instrument concerns the organisation of movement activities into a framework. For the purpose of this project, the categorisation of functional skills by Keogh and Sugden (1985) was taken as a starting point in the development of a framework for this early years checklist. The classification proposed by Keogh and Sugden (1985) involves categorising movement according to mover-environment relationships, using a framework first proposed by Gentile and colleagues (1975). The framework involves four sections: *Child stationary - Environment stable*, *Child moving - Environment stable*, *Child stationary - Environment changing*, *Child moving - Environment changing*. The starting point for the framework is a recognition that an individual performs a task in a contextual setting. Thus, when a task is being performed, an examination of both the individual and the state of the environment is required. The individual performs movements either with the body stationary or movements which involve the body moving. In addition, some movements involve limb manipulation and in this situation the body can be either stationary or moving. Similarly, the environment can be either stable or unstable. It is important, therefore, to analyse movement in each of these contexts. This type of analysis relates to the child's difficulties in such a way that distinctions can be drawn between those occasions when a child is in control of their own actions in a stable environment and those occasions when the child must respond to the demands of a moving environment.

However, after consultation with early years educators, it was felt that these four categories were far too complex for young children, and the activities within them would be beyond their experience. It was, therefore, decided to divide a list of motor activities seen in young children into the two categories *Movement for Self* and *Movement with Others*.

Interview of relevant professionals

The list of activities (List 1) was then taken to twenty professionals involved with young children who were asked to comment on the appropriateness and suitability of the activities in the list. The professionals interviewed included a Senior Paediatric Occupational Therapist, a Health Visitor, a Nursery Officer, a Nursery Headteacher, a Nursery Class Teacher, Physiotherapists and University Lecturers. The list of activities was also taken to a Child Developmental Centre (CDC); this group included Physiotherapists, Occupational Therapists, a Speech Therapist, a Social Worker and a Pre-school Liaison Officer.

The focus of the interviews with these professional centred on the following aspects:

- the appropriateness of the activities contained in the checklist
- the degree to which the activities are functional and everyday skills
- the specific nature of the activities
- suggestion of further activities to include in the checklist
- the categorisation of activities into a framework

Feedback on the List of Activities

Full details about all aspects of the interviews can be found in Appendix 1.

Appropriateness of activities contained in the list

When considering the appropriateness and suitability of the items in the list of activities, the majority of those interviewed expressed concern at some of the activities expected of the 3-year-old children. While it was acknowledged that there is variability in the age of acquisition of various movement skills, it was still felt that some of the activities would be outside of the experience of the majority of 3-year-old children. The particular concerns related to the following skills:

Feed self, using cutlery (e.g. use knife and fork to cut fish finger) All the comments that were received noted that it was inappropriate to expect 3-year old children to use a knife and it was suggested that it would be more appropriate to assess the child's ability to use a fork and spoon.

Copy/trace simple figures (circle, cross, square) Comments concerned the fact that 3-year-old children would not be able to copy a square and some suggested that some 3-year-olds would not be able to copy a cross. It was also suggested that this item should be divided into two separate items.

Plan and construct models from Duplo, Lego and Megablocks Again, it was noted that while 3-year-old children would be able to construct models, they would not be able to plan the construction.

Throw ball to hit a stationary target It was not expected that 3-year-old children would be able to do this. Most 3-year-old children would be able to throw a ball but not hit a target.

Clap hands/tap feet in time to a musical beat One professional commented that this item was dependent on musical ability and the inability to perform this activity was not an indication of a movement problem.

The comments which were offered on other activities reflected the degree of variability with which children acquire and develop specific movement skills, and the different expectations different people had of young children. For example, some of those consulted did not expect 3-year-old children to be able to *put on and take off articles of clothing*, while others felt that the activity was appropriate for the age group. Other skills where opinion was divided included *Unbutton accessible buttons or zip*, *Name/recognise body parts (wrist, elbow, ankle)*, *Use playground equipment competently (climbing frame, slide)*, *Demonstrate an understanding of directional commands (forward/backward; over/under; in/out)*, *Hop 1-3 times on preferred foot*, *Balance for 5 seconds on one leg*, *Move around tracking/staying with a person in the playground e.g. tig/tag*, and *Catch a large approaching bouncing ball with two hands.*

The degree to which the activities are functional

All of the professional interviewed commented that the activities contained in the list were functional skills which, if not seen everyday, were seen more often than not in early years classrooms. However, as noted above, some had reservations about the age appropriateness of some of the activities and would therefore not expect to encounter them in classes in which there were 3-year-old children.

The specific nature of the activities

Some of the professionals consulted made suggestions in order to make the activities more specific. For example, it was suggested that the activity *Put on and take off articles of clothing (sweater, T-shirt, coat)*, should involve putting on 'easy' clothes such as an apron for painting or an unbuttoned coat. It was suggested that the activity *Demonstrate good posture when sitting or standing*, should include a phrase such as 'keeping back straight' in order to assist in assessing this activity.

Suggestion of further activities to include in the checklist

Many activities were suggested by the professional consulted and have been detailed in Appendix 1. These suggestions can be broadly grouped into a number of categories, including balance and posture, self help skills, fine motor skills/manipulative skills, mimicking/imitation of everyday life motor skills, and specific ball skills.

The categorisation of activities into a framework

After consultation with these professionals, it was agreed that the categorisation of *Movement for Self* and *Movement with Others* would not be useful with young children because of the difficulty of *Movement with Others*; there were a far greater number of items in the section *Movement for Self* than in the section *Movement with Others*. This was not unexpected as the majority of the movements seen in young children are self-movements and it was felt that the present categorisation did not provide an appropriate balance of the range of movement skills seen in this age group.

Therefore, alternative ways in which to categorise the activities were considered. The focus of this study is the movement skill problems that children may experience within their everyday situation and the activities contained within the checklist are functional, everyday skills. It was felt that as movement difficulties are one of many developmental disorders in children, there may be some common element in assessment and management strategies running across other developmental disorders.

It was decided to examine management strategies in autism with an emphasis on language activities. The types and strategies for management in autism are guided primarily by a pragmatic concern for what is useful in promoting development and adaptation. Researchers and practitioners have made significant progress in improving language skills in autism and the current focus of communication enhancement efforts is the development of functional communication abilities, involving the development of a number of underlying abilities and behaviours. From this a number of principles emerge which it is felt could be useful in the development of a theoretical basis for the management of children with movement difficulties.

One of these is concerned with *natural contexts*, with a proposal that intervention should be central to a child's daily experiences and interests and should take place in contexts of predictable routines (Schuler et al., 1997). In support of this it is noted that functional language use and active participation communicative exchange are learned most effectively within activities and routines that are encountered regularly or can be scheduled to occur in a person's daily experiences (Duchan, 1991; Prizant, 1982).

Another principle concerns accurate *assessment of needs*. The main points centre around the consideration of the competencies and needs of the individuals involved, such that decisions regarding content and context of intervention efforts should be fine tuned, based on the assessment of related cognitive and socioemotional abilities and ongoing diagnostic teaching (Schuler et al., 1997). In the application of any of these treatments, an essential step involves a functional analysis of existing behavioural patterns.

The emphasis on function and context as exemplified in autism was a particularly attractive framework and it is this which is central to the thinking behind the construction and categorisation of the checklist.

Construction of Checklist 2

Checklist 2 (see Appendix 2) was constructed using some of the items contained in the original list of activities and some of the items suggested by the professionals interviewed. It was constructed by working bottom up from the list of activities and considering the appropriateness of each item in relation to the developmental literature and in relation to the comments made by the professionals who were consulted as to the appropriateness of the activities.

At the same time, the ecological psychology perspective was employed, recognising the importance of functional skills in context with the environment affording certain actions (top down). This was done by determining the type of skills which are seen in the school environment and considering the appropriateness of them in relation to the specific age group. This was then combined with the list of activities mentioned above.

Functional skills have been described as “movement skills - either early movement milestones, fundamental movement skills or specialised movement skills - that are performed in their natural and meaningful contexts” (Burton & Miller, 1998, p. 256-7). However, in most movement assessment situations, the specified tasks are performed in contrived or unnatural contexts and, as noted by Burton and Miller (1998), movement behaviour can be quite different in contrived or unnatural contexts compared with natural or meaningful contexts. Therefore, it was felt that a more realistic picture of a child’s abilities would emerge if the Checklist was designed to assess functional every day skills that are easily observed by teachers and parents as part of everyday activities. In addition, it was felt that intervention and management strategies that address movement difficulties in context are far more meaningful, particularly for young children (Sugden & Chambers, 1998).

Tasks have been included in the Checklist because they are demanded of the child in the early years environment. The focus of interest is how a child performs a task on a daily basis and, therefore, the Checklist contains items which can be observed by teachers/parents as part of the child's daily routine. The Checklist provides some detail about an individual child's performance with respect to functional competencies in realistic everyday situations. As seen above, relevant literature relating to developmental disorders such as autism, emphatically states that both assessment and intervention should be as close as possible to the child's daily interests and experiences. Therefore, one of the aims of the Checklist is to obtain a measure of the child's typical patterns of functioning in familiar and representative environments, such as home and school. It will provide an essential indicator of the extent to which the child is able to utilise his or her potential in the process of adaptation to environmental demands.

By working bottom up and top down the items from the list of activities fell naturally into four distinct categories: Self Help Skills, Desk Skills, General Classroom Skills and Recreational/Playground Skills. Each of these categories includes four or five classes of items.

Self Help Skills

Clothing

Small fasteners

Feed/Drink

Washing etc.

Desk Skills

Representation

Small object manipulation

Page/paper manipulation

Scissors, glue etc.

Constructing models

General Classroom Skills

Sitting appropriately

Carrying

Moving around not bumping into people/objects

Directional commands (forward, backward, imitation)

Recreational/Playground Skills

Use of playground equipment

Moving etc.

Ball skills

Run/jump/hop etc.

Balance

Construction of Checklist 3

Having decided on the categories for activities, each class of items was considered individually and various activities within each class were identified. The movements involved in each activity were considered and then it was decided from the original list of activities and the activities suggested by the professionals who were consulted which activity would best represent this class of activity. At the same time the appropriateness of the activity for the age group and the context in which it would occur was taken into account. For example, the original list of activities had a number of skills under the heading of Self Help Skills. One of the classes of activities concerned putting on and taking off articles of clothing. The movement skills necessary for this activity include planning and motor control. Activities which are appropriate for young children and demonstrate these movement skills include putting on a T-shirt, jumper or trousers. Having considered the context in which the activity would take place (i.e. school or home) and the appropriateness of the activity for the age group, the activity for this particular class of items was suggested as *Is able to put on and take off a T-shirt without assistance.* This process was repeated for each class of items mentioned above.

Using the concept of "class of items" is directly related to schema theory as proposed by Schmidt (1975). This theory has three major components: the generalised motor program, the recall schema and the recognition schema. At the base of the schema theory lies the notion of a generalised motor program, which can be executed in several ways to yield various response outcomes (Shapiro & Schmidt, 1982). Not every movement requires a separate motor program for its execution, and to attain the various movement outcomes, certain parameters of the program must be determined (e.g. speed or force). The theory does not concern itself with the selection of a motor program, but instead focuses on the processes that occur after the generalised motor program has been selected (parameter selection) to effectively execute a program. Thus, a generalised motor program can be thought of as a program that governs a given class of movements that require a common motor pattern.

Checklist 3, which can be found in Appendix 3, was developed using this process. For each activity there is an explanation of the movement skills involved, followed by some functional every day activities which are representative of that class of activity. The activities that are listed for each class of items are believed to best represent that particular class. One activity is chosen as the suggested activity to include in the Checklist. Below is one example from each section of the Checklist illustrating how each activity was presented:

SELF HELP SKILLS

Small fasteners Items which demonstrate dexterity in bimanual control and fine motor control in fastening and unfastening – buttons, zippers. Others?

Suggested item *Can fasten/unfasten accessible buttons*

DESK SKILLS

Page/paper manipulation Items which demonstrate manual dexterity and eye-hand coordination with non resistant materials such as paper. Turn pages of a book, give sheets of paper to teacher/child. Others?

Suggested item *Can turn single pages of a book*

GENERAL CLASSROOM SKILLS

Sitting appropriately Items which demonstrate postural control and static balance. Demonstrate good posture when sitting on a chair, at a desk, sitting on the floor with legs crossed and back straight. Others?

Suggested item *Is able to sit on the floor with legs crossed and back straight*

RECREATIONAL/PLAYGROUND SKILLS

Run/jump/hop etc. Items which demonstrate competence in motor control, dynamic balance, coordination and planning. Joins in playground activities demonstrating running and jumping, hopping. Runs fast and is able to change direction. Others?

Suggested item *Can join in playground activities, demonstrating running and jumping*

Checklist 3 was sent to fourteen professionals, the majority of whom were involved in the area of movement development either as lecturers, researchers or therapists. The main purpose of this exercise was to obtain the opinions of the professionals of which particular activity best represented each class of items, and to establish whether they had any suggestions for activities which had been omitted from the Checklist.

Feedback on Checklist 3

Overall, the majority of those who provided feedback commented that the activities in the Checklist needed to be more specific, in that each activity needed to specify exactly what the child was required to do. For example, in Section 1 (Self Help Skills) in the activity dealing with small fasteners many of the responses noted that the size of the button and the button hole should be specified. Other activities which needed to be more specific included feeding and drinking, representation (circle and cross), small object manipulation, cutting and gluing, constructing models and using playground equipment.

In addition, some of those who responded suggested that item 1 in Section 1 (Self Help Skills) *putting on and taking off a T-shirt without assistance* should be two separate items, similarly item 2 *fastening and unfastening accessible buttons.*

Some of those who provided feedback noted additional skills to consider including in the Checklist. These were

Section 1 Self Help Skills
Put on socks with shaped heels
Adjust clothing after using the toilet
Time taken to do certain activities

Section 2 Desk Skills
Simple maze for pencil control between two lines
Colouring
A posting activity

Section 3 General Classroom Skills
Ability to stand in line

Section 4 Recreational/Playground Skills

No additional skills were noted

The detail of the responses on individual activities and additional skills can be found in Appendix 4.

When the responses were analysed, the Checklist was modified accordingly. The modifications that were made to the Checklist include

Self Help Skills.

- *Is able to put on and take off a T-shirt without assistance* was made into two separate activities. The activities became *The child can put on a T-shirt without assistance*, and *The child can take off a T-shirt without assistance.*

- *Can fasten and unfasten accessible buttons* was made more specific by stating that the buttons should be coat buttons, and this activity was also made into two separate activities. The activities became *The child can fasten accessible coat buttons* and *The child can unfasten accessible coat buttons.*

Desk Skills

- *Can copy a circle and a cross* was made more specific with the addition of a statement indicating that this should be from a completed example. The activity thus became *The child can copy a circle and a cross from a completed example.*

- *Can use scissors to cut any whole shape and use glue to complete an appropriate task* was made more specific and more appropriate by specifying that the child was required to cut across a piece of paper about 4" in length. It was felt that the gluing activity was outside the experience of 3-year-old children and was therefore omitted from the activity. The activity became *The child can use scissors to cut across a piece of paper (e.g. 4" strip).*

General Classroom Skills

- *Can move forward, backward, sideways when shown.* It was felt that this activity would benefit from the addition of over and under to the directional commands. Thus, the activity became *The child can move forward, backward, sideways, under and over when shown.*

Recreational/Playground Skills

- *Can use playground equipment (climbing frame, slide, swing)* was made more specific by restricting the activity to fixed playground equipment, and thus omitting using a swing, which, not being a fixed piece of equipment, requires far more control to use than other pieces of playground equipment. The activity became *The child can use fixed playground equipment (e.g. climbing frame, slide).*

One additional activity was included in this section. Recreational and playground activities generally include ball skills for this age group and the section has activities involving throwing and kicking, but nothing dealing with catching. Catching is a fundamental ball skill and therefore the activity *The child can catch a large (10") ball with two hands* was included in this section.

In addition to the modifications that were made, a scoring system was also included on the Checklist. There are four alternative responses which describe how well the child deals with an activity. The four responses are divided into two categories Can Do and Cannot Do; the Can Do category is divided into two sections Well or Just and the Cannot Do category is divided into Almost and Not Close. The response to each activity is scored on a four-point scale from 1 (Well) to 4 (Not Close). Thus, a high score on the checklist indicates that a child is not able to perform activities as well as a child with a low score. The total score on the checklist is essentially an impairment score.

Construction of the Draft Checklist

Having made the modifications noted above and including the scoring system, the Checklist became the draft Checklist and was used in the pilot study. The draft Checklist can be found in Appendix 5.

Pilot Study of the Draft Checklist

The aim of the pilot study was to determine the appropriateness of the items in the draft Checklist, any problems that may be encountered while administering and/or scoring the draft Checklist and collect any suggestions of activities/tasks which it is believed will be more appropriate in the early years environment. In addition, it was also hoped that the draft Checklist would distinguish between young children with movement difficulties and those without movement difficulties. It will be noted from the draft Checklist that two titles were included; the teachers involved in the pilot study were asked for their opinion on these titles and which one they felt would be more appropriate.

Five schools in a neighbouring LEA were randomly selected to take part in the pilot study, and 6 teachers were asked to randomly choose 2 girls and 2 boys with whom to complete the draft Checklists. They were also asked to each choose one child displaying motor difficulties with whom to complete the Checklist. The Checklists, and instructions for administering and scoring the Checklists, were left in schools for three weeks, after which time the completed Checklists were collected.

The random sample of five schools included 2 LEA maintained Infant Schools, 1 LEA maintained Nursery School and 2 Private Day Care Nurseries.

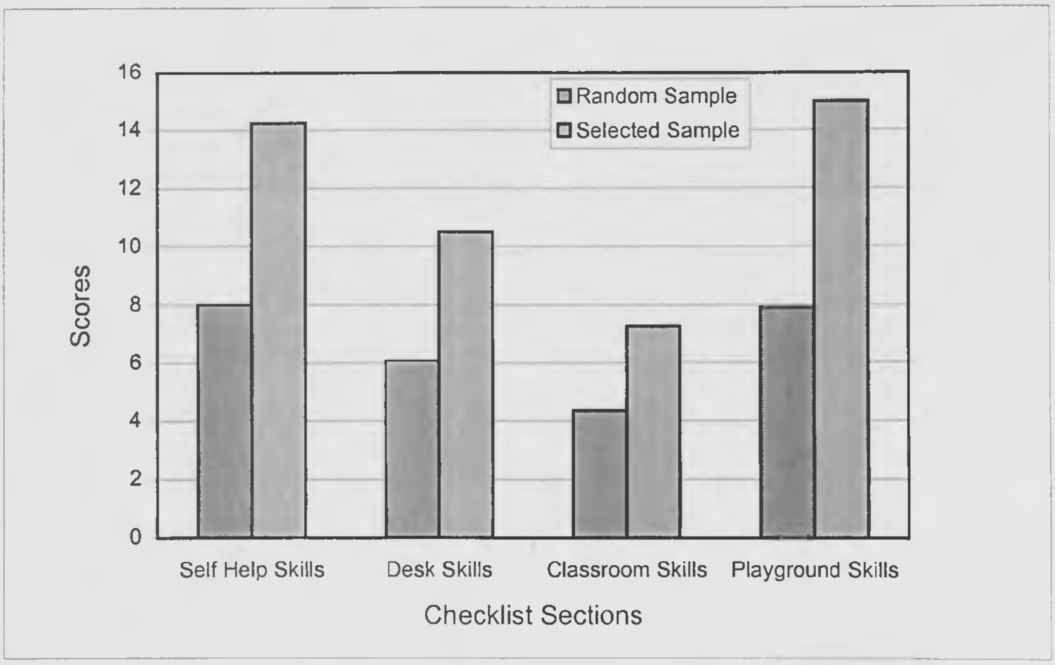
Pilot study data

24 Checklists were returned from 4 of the Schools whilst 1 school failed to return any of the Checklists. Of the Checklists which were returned, 20 were from the random sample and 4 were from the selected sample. The random sample

consisted of 10 boys and 10 girls, while the selected sample consisted of 2 boys and 2 girls.

The mean age for the random sample was 4.15 and the age range was 3.03 to 5.10, while the mean age for the selected sample was 4.05 and the age range was 3.10 to 5.04. Figure 4a shows the mean scores for each section for the random sample and the selected sample. The total mean scores for Section 1-4 for the random sample was 26.3 and for the selected sample was 47.

Figure 4a Mean scores per section for the random sample and selected sample



One of the aims of the Checklist was to determine if the Checklist would distinguish between children with movement difficulties and children without difficulties. The data presented in Figure 4a provides evidence that, despite both samples being small, the Checklist successfully distinguishes those children with difficulties from those children without difficulties. The children in the selected sample scored considerably higher than the children in the random sample.

Table 4.1 gives detail of mean scores for individual sections, mean item scores for each section, and standard deviations for each section, along with total scores for Sections 1-4. The random sample has been divided into boys and girls. It will be noticed from Table 4.1 that the girls in the random sample have higher mean scores for Sections 1 and 3 than the boys, along with mean item scores and the standard deviation for section scores. In Section 2 the girl's score is slightly lower than the boy's score, as is the mean item score, but the standard deviation is higher. Both these groups scored the same for Section 4. While the total mean score for both groups for Sections 1-4 is very similar, the standard deviation value for the girls is 7.00; this is due to one of the girls scoring highly on the Checklist. Again, this points to the fact that the Checklist is able to distinguish between children with difficulties and those without difficulties. Table 4.1 also gives detail of the scores obtained by the selected sample.

Table 4.1 Mean scores per section and per item and standard deviation for boys and girls from the random sample and selected sample.

	Random Sample		Selected Sample
	BOYS	GIRLS	**Boys and Girls**
Section 1	7.60	8.40	14.25
Per item	1.27	1.40	2.83
SD	1.43	2.50	2.36
Section 2	6.20	5.90	10.50
Per item	1.24	1.18	2.10
SD	1.32	1.66	1.73
Section 3	4.30	4.40	7.25
Per item	1.08	1.10	1.81
SD	0.67	0.97	1.26
Section 4	7.90	7.90	15.00
Per item	1.32	1.32	2.50
SD	2.23	2.23	4.97
Sections 1-4	26.00	26.60	47.00
Per item	1.24	1.27	2.23
SD	4.03	7.00	9.20

Feedback on the draft checklist

All the teachers who returned Checklists commented that the Checklist was very easy to administer and the activities contained in it were all entirely within the natural routine work of early years classes. Feedback also concerned the length of time which was required to complete the Checklists; all the teachers commented that each Checklist took no longer than 15 minutes to complete yet, at the same time, gave an accurate reflection of the skills of the children.

Comments concerning the Checklist concerned the fact that a few items contained more than one activity. These items were *Move around the classroom/school avoiding collision with stationary or moving people/objects* and *Kick a large stationary ball, and throw a large ball overarm using both hands.* Staff commented that in instances where a child could perform only one of the activities with ease, it was difficult to score both items appropriately. As a result, the modifications that were made to the Checklist concerned ensuring that there was only one activity contained in each item to be scored. Thus, the Checklist used for the main sample of data contained 23 items as opposed to the draft Checklist, used in the pilot study, which contained 21 items.

After consultation with the staff involved in the pilot study it was decided to refer to the Checklist as the **Early Years Movement Skills Checklist**, as this was a better reflection of the scope of the Checklist than the previously used title of Pre-school Checklist. The Checklist was developed for use with 3 to 5-year-old children and, whilst 3 and 4-year-old children attend pre-school establishments such as Nursery schools, Nursery classes or play groups, the majority of 5-year-old children will be found in Reception and Year 1 classes. Therefore, it was felt that the title Pre-school Checklist was inappropriate for this age group.

One of the aims of the Checklist was to investigate the relationship between motor skill behaviour and movement-related behaviours in young children with and without movement difficulties. In order to achieve this, a section was included in the Checklist to assess behaviours that are seen within a movement skill context. The purpose of this section was to describe behaviours associated with the execution of movement that are characteristic of each child, and which may influence performance on activities within the Checklist.

It was decided to use the Movement ABC Checklist, Section 5: Behavioural Problems Related to Motor Difficulties (Henderson & Sugden, 1992), to assess related behaviours. This Checklist contains items that are representative of the behaviours that parents and teachers most often report as being detrimental to the child's motor performance. The items range from general observations on characteristics such as timidity to more specific observations concerned with response to failure on motor tasks. Henderson and Sugden (1992) note that these observations provide information relevant to the evaluation of observations from Section 1 to 4 of the Movement ABC Checklist. Interpretations of this section are qualitative rather than quantitative, since the items represent clinical concerns rather than any systematic model of movement-related behaviours. The value of this section is that it highlights behaviour significant to both assessment and treatment.

Main Study

One of the aims of this study was to design a speedy, efficient and accurate instrument to aid in the identification of children with movement difficulties. At the same time, the intention was to design a Checklist which contained functional, everyday activities which could be observed and assessed in the daily routine of the classroom. Following on from the pilot study and having made the relevant modifications, it was believed that the Early Years Movement Skills Checklist had achieved both these aims. In order to investigate this further, the Checklist was used for the main collection of data for the study.

It was anticipated that the main collection of data would involve identifying around 120 children in each of the age groups of children of 3, 4 and 5 years of age with whom to complete the Checklist and, in addition, to obtain a measure of the reliability and validity of the Checklist.

Selection of sample

Having obtained permission from three nearby Local Education Authorities to approach Nursery Schools/classes and Primary Schools, to carry out the research project, 34 schools in these Local Education Authorities were randomly selected to participate in the study. This random sample consisted of 24 Nursery Schools/classes, 25 Reception classes, and 22 Year 1 classes and involved 71 class teachers. Checklists taken to schools included 144 for 3 year olds, 150 for 4 year olds, and 132 for 5 and 6 year olds. Overall, 426 Early Years Movement Skills Checklists were taken to 34 schools. The Early Years Movement Skills Checklist, with instructions for administering and scoring the Checklist, is shown on pages 91 to 95.

EARLY YEARS MOVEMENT SKILLS CHECKLIST

The Early Years Movement Skills Checklist is an instrument which has been designed to be used flexibly by teachers, parents and other professionals involved with children showing movement difficulties. Our aim has been to design an efficient, speedy and accurate instrument to aid in the identification and assessment of young children (3 to 5 years of age) with movement difficulties. It is a functional Checklist which has been designed to be completed as part of the teacher's daily routine, obtaining a measure of the child's typical patterns of functioning in familiar and representative environments, such as home and school.

There are five parts to the Checklist. The focus of assessment in each section is as follows:

Section 1	Self help skills
Section 2	Desk skills
Section 3	General classroom skills
Section 4	Recreational/Playground skills
Section 5	Behavioural problems related to motor difficulties

ADMINISTERING AND SCORING THE CHECKLIST

The focus of interest is how a child performs a task on a daily basis and therefore the Checklist contains items which can be observed by teachers and/or parents as part of the child's daily routine. It has been designed to be completed from memory or filled in over a period of one to two weeks to allow for careful observation of the child in the classroom and the playground.

As the sample of children is to be random we would ask that class teachers choose the 2nd, 11th and 13th named boys on the class register, and the 6th, 7th and 12th named girls on the class register. If you have a child in your class that you suspect may have a movement problem we would be very grateful if you would complete a Checklist on this child in addition to the selected 6. This child can be a boy or girl.

Sections 1 – 4
The Checklist is a criterion referenced assessment instrument and for each of the tasks included in Sections 1 to 4 there are four alternative responses which describe how well the child deals with the task:

Can Do		Cannot Do	
Well	Just	Almost	Not Close
1	2	3	4

First, it is necessary to decide whether the child **can** or **cannot** do the task. Then, consider how well they perform. If the child **can** do it, can they perform it 'Well' or only 'Just'? If the child **cannot** perform the task, can they 'Almost' do it or are they 'Not Close'?

Please rate the child on how s/he performs the task not on whether s/he is good or not so good for his/her age. Each item requires a single overall rating. The responses to each of the activities are scored on a four-point scale from 1 ('Well') to 4 ('Not Close'). Select the response for each activity that best describes the child being assessed and enter the score on the Checklist. Scores for each section are then added and the result entered at the end of the section. These four separate totals are then entered in the summary box at the beginning of the Checklist and summed to achieve an overall score.

Section 5

The purpose of Section 5 is to describe behaviour associated with the execution of movement that is characteristic of each child, and which may influence performance on Checklist tasks. For Section 5 the three response alternatives refer to the frequency with which the child displays the behaviour described in each item:

Rarely	Occasionally	Often
0	1	2

The response to each question is scored on a three-point scale from 0 ('Rarely') to 2 ('Often'). Scores for this section are then added and the result entered at the end of the section. The total for this section is then entered in the summary box at the beginning of the Checklist. As well as contributing to the overall picture of the child's approach, Section 5 scores will also help in establishing the status of the child's scores on the other sections. An impulsive child, for example, may score poorly for reasons of temperament rather than because of movement difficulties.

We are very grateful to you for agreeing to participate in this study. We would appreciate feedback concerning the appropriateness of the items in the Checklist, any problems you may encounter while administering and/or scoring the Checklist and any suggestions of activities/tasks which you believe to be more relevant in the early years environment.

When the results of the study are completed, we will make them available to you and we are willing to come to the school and discuss any issues relating to children with such difficulties.

Mary E Chambers
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Tel. 0113 233 4581

EARLY YEARS MOVEMENT SKILLS CHECKLIST

Name			Date of birth		Gender
School					Age y m
Assessed by			Date of test		Class
Section 1	Section 2	Section 3	Section 4	Total	Section 5

Can Do		Cannot Do	
Well	Just	Almost	Not Close
1	2	3	4

SECTION 1 Self Help Skills

The child can

- Put on a T-shirt without assistance ....
- Take off a T-shirt without assistance ....
- Fasten accessible coat buttons ....
- Unfasten accessible coat buttons ....
- Feed self using fork and spoon ....
- Wash and dry hands ....

Section 1 Total ....

SECTION 2 Desk Skills

The child can

- Copy a circle and a cross from a completed example ....
- Pick up and place pieces in an interlocking jigsaw ....
- Turn single pages of a book ....
- Use scissors to cut across a piece of paper (e.g. 4" strip) ....
- Construct simple models using duplo, lego, megablocks ....

Section 2 Total ....

EARLY YEARS MOVEMENT SKILLS CHECKLIST

Can Do		Cannot Do	
Well	Just	Almost	Not Close
1	2	3	4

SECTION 3 General Classroom Skills

The child can

- Sit on the floor with legs crossed and back straight ....
- Carry books and toys across the classroom in order to put away ....
- Move around the classroom/school avoiding collision with stationary people/objects ....
- Move around the classroom/school avoiding collision with moving people/objects ....
- Move forward, backward, sideways, under and over when shown ....

Section 3 Total ....

SECTION 4 Recreational/Playground Skills

The child can

- Use fixed playground equipment (e.g. climbing frame, slide) ....
- Ride a variety of moving vehicles (e.g. pedal car, tricycle) ....
- Kick a large stationary ball ....
- Throw a large ball overarm using both hands ....
- Join in playground activities, demonstrating running and jumping ....
- Walk on tip toes for four steps ....
- Catch a large (10") ball with two hands ....

Section 4 Total ....

Mary E Chambers and David A Sugden, School of Education, University of Leeds, LS2 9JT.

EARLY YEARS MOVEMENT SKILLS CHECKLIST

Rarely	Occasionally	Often
0	1	2

SECTION 5 Behavioural Problems Related to Motor Difficulties

The child is

- Overactive (squirms and fidgets; moves constantly when listening to instructions; fiddles with clothes) ....
- Passive (hard to interest; requires much encouragement to participate; seems to make little effort) ....
- Timid (fearful of activities like jumping and climbing; does not want to move fast; constantly asks for assistance) ....
- Tense (appears nervous, trembles; fumbles with small objects; becomes flustered in a stressful situation) ....
- Impulsive (starts before instructions/demonstrations are complete; impatient of detail) ....
- Distractible (looks around; responds to noises/movement outside the room) ....
- Disorganized/confused (has difficulty in planning a sequence of movements; forgets what to do next in the middle of a sequence) ....
- Overestimates own ability (tries to change tasks to make them more difficult; tries to do things too fast) ....
- Underestimates own ability (says tasks are too difficult; makes excuses for not doing well before beginning) ....
- Lacks persistence (gives up quickly; is easily frustrated; daydreams) ....
- Upset by failure (looks tearful; refuses to try task again) ....
- Apparently unable to get pleasure from success (makes no response to feedback; has a blank facial expression) ....

Section 5 Total ....

Table 4.2 shows the breakdown of the randomly selected sample by the type of school attended by the children.

Table 4.2 Breakdown of sample by type of school attended by children in sample

	Nursery	Reception	Year 1
LEA Maintained School	90	108	126
Independent School	6	6	6
Private Day Care Nursery	42	30	0
University Children's Centre	6	6	0
Total	144	150	132
Overall Total	426		

Procedure

The Early Years Movement Skills Checklists were taken to the schools, along with an explanation of the aims and purpose of the Checklist, and instructions for administering and scoring the Checklist. Each teacher was asked to choose 3 girls and 3 boys from their class, according to random numbers supplied with the instructions. In classes where there was more than one adult (for example teaching assistant, nursery nurse, regular parent helper) one extra Checklist was left with the teacher to be completed by the other adult, independently of the teacher, in order to obtain a measure of interrater reliability. A total of 68 Early Years Movement Skills Checklists were left in schools to be completed for use as an interrater reliability measure. All the teachers were shown how to use the Early Years Movement Skills Checklist, which were left with them for a period of three weeks. At the end of the three-week period, completed Checklists were collected from each of the schools.

When returning to schools to collect the completed Early Years Movement Skills Checklists, one further Checklist was left with each class teacher, with the request that it was completed on one of the same children one month after the initial Checklist, as a measure of test-retest reliability. A total of 70 Early Years Movement Skills Checklists were left in schools to be completed for use as a measure of test-retest reliability.

In order to obtain a measure of the predictive validity of the Early Years Movement Skills Checklist, a sample from the 4, 5 and 6 year olds was selected for testing on an established test of motor skills. The selected sample included children whose scores were in the lowest 5% of the total scores of the Checklist (Sample 1), those children whose scores were in the lowest 5-10% of the total scores of the Checklist (Sample 2) and a random sample of 5% of children whose scores were not in the bottom 10% of the total scores of the Checklist (Sample 3). This was to establish whether children scoring poorly on the Early Years Movement Skills Checklist would also score poorly on an established test of motor skills and children who scored satisfactorily on the Early Years Movement Skills Checklist would also score satisfactorily on another measure of motor skills.

The assessment instrument that was used to measure predictive validity was the test component of the Movement Assessment Battery for Children (Movement ABC) (Henderson and Sugden, 1992). The Movement ABC contains two assessment modes - a teacher rated Checklist and a performance test. The Checklist is a criterion-referenced assessment instrument which examines functional everyday skills and is completed through observation by a teacher or parent or someone else who is familiar with the child. The Movement ABC Test is a normative-referenced test which is given by a professional in a formal testing situation. The primary purpose of the Movement ABC Test is to identify children with movement difficulties, and, in addition, includes an emphasis on practical applications and intervention, through the use of qualitative statements recorded alongside the objective scores on each motor task. The Movement ABC Test consists of a series of performance tasks in three sections of manual dexterity, ball skills and static and dynamic balance.

The reliability of the Movement ABC Test is reported in some depth in the Movement ABC Manual (Henderson & Sugden, 1992). Both test-retest and interrater reliability have been established, and yielded good results. A test-retest investigation over a two-week period revealed 97% agreement for age 5, 91% for age 7 and 73% for age 9. Interrater reliability measures are also reported where a minimum value of 0.70 interrater reliability on total scores is reported, with a minimum of 75% agreement and maximum of 98% agreement on item scores from one tester to another. The overall reliability of the Movement ABC Test is considered to be good (Henderson & Sugden, 1992).

The validity of the Movement ABC Test has been assessed in several ways. One of these has been established by using children selected by teachers, therapists and paediatricians, who used either their own judgement or commonly used test batteries to identify children with motor impairments. The Movement ABC Test is compared and assessed through its concordance with these other reference points. The results of these comparisons with the Movement ABC Test invariably differentiate the children groupwise as the other sources do, and are reported in detail in the Movement ABC Manual (Henderson & Sugden, 1992). In addition to the above comparisons, the Movement ABC Test was used to assess groups of children expected to exhibit a high incidence of motor impairment, such as those with low birth weights (Mutch, Leyland & McGee, 1993), mild intellectual handicap (Sugden & Wann, 1987), children with spina bifida (Tew, 1979; Turner, 1986) or those with emotional or behavioural problems (Stott, Marston & Neill, 1975). The Movement ABC Test reveals the expected results when testing these groups of children. A considerable amount of data is available from the manual to confirm that the Movement ABC Test does in fact measure what it is intended to measure.

The results obtained from the collection of data, including the reliability study and the validity study, are analysed and discussed in Chapters 5 and 6.

CHAPTER 5

RESULTS AND ANALYSIS

Introduction

This chapter reports on the main collection of data and will detail results in a number of ways. Firstly, the data collected for the **main sample** will be analysed – the **main sample** includes all the children with whom the Early Years Movement Skills Checklist was originally completed. A reliability study was carried out with a teacher selected sample of children from the main sample. The reliability study considers interrater reliability and test-retest reliability. A validity study was also carried out and this included a **selected sample** of children from within the main sample – the **selected sample** includes children whose Checklist scores fall within the lowest 5% of scores of the 4, 5 and 6-year-old children, those children whose scores fall within the lowest 5-10% of 4, 5 and 6-year-old children and a randomly selected 5% of children whose scores did not fall within the lowest 10% of scores from the 4, 5 and 6-year-old children. Throughout the analysis, comparisons are made between the main sample and the selected sample. A final section looks at movement-related behaviours in both groups.

Checklists in the main sample

Of the 426 Early Years Movement Skills Checklists taken to schools 422 were returned (99%); two of these were completed for children under three years of age and could not be used in the analysis, leaving the number of returned checklists at 420 (98.5%). The groupings according to age and gender can be seen in Table 5.1.

Table 5.1 Number of checklists returned by age and gender

Age in years	BOYS	GIRLS	TOTAL
3	59	63	122
4	69	77	146
5	80	72	152
TOTAL	208	212	420

The detail of the children involved in the main sample can be seen in Table 5.2 showing mean age, standard deviation and range.

Table 5.2 Mean age, standard deviation and range of main sample

Age in years	N	Boys	Girls	Mean age in months	S.D. in months	Range in months
3	122	59	63	42.62	3.23	11
4	146	69	77	53.68	3.49	11
5+	152	80	72	65.48	3.78	14

This has been further broken down into mean age, standard deviation and range for boys and girls in each age group (Table 5.3).

Table 5.3 Mean age, standard deviation and range of main sample by age and gender

Age	N	Gender	Mean Age in months	S.D. in months	Range in months
3	59	Boys	42.22	3.38	11
3	63	Girls	43.00	3.05	11
4	69	Boys	53.72	3.44	11
4	77	Girls	53.64	3.56	11
5+	80	Boys	65.83	3.88	14
5+	72	Girls	65.10	3.66	13

Checklists were returned from 34 schools, involving 65 classes. Maximum and minimum scores for Sections 1 to 4 were calculated for each class, along with mean scores for each class. As high scores are indicative of poorer performance, the expectation was that children in Nursery classes would score more highly than children in Reception classes who, in turn, would score more highly than children in Year 1. The range of scores and mean scores are shown below in Table 5.4

Table 5.4 Range of scores for Sections 1 to 4 for Nursery, Reception and Year 1 classes

	Observed Scores		Mean Scores	
Class	**Maximum**	**Minimum**	**Maximum**	**Minimum**
Nursery	79	23	43.83	23.00
Reception	57	23	35.67	23.33
Year 1	49	23	32.17	23.33

The maximum scores (observed and mean scores) can be seen to decrease with age, confirming expectation. The minimum score of 23 is the same for Nursery, Reception and Year 1 classes.

It was decided to group the children according to age rather than class, as there was a cross over of ages within classes. Again, maximum and minimum scores and mean scores were calculated for each age group and are shown in Table 5.5.

Table 5.5 Range of scores for Sections 1 to 4 on the Checklist according to age groups

	Observed Scores		
Age groups	**Maximum**	**Minimum**	**Mean Scores**
3 year olds	79	23	34.89
4 year olds	60	23	28.77
5 year olds	55	23	26.86

As expected, maximum scores for Sections 1 to 4 were seen to decrease with age and, as noted above, minimum scores are the same for each age group. Mean scores are also seen to decrease with age.

The overall results for the main sample of the Early Years Movement Skills Checklist are shown in Table 5.6. The mean score per item is also indicated, as this is a more accurate reflection of performance, as the number of items that each section contains affects the mean score per section. The results from Section 5 are dealt with separately as the results of this section do not contribute to the motor score but rather relate to associated behaviour patterns when a child is involved in moving.

Table 5.6 Mean scores per section and per item

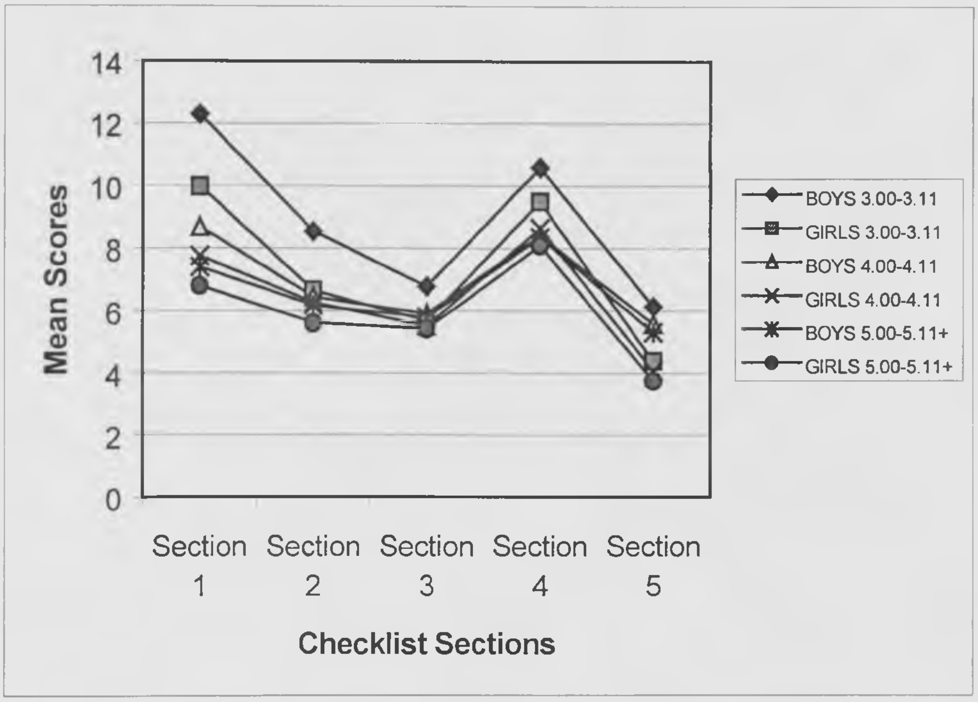
	3 Year olds		4 Year olds		5 Year olds	
	Boys	Girls	Boys	Girls	Boys	Girls
Section 1	**12.29**	**9.98**	**8.68**	**7.74**	**7.40**	**6.79**
per item	2.05	1.66	1.44	1.29	1.23	1.13
Section 2	**8.54**	**6.65**	**6.45**	**6.27**	**6.18**	**5.61**
per item	1.71	1.33	1.29	1.25	1.24	1.12
Section 3	**6.78**	**5.67**	**5.90**	**5.51**	**5.79**	**5.42**
per item	1.36	1.13	1.18	1.10	1.16	1.08
Section 4	**10.59**	**9.49**	**8.42**	**8.65**	**8.35**	**8.10**
per item	1.51	1.34	1.20	1.24	1.19	1.16
Total 1-4	**38.20**	**31.79**	**29.45**	**28.17**	**27.71**	**25.92**
per item	1.66	1.38	1.28	1.22	1.20	1.12
Section 5	**6.14**	**4.37**	**5.57**	**4.06**	**5.30**	**3.74**
per item	0.51	0.36	0.46	0.34	0.44	0.31

In each of the three age groups the mean scores for each section are lower for the girls than for the boys, except the mean score for Section 4 (Recreation and Playground Skills) for the 4 year old children; the mean score for the boys is 8.42 (mean item score 1.20) and for the girls is 8.65 (mean item score 1.24). This may be due in part to the nature of Section 4, involving a number of ball skills – a task which boys traditionally perform as well as or better than girls.

However, the picture is slightly different across age groups - in Section 3 (General Classroom Skills) the mean score of 5.67 for 3-year-old girls is lower than the mean score of 5.90 for 4-year-old boys and the mean score of 5.51 for 4-year-old girls is lower than the mean score of 5.79 for 5-year-old boys. In fact, the mean score for 3-year-old girls (5.67) is lower than the mean score for 5-year-old boys (5.79). Similarly, in Section 5 (Behaviour) the mean score for 3-year-old girls is lower than the mean score for 4-year-old boys, and the mean score for 4-year-old girls is lower than the mean score for 5-year-old boys.

The mean scores per section for age and gender are shown graphically in Figure 5a.

Figure 5a Mean section scores for the main sample according to age and gender



The standard deviation and median along with mean scores for each section have been calculated, and are reported in Table 5.7. As above, results for Section 5 are dealt with separately.

Table 5.7 Mean scores per section, standard deviations and medians

	3 Year olds		4 Year olds		5 Year olds	
	Boys	Girls	Boys	Girls	Boys	Girls
Section 1	**12.29**	**9.98**	**8.68**	**7.74**	**7.40**	**6.79**
SD	4.36	3.17	2.80	2.58	2.13	1.76
Median	12.00	10.00	8.00	6.00	6.00	6.00
Section 2	**8.54**	**6.65**	**6.45**	**6.27**	**6.18**	**5.61**
SD	3.13	1.90	1.79	2.07	2.04	1.46
Median	8.00	6.00	6.00	5.00	5.00	5.00
Section 3	**6.78**	**5.67**	**5.90**	**5.51**	**5.79**	**5.42**
SD	2.45	1.19	1.67	1.34	1.78	1.46
Median	6.00	5.00	5.00	5.00	5.00	5.00
Section 4	**10.59**	**9.49**	**8.42**	**8.65**	**8.35**	**8.10**
SD	4.48	3.11	2.24	2.84	2.27	1.64
Median	9.00	8.00	7.00	7.00	7.00	7.00
Total 1-4	**38.20**	**31.79**	**29.45**	**28.17**	**27.71**	**25.92**
SD	12.28	7.30	6.59	7.52	6.68	5.22
Median	35.00	31.00	28.00	25.00	25.50	24.00
Section 5	**6.14**	**4.37**	**5.57**	**4.06**	**5.30**	**3.74**
SD	4.74	3.97	4.34	4.11	4.60	3.94
Median	5.00	3.00	5.00	3.00	4.00	3.00

The calculated standard deviations (SD) are shown above - the majority of which are small. Despite the results following the expected pattern, a statistically 'normal' plot will not be seen because the scoring system of the Checklist does not allow for negative scores. Also, this group includes some high outlying scores which will affect the value of the standard deviation.

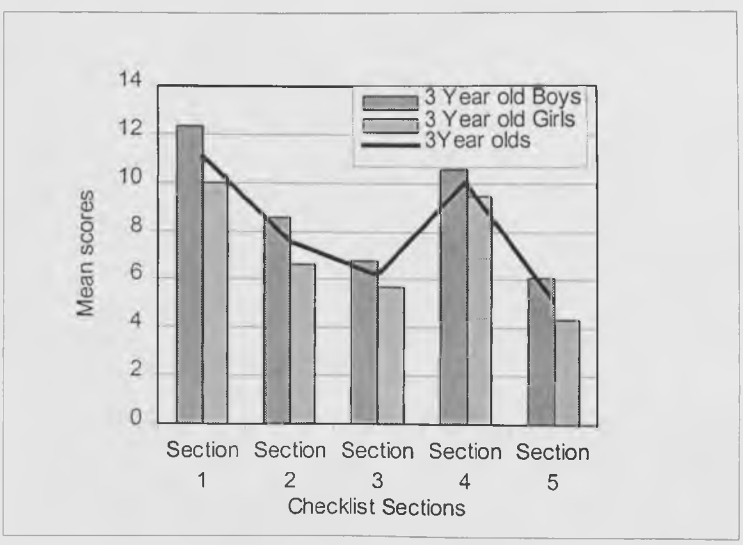
In addition to calculating the standard deviations (SD) the medians of each section and total scores were determined so that the point where 50% of the scores lie above and below can be shown. The calculated medians show a close resemblance to the mean scores, a feature of an evenly distributed data set.

Detail of Checklist scores

3 year old boys

The total scores for Section 1 to 4 for the 3-year-old boys ranged from 79 to 24, with a mean score of 38.2. The mean score for Section 1 was 12.29, while the mean score for each item was 2.05; both of these scores indicate that the majority of the children were unable to do the tasks in this section. The tasks which the 3-year-old boys found most difficult were items 3 and 4 in Section 1; 39 of the children (66%) were unable to fasten accessible coat buttons and 33 of them (60%) were not able to unfasten accessible coat buttons. In Section 2, 32 of the children (54%) were unable to copy a circle and cross from a completed example (item 1). The children scored well on items 3 and 5 in this section, with 56 children (95%) able to turn single pages of a book (item 3) and 57 (97%) able to construct simple models (item 5). In Section 3 (General Classroom Skills), this group scored well on items 2 and 3, with very few children being unable to carry books and toys across the classroom, and move around the classroom avoiding collision with stationary people or objects. Section 4 (Recreational/Playground Skills) was found to be more difficult than the previous section for 19 of the children (32%) – all of whom scored above the mean score of 10.59 for the section; this section also has the largest standard deviation for the 3-year-old boys.

Figure 5b Mean scores for 3-year-old boys and girls



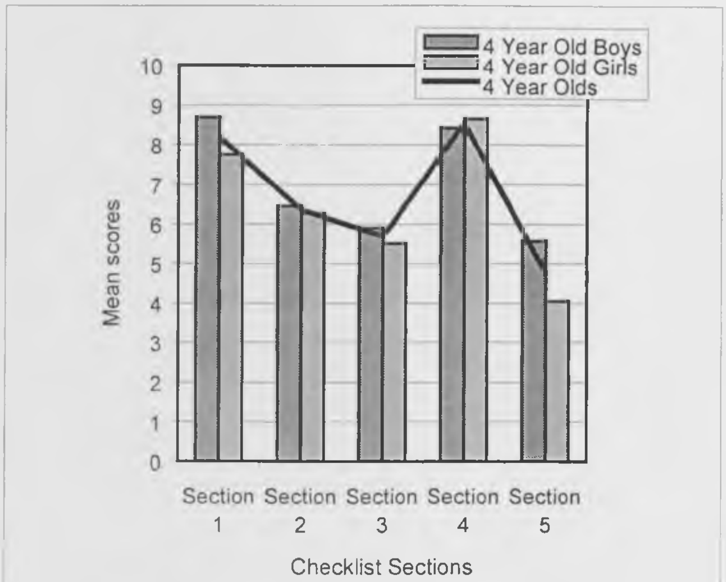
3 year old girls

The total scores for Section 1 to 4 for the 3-year-old girls ranged from 58 to 23, with a mean score of 31.79. Overall, the 3-year-old girls performed better than the 3-year old boys, particularly for Section 1. They had difficulties with only one item in this section – 32 of the girls (51%) were unable to fasten accessible coat buttons (item 3). 60 children (95%) were able to feed themselves using a fork and spoon (item 5) and all 63 of them were able to wash and dry their hands (item 6). In Section 2, all but one of them were able to turn single pages of a book and all of them were able to construct simple models. All the children managed the tasks extremely well in Section 3, even those who scored highly in other sections. In Section 4 (Recreation/Playground Skills), only one child was unable to use fixed playground equipment (item 1) and only one child was unable to kick a large stationary ball (item 3).

4 year old boys

The total scores for Section 1 to 4 for the 4-year-old boys ranged from 60 to 23, with a mean score of 29.45. In a similar way to the 3-year-old girls, the 4-year old boys found item 3 in Section 1 the most difficult activity on the Checklist – 20 of the 69 boys (30%) were unable to fasten accessible coat buttons, while 10 of the boys (14%) were not able to unfasten accessible coat buttons. Total scores for Section 1 show that 6 of the 4-year-old boys had difficulty with this section. In Section 2, 9 boys (13%) were unable to copy a circle and a cross (item 1) and 7 of the boys (10%) were unable to use scissors to cut across a piece of paper (item 4). All the 4-year-old boys were able to turn single pages of a book (item 3) and all the boys were able to construct simple models (item 5). Only 1 of the boys scored highly for Section 2. Section 3 was the easiest of the sections for the 4-year-old boys, with at least 97% of the boys being able to do each activity. Only 2 of the 4-year-old boys scored highly on Section 4, with total scores of 15 and 17. The majority of children were able to do all the activities in this section; item 5 (catch a large (10") ball with two hands) was the activity that the 4-year-old boys found most difficult, with 5 of them (7%) being unable to do the activity.

Figure 5c Mean scores for 4-year-old boys and girls



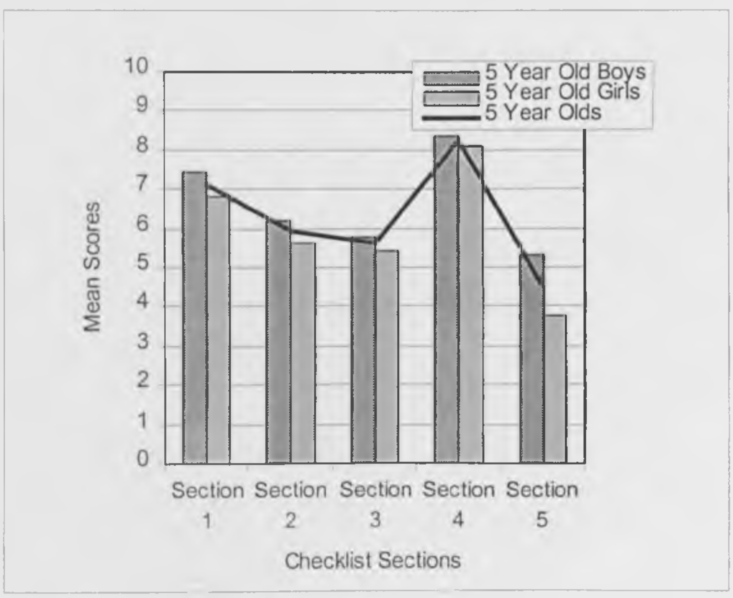
4 year old girls

The total scores for Section 1 to 4 for the 4-year-old girls ranged from 60 to 23, with a mean score of 28.17. Overall, the 4-year-old girls performed better than the 4-year old boys, except in Section 4. Only 2 of the 4-year-old girls scored highly on Section 1, but, as with the other groups, item 3 was the most difficult activity (fastening accessible coat buttons), with 14 of the girls (18%) unable to do the activity. In Section 2, 13 of the 4-year-old girls (17%) were unable to copy a circle and a cross (item 1) and 8 of them (10%) were unable to use scissors to cut across a piece of paper. All of the girls were able to turn single pages of a book (item 3) and all but 2 were able to construct simple models (item 5). Again, Section 3 was easiest of the sections for the 4-year-old girls, with at least 74 of them (96%) able to do all the activities. The scores for Section 4 were fairly evenly distributed, with most children being able to do all the activities. 5 of the 4-year-old girls (6%) were unable to throw a large ball overarm (item 4) and 7 of them (9%) were unable to catch a large (10" ball) with two hands (item 7). It was noted above that in all the sections apart from Section 4 the girls had lower mean scores than the boys. However, for the 4-year-old children, the mean score for Section 4 for the boys was 8.42 and 8.65 for the girls.

5 year old boys

The total scores for Section 1 to 4 for the 5-year-old boys ranged from 55 to 23, with a mean score of 27.71. Unlike the younger two groups, this group did not find Section 1 the most difficult. At least 77 of the 80 5-year-old boys (96%) were able to do all the activities with the exception of items 3 and 4; 7 of the boys (9%) were unable to fasten accessible buttons and 5 (6%) were not able to unfasten accessible buttons. In Section 2, 7 of the 5-year-old boys (9%) were unable to copy a circle and a cross (item 1) and 8 of them (10%) were unable to use scissors to cut across a piece of paper (item 4). Overall, 69 of the 80 boys (86%) were able to do all the activities in Section 2. It was noted earlier that the total mean score for Section 3 for 4-year-old girls was lower than the total mean score for 5-year-old boys. Item 2 (carry books and toys across the classroom in order to put away) was the only activity in this section which all 80 children could do. 4 of the 5-year-old boys (5%) were unable to move around the classroom/school avoiding collision with moving people or objects (item 4) and 3 of them (4%) were unable to move forward, backward, sideways, under and over when shown (item 5). In Section 4, at least 76 of the children (96%) were able to do all the activities.

Figure 5d Mean scores for 5-year-old boys and girls



5 year old girls

The total scores for Section 1 to 4 for the 5-year-old girls ranged from 51 to 23, with a mean score of 25.92. The 5-year-old girls performed better than the 5-year old boys in all sections. Only 2 of the 5-year-old girls scored highly on Section 1, but, as with the other groups, item 3 was the most difficult activity (fastening accessible coat buttons), with 3 of the girls (4%) unable to do the activity. All the 5-year-old girls could do items 5 and 6 from Section 1 (feed self using fork and spoon and wash and dry hands). In Section 2, 2 of the girls (2%) were unable to copy a circle and a cross (item 1) and 3 of them (4%) were unable to use scissors to cut across a piece of paper (item 4). For Section 3, at least 70 of the 72 girls (97%) could do all the activities, with only 2 of the children being unable to move around the classroom/school avoiding collision with moving people/objects (item 4) and move forward, backward, sideways, under and over when shown (item 5). One of these children was unable to carry books and toys across the classroom in order to put away (item 2) and the other child was unable to move around the classroom/school avoiding collision with stationary people/objects (item 3). As in Section 3, at least 97% of the 5-year-old girls could do the activities in Section 4. 2 of the girls (2%) were unable to throw a large ball overarm using both hands (item 4). 1 child was unable to join in playground activities (item 5) and 1 child was unable to catch a large (10") ball with two hands (item 7).

Analysis of Sections 1-4 on the Early Years Movements Skills Checklist

A 2 (gender) by 3 (age) by 4 (section) ANOVA with repeated measures on the last factor was performed on the data. There were main effects for section, F (3, 1011) = 364, P<0.0001, gender, F (1, 64) = 17.325, P<0.0001; and age, F (2, 149) = 39.98, P<0.0001. Also, there were interaction effects involving both these variables and these are examined for a more detailed picture.

There was an interaction effect involving section and gender, F (3, 15.62) = 5.64, P<0.0001 (Figure 5e) and an interaction effect involving section and age, F (6, 71.96) = 38.94, P<0.0001 (Figure 5f). There was a significant difference between gender in Sections 1, 2 and 3 but not in 4 and, where there was a difference, the boys scored higher (poorer) than the girls. The nature of the interaction between age and section was examined by using simple main effects and Tukey's HSD test. There were significant differences between the 3-year-old children and the 4- and 5-year-old children for Sections 1, 2 and 4.

Figure 5e Interaction of Section and Gender

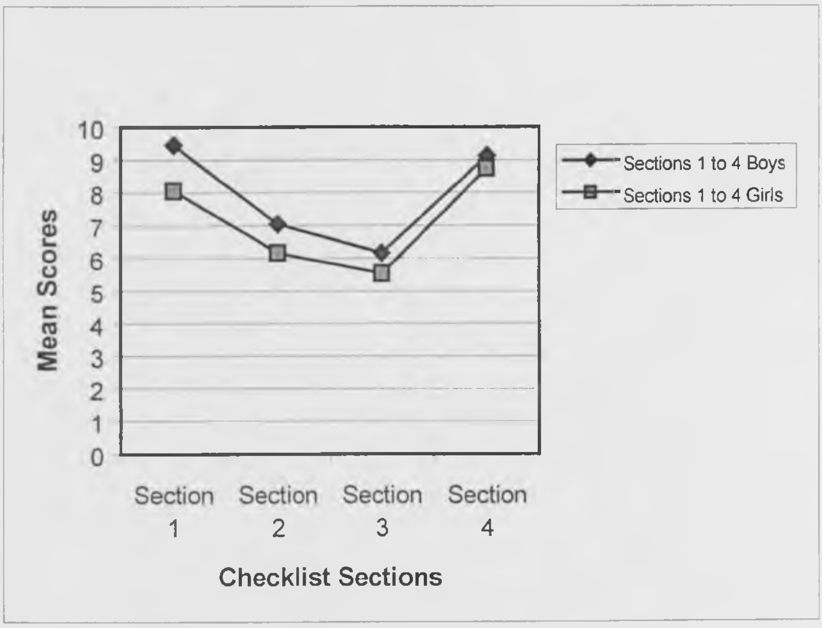
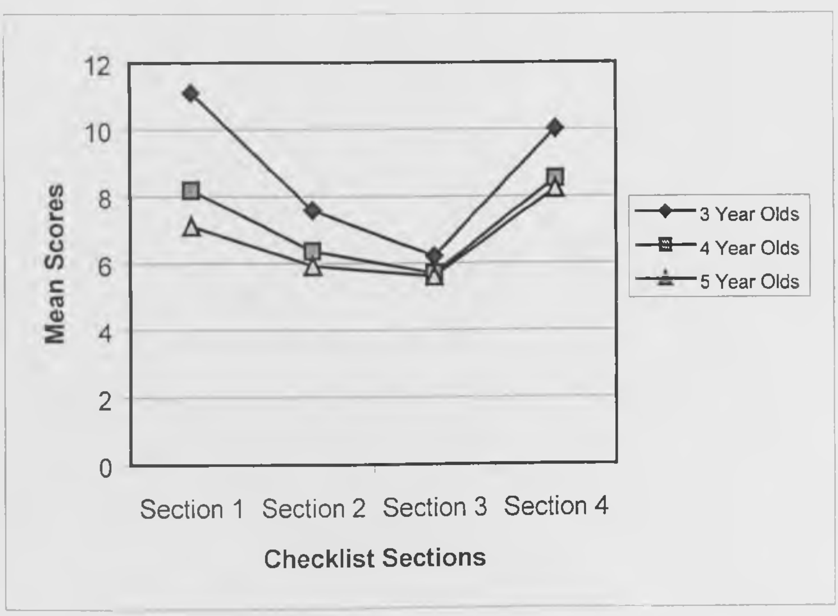


Figure 5f Interaction of Section and age



Reliability of the Early Years Movement Skills Checklist

The reliability of the checklist was examined in two ways – interrater reliability and test-retest reliability.

Interrater Reliability

When the Early Years Movement Skills Checklists were taken to schools to be completed for the main sample, one additional Checklist was left in classes where there was more than one adult (for example teaching assistant, nursery nurse, regular parent helper). It was requested that this Checklist be completed by the other adult, independently of the teacher, in order to obtain a measure of interrater reliability. A total of 68 Early Years Movement Skills Checklists were left in schools to be completed for use as an interrater reliability measure. Early Years Movement Skills Checklists for interrater reliability were returned for 37 children and correlations were performed on the scores obtained in each of the five sections of the Checklist, on the total of Sections 1 to 4 and, finally, on the total of all the sections. Pearson's product-moment correlations are shown in Table 5.8.

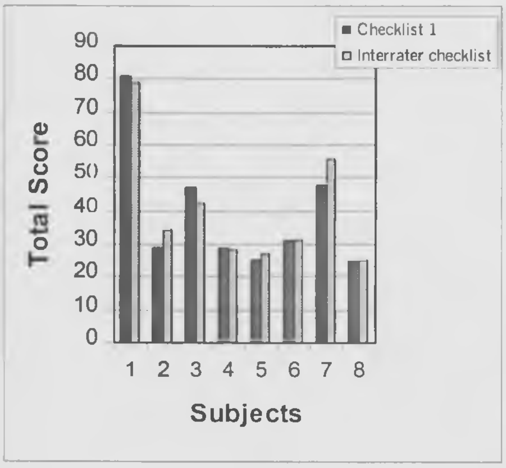
Table 5.8 Interrater reliability coefficients of the Checklist

	3 Year olds		4 Year olds		5 Year olds	
	Boys	**Girls**	**Boys**	**Girls**	**Boys**	**Girls**
Section 1	0.97	0.94	0.46	0.94	0.81	1.00
Section 2	0.93	0.95	1.00	1.00	0.93	0.88
Section 3	0.95	0.58	1.00	0.99	0.80	1.00
Section 4	0.91	0.76	0.58	0.98	0.80	0.82
1-4 Total	0.98	0.80	0.84	0.98	0.95	0.95
Section 5	0.85	0.71	0.94	0.99	0.61	0.95
1-5 Total	0.97	0.76	0.90	0.99	0.82	1.00

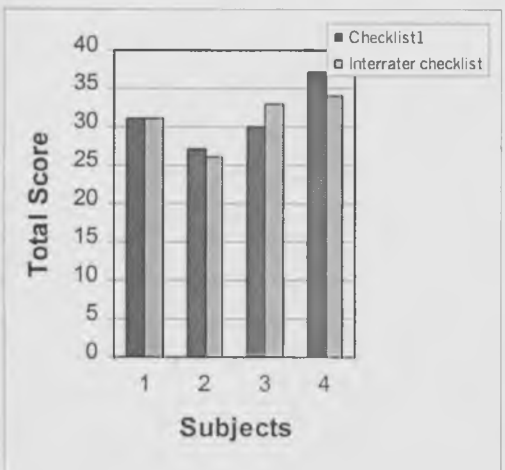
All the correlations are significant at the 0.01 level except for the score for 4-year-old boys on Section 1, which is significant at the 0.05 level. The number of interrater reliability Checklists returned for 4-year-old boys was small (4) and, even though agreement between the two sets of data was good, a difference of 4 points for 1 child for the total of Section 1 made a large difference to the statistical analysis.

The interrater reliability checklist scores for different age groups are shown graphically in Figure 5g.

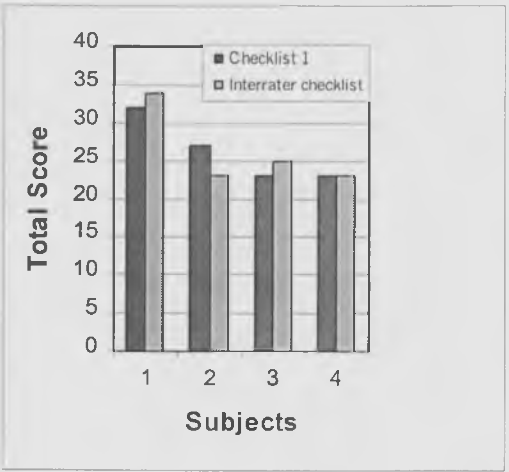
Figure 5g: Interrater reliability scores



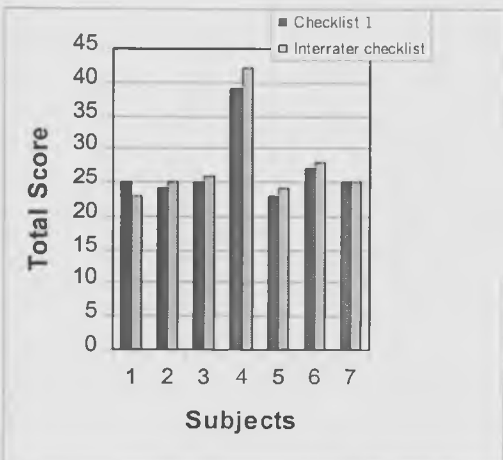
Interrater reliability checklist scores for 3-year-old boys. Correlation 0.98



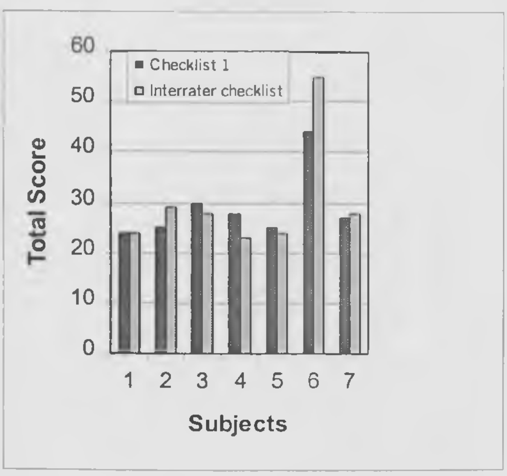
Interrater reliability checklist scores for 3-year-old girls. Correlation 0.80



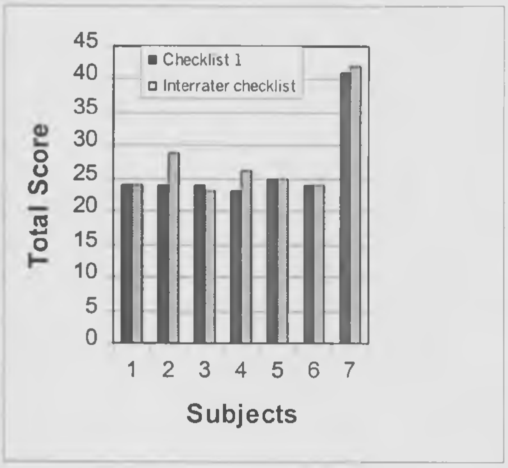
Interrater reliability checklist scores for 4-year-old boys. Correlation 0.84



Interrater reliability checklist scores for 4-year-old girls. Correlation 0.98



Interrater reliability checklist scores for 5-year-old boys. Correlation 0.95



Interrater reliability checklist scores for 5-year-old girls. Correlation 0.95

In addition to the above correlation coefficients, the correlation for the group as a whole was computed. The total motor score (Sections 1 to 4) yielded a correlation coefficient of 0.96, which is highly significant ($p<0.01$). The same correlation coefficients were computed for individual sections; the correlation coefficients were 0.94 for Section 1, 0.93 for Section 2, 0.91 for Section 3 and 0.87 for Section 4. The correlation coefficient for Section 5 was 0.91 and for all 5 sections was 0.96. All of these correlations are statistically significant ($p<0.01$).

Overall, the results of the interrater reliability are very encouraging with 61% of the scores over 0.90, 83% of the scores over 0.80, and only one, 0.46 for Section 1 for the 4-year-old boys, being low.

The correlation coefficients reported above have been computed for the whole of the main sample and for boys and girls from the three age groups. In both cases, reliability of total scores for each section, the overall motor score involving Sections 1 to 4, and Section 5, have been calculated. However, a more accurate measure of reliability is to measure the correlation coefficient for individual items in each section. Each item in the Checklist is scored on a scale between 1 and 4 and the difference in individual item scores is not reflected in the total section scores and the total motor score. Thus, two checklists may each record the same total section score but, given the number of items in each section and the four alternative responses, the individual item scores may be very different between the two checklists. However, this difference is not seen in total section scores. In view of this, it was felt that it would be useful to compute correlation coefficients for each item across the five sections. Pearson's product-moment correlations for individual items in each of the five sections are shown in Table 5.9.

Table 5.9 Interrater reliability coefficients for individual items in the Checklist

Section 1		**Section 4**	
Item 1	0.91	Item 1	0.85
Item 2	0.83	Item 2	0.95
Item 3	0.84	Item 3	0.92
Item 4	0.84	Item 4	0.83
Item 5	0.96	Item 5	0.71
Item 6	0.84	Item 6	0.87
		Item 7	0.55
Section 2			
Item 1	0.96	**Section 5**	
Item 2	0.88	Item 1	0.88
Item 3	0.76	Item 2	0.60
Item 4	0.87	Item 3	0.62
Item 5	0.81	Item 4	0.65
		Item 5	0.78
Section 3		Item 6	0.66
Item 1	0.84	Item 7	0.81
Item 2	0.98	Item 8	0.60
Item 3	0.77	Item 9	0.68
Item 4	0.41	Item 10	0.71
Item 5	0.85	Item 11	0.42
		Item 12	0.50

Again, the results of the interrater reliability for individual items of the Checklist are very encouraging. For Sections 1 to 4, 78% of the scores are over 0.80, and 91% of the scores are over 0.70. For Section 5, 33% of scores are over 0.70, and 83% of scores are over 0.60. All these correlation coefficients are significant at the 0.01 level. These results confirm the correlation coefficients for total section scores and for the total of Sections 1 to 4.

Test-retest Reliability

When returning to schools to collect the completed Early Years Movement Skills Checklists, one further Checklist was left with each class teacher, with the request that it was completed on one of the same children one month after the initial Checklist, as a measure of test-retest reliability. A total of 70 Early Years Movement Skills Checklists were left in schools to be completed for this purpose. 68 Early Years Movement Skills Checklists were returned for use as a test-retest reliability measure. Correlations were performed on each of the five sections of the Checklist, on the total of Sections 1 to 4 and, finally, on the total of all the sections. Pearson's product-moment correlations are shown in Table 5.10.

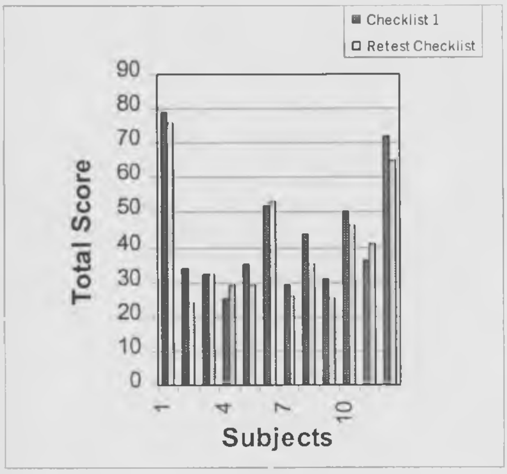
Table 5.10 Test-retest reliability coefficients of the Checklist

	3 Year olds		4 Year olds		5 Year olds	
	Boys	Girls	Boys	Girls	Boys	Girls
Section 1	0.93	0.76	0.94	0.98	0.92	0.87
Section 2	0.87	0.92	0.83	1.00	0.89	0.34
Section 3	0.90	0.96	0.68	1.00	0.64	0.96
Section 4	0.97	0.87	0.82	0.99	0.75	0.95
1-4 Total	0.96	0.90	0.90	1.00	0.89	0.98
Section 5	0.76	0.93	0.90	0.99	0.82	0.84
1-5 Total	0.95	0.94	0.93	1.00	0.85	0.93

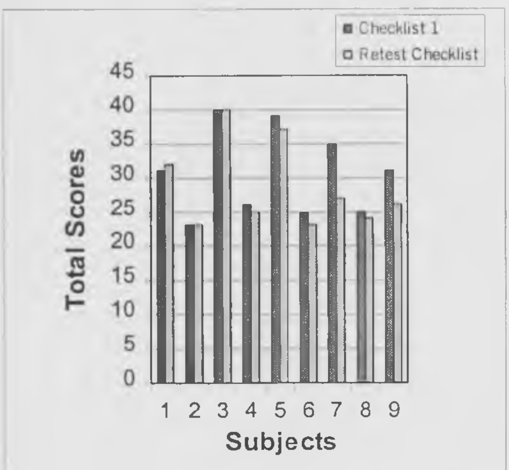
All the correlations are significant at the 0.01 level, except for the 5-year-old girls on Section 2, which is significant at the 0.05 level. There was strong agreement between the two sets of Checklists for the 5-year-old girls; however, the two sets of scores showed a difference of a few points and with such a small number of subjects (4) these few points make a large difference to the statistical analysis. In addition, this group had low scores with smaller ranges than other groups, which would tend to depress the correlation coefficient even though there was strong agreement between the two sets of data. Overall, the results of the test-retest reliability are very encouraging with 60% of the scores over 0.90, 84% of the scores over 0.80, and only one, 0.34 for Section 2 for the 5-year-old girls, being low.

The test-retest reliability checklist scores for different age groups and gender are shown graphically in Figure 5h.

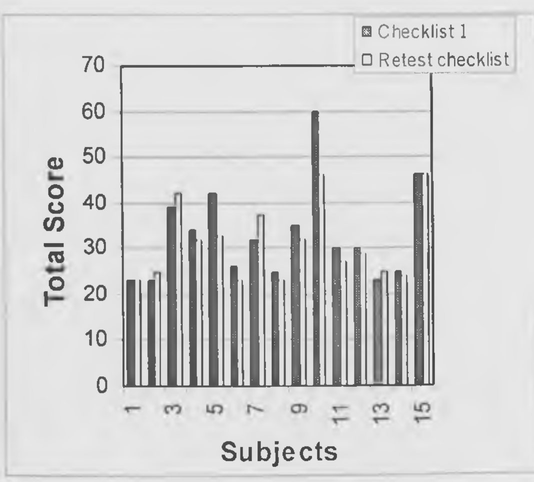
Figure 5h: Test-retest reliability scores



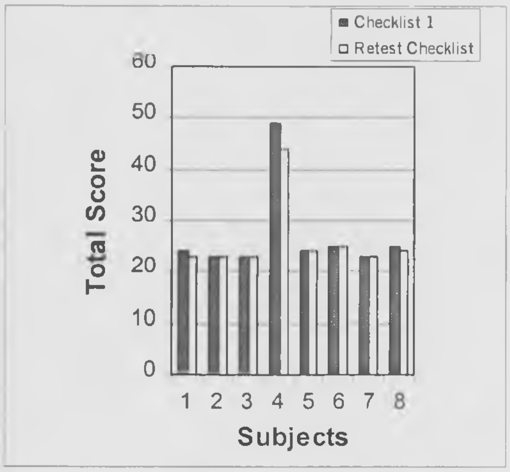
Test-retest reliability checklist scores for 3-year-old boys. Correlation 0.96



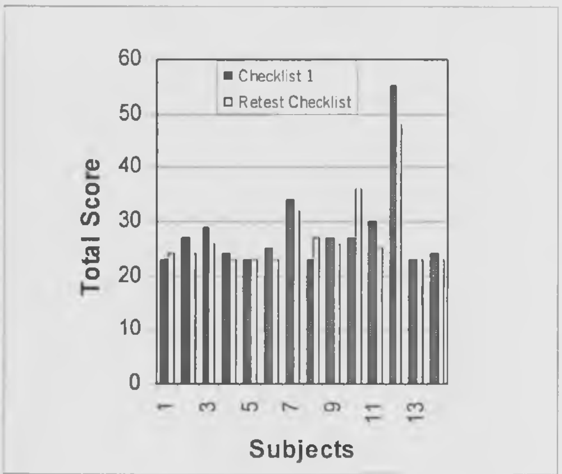
Test-retest reliability checklist scores for 3-year-old girls. Correlation 0.90



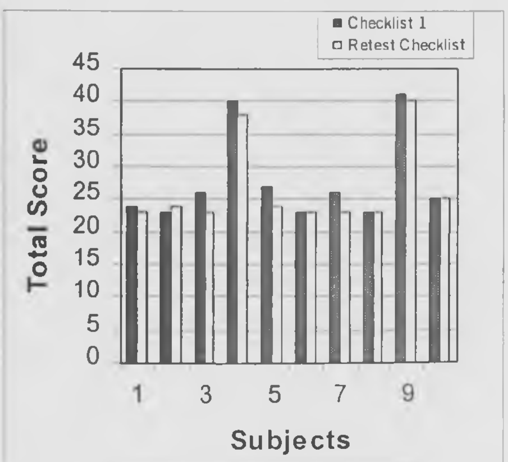
Test-retest reliability checklist scores for 4-year-old boys. Correlation 0.90



Test-retest reliability checklist scores for 4-year-old girls. Correlation 1.00



Test-retest reliability checklist scores for 5-year-old boys. Correlation 0.89



Test-retest reliability checklist scores for 5-year-old girls. Correlation 0.98

In addition to the above correlation coefficients, the correlation coefficients for the group as a whole were computed. The total motor score (Sections 1 to 4) yielded a correlation coefficient of 0.95, which is highly significant ($p<0.01$). The same correlation coefficients were computed for individual sections; the correlation coefficients were 0.92 for Section 1, 0.88 for Section 2, 0.84 for Section 3 and 0.93 for Section 4. The correlation coefficient for Section 5 was 0.85 and for all 5 sections was 0.94. All of these correlations are statistically significant ($p<0.01$).

As above for the interrater reliability measure, it was felt it would be useful to compute Pearson's product-moment correlations for individual items for each section of the Checklist. The results are shown in Table 5.11.

Table 5.11 Test-Retest reliability coefficients for individual items in the Checklist

Section 1		**Section 4**	
Item 1	0.72	Item 1	0.81
Item 2	0.72	Item 2	0.75
Item 3	0.86	Item 3	0.81
Item 4	0.74	Item 4	0.79
Item 5	0.78	Item 5	0.69
Item 6	0.89	Item 6	0.87
		Item 7	0.68
Section 2			
Item 1	0.81	**Section 5**	
Item 2	0.54	Item 1	0.79
Item 3	0.75	Item 2	0.62
Item 4	0.80	Item 3	0.71
Item 5	0.76	Item 4	0.59
		Item 5	0.70
Section 3		Item 6	0.74
Item 1	0.64	Item 7	0.77
Item 2	0.49	Item 8	0.48
Item 3	0.76	Item 9	0.73
Item 4	0.74	Item 10	0.74
Item 5	0.56	Item 11	0.72
		Item 12	0.68

The results of the test-retest reliability for individual items of the Checklist are encouraging. For Sections 1 to 4, 30% of the scores are over 0.80, and 74% of the scores are over 0.70. For Section 5, 67% of scores are over 0.70, and 83% of scores are over 0.60. All these correlation coefficients are significant at the 0.01 level. These results confirm the correlation coefficients for total section scores and for the total of Sections 1 to 4.

Stability of Checklists in the reliability study

Another measure of reliability was calculated. The stability of total scores on the Checklists used in the reliability study was evaluated. This involved examining the interrater checklists and the test-retest checklists and comparing the total scores for each pair of checklists. The original Checklists were assigned to three categories: those whose total scores on the Checklist were in the lowest 5%, those whose total scores were in the lowest 5-10% and those whose total scores were not in the lowest 10%.

The Checklists used in the reliability study were examined to determine to what extent, if any, each pair changed category. Of the 37 Checklists used for the interrater reliability measure, 3 interrater Checklists placed children in a different category from the original Checklist: 2 Checklists originally had total scores of 39 and 41 which placed them in the lowest 5%-10%, while the interrater Checklists both had total scores of 42, which changed the category to the lowest 5%. 1 Checklist originally had a total score of 37 which placed it in the lowest 5-10%, while the interrater Checklist had a total of 34, which changed the category to those outside of the lowest 10% of scores. All other interrater Checklists remained in the original categories. The results indicated 91.8% agreement for the interrater reliability Checklists.

Of the test-retest Checklists, 5 out of 68 placed children in a different category from the original category. 2 Checklists originally had total scores of 32 and 36, which placed them in the category outside of the lowest 10%, while the test-retest Checklists had total scores of 37 and 41 respectively, placing them in the lowest 5-10% category. 2 Checklists originally had total scores in the lowest 5% (44 and 42), while the test-retest Checklists placed both in the category outside of the lowest 10%, scoring 35 and 33 respectively. 1 Checklist which had originally been placed in the lowest 5-10%, was placed by the test-retest Checklist in the lowest 5%; the total score having changed from 39 to 42. All other test-retest Checklists remained in the original categories. The results indicated a 92.6% agreement for the test-retest reliability Checklists. This measure of reliability is, once again, encouraging.

While it is acknowledged that the reliability studies involved small samples, it is also recognised that the overall reliability of the Early Years Movement Skills Checklist is considered to be good.

Validity Of The Early Years Movement Skills Checklist

As noted in Chapter 4, any new assessment instrument not only should be reliable but there should also be some demonstration of validity. This has been done in a number of ways – construct validity and content validity were addressed during the construction of the Early Years Movement Skills Checklist and are discussed in Chapter 4. Another way is to critically examine the predictive validity of the instrument and this section will focus on the procedure adopted to evaluate the predictive validity of the Checklist. One way to establish the predictive validity of an assessment instrument is to determine whether the judgements yielded by that instrument are consistent with the judgements yielded by another assessment instrument. In this study, the focus of the measure of the predictive validity is whether children identified in the lowest 5% on the Checklist will also obtain a score in the same range on another assessment instrument, and similarly for children in the lowest 5-10% and children in the random 5%. The assessment instrument which was used to compare consistency was the Movement Assessment Battery for Children (Movement ABC) (Henderson & Sugden, 1992).

Selection of children for the validity study

A sample from the 4, 5 and 6 year olds was selected for testing on the Movement ABC (Henderson & Sugden, 1992). The selected sample included children whose total scores on the Checklist were in the lowest 5% (Sample 1), those children whose total scores were in the lowest 5-10% (Sample 2) and a random sample of

5% of children whose total scores were not in the bottom 10% (Sample 3). 298 Checklists were returned for the 4, 5 and 6 year old children, indicating that each of the 3 sample groups would consist of 15 children; giving a total of 45 children to be tested.

The selected sample

The scores for Sample 1 (lowest 5%) ranged from 60 to 42, and, as there were 5 children with scores of 42, the total number of children with the lowest scores was 17. The scores for Sample 2 (lowest 5-10%) ranged from 41 to 37, and, again, 6 children had scores of 37, bringing the total in this group to 16. For Sample 3 (randomly selected group), a random set of numbers was generated by a computer programme which identified 16 children whose scores were not in the lowest 10%. The scores of this group were at or below 32. The total number of children identified for testing on the Movement ABC (Henderson & Sugden, 1992) was 49.

2 children whose scores were in the lowest 5% were not tested: one child refused to cooperate on any of the tasks in the test and was, therefore, not included in the analyses, and another child was not included as the school took the decision not to take any part in the research beyond the Checklist stage. This gave a total of 15 children in Sample 1. For the group containing children scoring in the lowest 5-10%, 2 children were not tested as their schools also took the decision not to take any part in the research beyond the Checklist stage. Sample 2 ultimately contained 14 children. The group containing the random sample of children (Sample 3) remained at 16, but 3 of the children who were originally identified did not take part in the test, as two children transferred to schools outside of the immediate area and the school of one child did not want to take any further part in the research. These three children were replaced by three other randomly selected children. The total number of children tested with the Movement ABC (Henderson & Sugden, 1992) was 45.

Table 5.12 shows the number of boys and girls, mean age, standard deviation and age range of the children involved in the validity study.

Table 5.12 Children in the validity study

	N	Boys	Girls	Mean age in months	S.D. in months	Range in months
Sample 1	15	8	7	62.33	6.73	21
Sample 2	14	7	7	61.07	7.99	23
Sample 3	16	10	6	65.06	6.79	22

It can be seen from Table 5.12 that the numbers of girls and boys in Sample 1 and Sample 2 is fairly evenly split, indicating that about even numbers of girls and boys are in the lowest 5% and the lowest 5-10% of scores.

The children in Sample 1 came from 11 different schools with 3 of the children from the same school. The children in Sample 2 also came from 11 different schools. However, of those 11 schools 7 of them also had children who were in Sample 1. Overall, the total number of schools included in Sample 1 and Sample 2 was 16, 47% of the original sample of 34 schools.

In Sample 1, 6 children were 4 years of age, 10 children were 5 years of age and 1 child was 6 years of age. In Sample 2, 8 children were 4 years of age, 4 children were 5 years of age and 2 children were 6 years of age. The three children who were 6 years of age were all 5 years of age when assessed with the Early Years Movement Skills Checklist. Sample 3 consisted of 7 children who were 4 years of age and 9 children who were 5 years of age.

The standard deviation, median and mean scores for each section of the Checklist have been calculated, with separate totals for Section 5 (Table 5.13).

Table 5.13 Checklist scores for the selected sample

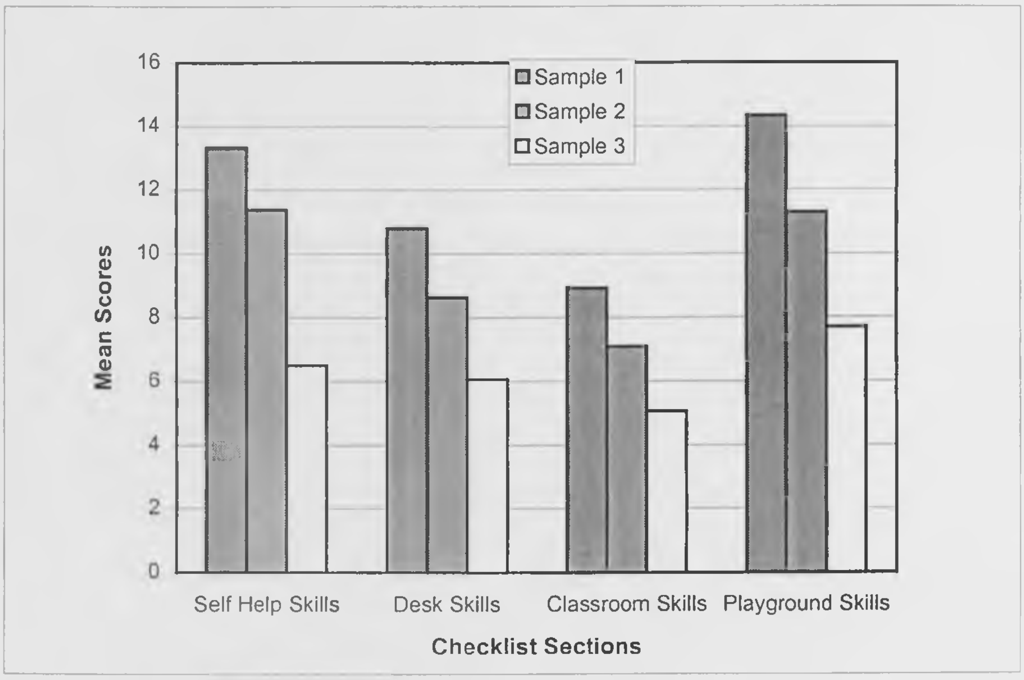
	Sample 1	Sample 2	Sample 3
Section 1	**13.33**	**11.36**	**6.50**
Per item	2.22	1.89	1.08
SD	1.95	2.10	0.82
Median	13.00	11.00	6.00
Section 2	**10.80**	**8.64**	**6.06**
Per item	2.16	1.72	1.21
SD	2.27	4.04	1.73
Median	11.00	9.00	5.00
Section 3	**8.93**	**7.07**	**5.06**
Per item	1.78	1.41	1.01
SD	2.94	2.43	0.25
Median	9.00	6.50	5.00
Section 4	**14.33**	**11.29**	**7.69**
Per item	2.04	1.61	1.09
SD	3.06	3.29	1.45
Median	15.00	11.00	7.00
Total 1-4	**47.40**	**38.36**	**25.31**
SD	6.03	1.34	2.89
Median	46.00	38.00	24.00
Section 5	**10.07**	**9.07**	**5.31**
Per item	0.83	0.75	0.44
SD	2.22	3.50	4.63
Median	10.00	9.50	4.00
Total 1-5	**57.47**	**47.43**	**30.63**
SD	6.22	4.29	7.00
Median	57.00	47.00	28.00

The mean scores for the Checklist followed the expected pattern: the children in Sample 1 had higher scores than the children in Sample 2, who, in turn, had higher scores than the children in Sample 3. The calculated standard deviations (SD) are shown above - the majority of which are small. As noted above in the discussion for the main sample, despite the results following the expected pattern, a statistically ‘normal’ plot will not be seen. In addition, the group of children in Sample 1 and the group of children in Sample 3 included some high outlying scores which affected the standard deviation.

In addition to calculating the standard deviation, the median of each section and total scores were determined so that the point where 50% of the scores lie above and below can be shown. As with the main sample, the calculated medians show a close resemblance to the mean scores and, as noted above, this is a feature of an evenly distributed data set.

A graphic display of the mean scores for each section is presented in Figure 5i.

Figure 5i Mean section scores by group for the Checklist for the selected sample



Detail of the Checklists selected for the validity study

Sample 1 (children with the lowest 5% of scores) consisted of 8 boys and 7 girls, whose Checklist scores ranged from 60 to 42. Their scores on the Checklist followed the expected pattern - many of them scored highly on each section. Section 1 was a particularly difficult section for 9 of the 15 children in this group (60%); of the remaining 6 children, 3 were able to adequately perform all the items in this section and the other 3 had problems with one or more items. Items which caused particular difficulty were item 1 (putting on a T-shirt without assistance) for which no child gained a score of 1 indicating that it could be performed well, item 2 (taking off a T-shirt without assistance). Items 3 and 4 also caused considerable difficulty for the group. 11 of the 15 children (73%) were unable to fasten accessible coat buttons (item 3), but 9 of the 15 children (60%) were able to perform item 4 (unbuttoning accessible coat buttons), but none of them could perform the activity well. Table 5.13 shows that for Section 1 the mean score per item is 2.22, which is the highest mean score per item for the entire selected sample.

In Section 2, 10 children (66%) were unable to copy a circle and cross from a completed example (item 1) and for those who were able to perform the task only 1 could perform it well. All 15 of the children could perform item 3 (turning single pages of a book) and 14 (93%) could construct simple models using duplo, lego and megablocks (item 5).

The total mean score and mean score per item indicate that, in a similar manner to the 3-year-old children, the children found Section 3 the easiest of the sections. 2 of the 15 children (13%) scored minimum points in this section – being able to perform all activities well. Item 5 (moving forward, backward, sideways, under and over when shown) gave the children most problems with 4 children (26%) being unable to perform the task, 8 children (53%) being able to only 'just' perform it and only 3 children (20%) being able to perform the activity well.

In Section 4, all but 1 of the children were able to perform item 1 (using fixed playground equipment) and item 2 (riding moving vehicles). 13 of the children (86%) were able to kick a large stationary ball (item 3) and 9 children (60%) were able to throw a large ball overarm using both hands. For item 7 (catching a large ball with two hands) only 1 child (6%) was able to perform the task well, with 7 children (46%) just managing to perform the task.

Overall, it would appear that the children in Sample 1 have difficulties in all areas covered by the Checklist, except for one or two of the children whose difficulties appear to be focused in one or more specific areas. For example, two children scored highly in Section 1 Self Help Skills, but had adequate scores for the remainder of the Checklist.

Sample 2 (children with the lowest 5-10% of scores) consisted of 7 boys and 7 girls, and the total scores for the Checklist ranged from 41 to 37. Unlike the children in Sample 1, the children in this group did not score consistently highly for each section. The pattern that emerges is that children in this group score highly in one or two sections only, and adequately in the other sections. For example, one child (a boy) scored 17 for Section 1, for the other sections he scored 7, 5 and 8 respectively. Another child (a girl) scored 11 for Section 1 and 13 for Section 2 (two fairly high scores) while for Section 3 and 4 she scored 7 and 10. Again, similarly to the children in Sample 1 and the 3-year-old children, Section 1 appears to have caused most difficulties for the group as a whole; the nearest score to the minimum of 6 was a score of 8 for 1 child.

Minimum scores for the other three sections were obtained by a least 1 child in each section - 1 child scored the minimum of 5 for Section 2, 5 children scored the minimum of 5 for Section 3 and 1 child scored the minimum of 7 for Section 4. In a similar manner to the children in Sample 1 and the 3-year-old children, the children in this group appear to have found Section 3 the easiest of the sections, with the exception of 1 child who scored 13.

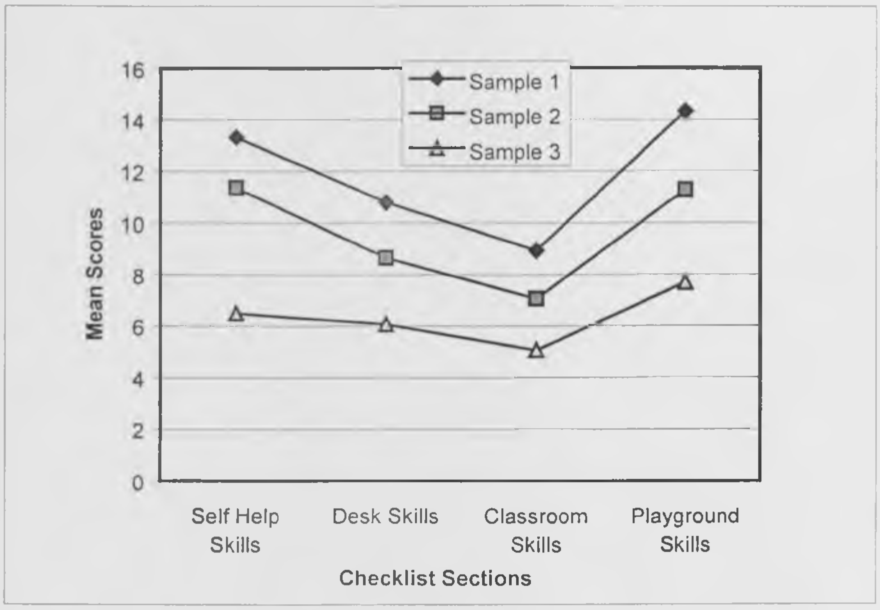
Sample 3 (children in the random 5%) consisted of 10 boys and 6 girls, and the total scores for the Checklist ranged from 32 to 23. Unlike the previous groups, this group did not find Section 1 the most difficult; the scores for this section ranged from 6 to 8 with 11 children scoring the minimum of 6, 2 children scoring 7 and 3 scoring 8. A look at the item scores reveals that no child was unable to perform any of the activities in Section 1. In Section 2, 2 children were unable to copy a circle and a cross from a completed example (item 1) and 2 children were unable to use scissors (item 4). Again, this group found Section 3 the easiest of the sections; 15 of the 16 children gained the minimum score of 5, while the remaining child scored 2 for item 5 (moving forward, backward, sideways, under and over when shown), giving a total score of 6 for the section. 12 of the 16 children scored the minimum score of 7 for Section 4, while the other 4 scores in this section were 8, 9 10 and 12 – once again showing that no child was unable to perform any item in this section.

Overall, all the children in Sample 3 scored adequately on the Checklist with 6 of the 16 (37.5%) scoring the minimum of 23 for the total score. For the children in this group, there were two occasions when a score of 4 for an item was given and two occasions when a score of 3 for an item was given. While these scores are considered to indicate that the child is unable to perform an activity, in comparison with the children in Sample 1 they are isolated occasions and do not indicate that these children have movement difficulties.

Analysis of Sections 1-4 on the Early Years Movements Skills Checklist

A 3 (group) by 4 (section) ANOVA with repeated measures was performed on the selected sample. The analysis provided a main effect for section, $F(3,150) = 30.37$ $P<0.0001$ and for group, $F(2, 120) = 122.20$ $P<0.0001$ with the children in Sample 1 (lowest 5%) scoring higher (poorer). There was also a section by group interaction and Tukey's HSD test revealed significant differences between the three groups. These are shown in Figure 5j.

Figure 5j Interaction of Section and the selected sample



Nature of the problems

Checklists of the children who scored poorly were examined to determine the nature of the problems identified. Checklists in Sample 1 and Sample 2 were examined, which enabled profiles to be analysed on these children. Means and standard deviations of the section scores were calculated for each child, providing intra-child measures. The individual section scores for each child were then examined in the light of the mean and the standard deviation for that particular child. If the section score was within plus or minus one standard deviation from the mean it was considered to be consistent with the overall scores of the child; if it was outside of this range, it was considered to be part of a different profile.

Using this method a number of different profiles emerged. No children in the sample of 29 scored within plus or minus one standard deviation for all sections of the Checklist. One profile to emerge involved Section 3, where 12 children (42%) had a score that was more than one standard deviation below the mean, showing that on this section the children were relatively good compared with the other sections. Of these 12, 6 of the children (21%) showed this as a 'pure' profile, with all other section scores falling within plus or minus one standard deviation of the mean. The other 6 children who scored well on Section 3, showed it in combination with another section score being higher than one standard deviation above the mean; 3 of them scored highly on Section 1 and 3 of them scored highly on Section 4.

Another profile which emerged involved 11 (40%) of the 29 children and showed a discrepancy between Sections 1, 2 and 3 compared with Section 4. All 11 of the children had higher scores on Section 4 than on the other sections. 5 of these (17%) were ‘pure’ profiles, while 6 of the children (21%) showed this in combination with low scores on other sections; 3 of them had low scores on Section 2, and 3 of them had low scores on Section 3.

Another profile to emerge involved Section 1 where 8 children (34%) scored above one standard deviation of the mean. Of these, 4 (17%) had ‘pure’ profiles, while the other 4 showed it in combination with low scores on other sections (3 of them with Section 3, as noted above) and 1 child with a low score on Section 4.

These profiles account for 89% of the children with problems; the remaining 11% consists of 1 child scoring highly on Section 2, 1 child scoring highly on Section 3 and 2 children with low scores – one on Section 2 and one on Section 4.

Detail of the testing with the Movement ABC

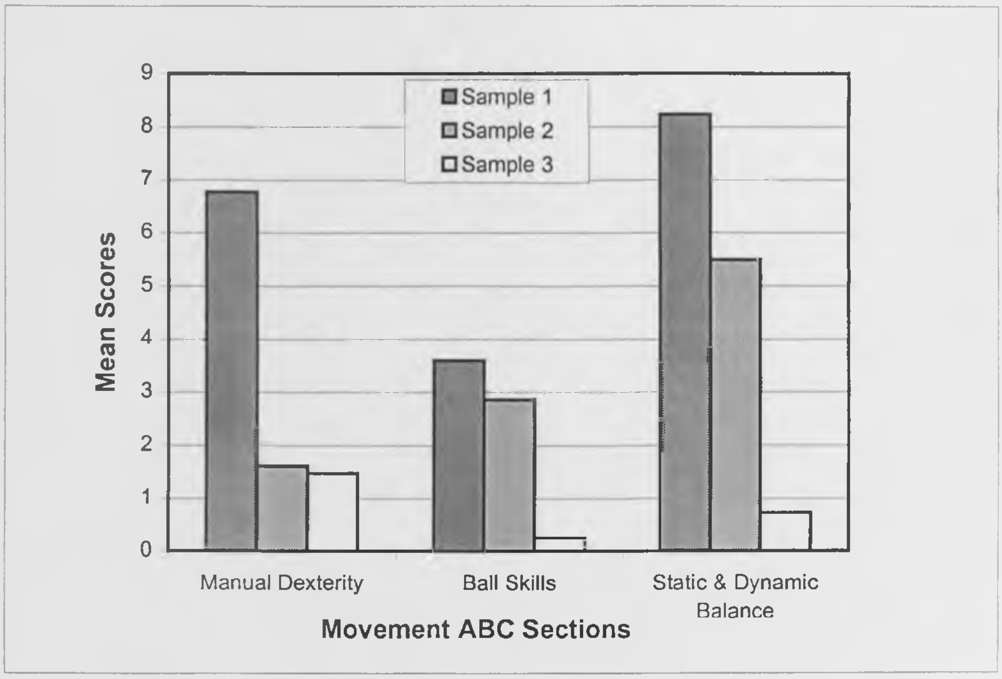
All of the children in the three groups were tested with the Movement ABC Test (Henderson & Sugden, 1992) and the results are reported and analysed below. Table 5.14 shows the comparative results of the mean test total and section scores, along with the standard deviation and median for each section in the Movement ABC. As with the Checklist scores, the mean score per item is also indicated, as this is a more accurate reflection of performance, as the number of items that each section contains affects the mean score per section.

Table 5.14 Mean section and item scores, total scores, SD and medians

	Sample 1	Sample 2	Sample 3
Manual Dexterity			
Mean	6.77	1.61	1.47
Per item	2.57	0.54	0.49
SD	4.87	2.13	1.54
Median	7.00	1.25	1.00
Ball Skills			
Mean	3.60	2.86	0.25
Per item	1.80	1.43	0.12
SD	1.84	2.21	0.58
Median	3.00	2.00	0.00
Balance			
Mean	8.23	5.50	0.72
Per item	2.74	1.83	1.24
SD	2.88	3.37	1.57
Median	8.50	6.75	0.00
Total score			
Mean	18.60	9.96	2.44
SD	6.92	5.35	2.69
Median	18.50	11.25	1.50

The mean results of the tests for each of the groups as a whole reflect the groupings from the Checklist into Sample 1, Sample 2 and Sample 3. In all sections of the Movement ABC Test (Henderson & Sugden, 1992) the mean scores for children in Sample 1 are higher than the other two groups, and the mean scores for children in Sample 2 are higher than the mean scores for children in Sample 3. However, there is very little difference between the mean score for Manual Dexterity for children in Sample 2 (1.61) and children in Sample 3 (1.47). As with the Checklist, the children who record higher scores indicate a poorer performance. The mean section scores are shown graphically in Figure 5k.

Figure 5k Mean section scores by group for the Movement ABC Test



Analysis of the Movement ABC Test

A 3 (group) by 3 (section) ANOVA with repeated measures on the last factor was performed on the data for the Movement ABC Test scores. As expected, the analysis provided a main effect for section, F (2, 75.66) = 17.71 P<0.0001 and for group, F (2, 112.41) = 29.22 P<0.0001. Tukey's HSD test revealed significant differences between the three groups, although there was no difference between Sample 2 and Sample 3 for Manual Dexterity, and no significant difference between Sample 1 and Sample 2 for Ball Skills. There was a significant difference between all the groups on Static and Dynamic Balance and there was an interaction effect involving group and section, F (4, 36.42) = 8.52 P<0.0001.

Stability of the groupings

While the groupings as a whole confirm the groupings identified by the Checklist, it is necessary to look at individual Movement ABC Test profiles. The Movement ABC Test scores are interpreted in the light of percentile norms; scores below the 5th percentile should be considered as indicative of a movement problem while scores between the 5th and 15th percentile suggest a degree of difficulty that is borderline. For the purpose of this study scores between the 5th and 10th percentile have been considered, as the children in the validity study scored in the lowest 5% of the Checklist and the lowest 5-10% of the Checklist. The percentile norms are divided into two age groups (4-5 years of age and 6 years and above): the 5th percentile cut-off point for age 4 and 5 years is 17 and 13.5 for 6 years and above. At the 10th percentile, the cut-off points for age 4 and 5 years is 13 and 11.5/11 for 6 years and above.

Movement ABC Test scores of the children in Sample 1 placed 9 out of 15 children (60%) at or below the 5th percentile, 4 out of 15 (27%) between the 5th and 10th percentile and 2 out of 15 (13%) above the 10th percentile. Test scores of the children in Sample 2 placed 3 out of 14 (21%) at or below the 5th percentile, 4 out of 14 (29%) between the 5th and 10th percentile and 7 out of 14 (50%) above the 10th percentile. Test scores of the children in Sample 3 placed all 16 above the 10th percentile. These results have been entered in Table 5.15.

Table 5.15 Comparisons of scores on the Checklist with the Movement ABC

	5th percentile	5th – 10th percentile	Above 10th percentile
Sample 1	9	4	2
Sample 2	3	4	7
Sample 3	0	0	16
TOTAL	12	8	25

Overall, 12 children were identified by the Movement ABC Test as having movement difficulties, 8 as being at risk and 25 as having no difficulties.

Children scoring below the 5th percentile

The group of children scoring at or below the 5th percentile included 9 children originally identified in Sample 1 and 3 children who were originally identified in Sample 2. The mean score for the Checklist for this group was 45, and for the Test was 21.88. The group consisted of 8 boys and 4 girls.

Subject 1 is a 5-year-old boy. His total score on the Checklist was 42, with particularly high scores for Self Help Skills (15) and Desk Skills (12). His total score on the Movement ABC Test was 23, with high scores for Manual Dexterity (12) and Static and Dynamic Balance (8). The Checklist score placed the child in Sample 1 and the test score confirmed his place below the 5th percentile.

Subject 2 is a 6-year-old boy. The class teacher reported that this child finds it very hard to concentrate and is very easily distracted. His total score on the Checklist was 42, with high scores for Self Help Skills (12), Desk Skills (10) and Recreational/Playground Skills (11). His total score on the Movement ABC Test was 17, with high scores for Manual Dexterity (7) and Static and Dynamic Balance (8). His Checklist score placed him in Sample 1 and the test score confirmed his place below the 5th percentile.

Subject 3 is a 5-year-old boy. The class teacher reported that this child is very easily distracted. His total score on the Checklist was 49, with high scores for Desk Skills (12) and General Classroom Skills (14). His total score on the Movement ABC Test was 22.5, with high scores for all sections - Manual Dexterity (7), Ball Skills (5) and Static and Dynamic Balance (10.5). His Checklist score placed him in Sample 1 and the test score confirmed his place below the 5th percentile.

Subject 4 is a 5-year-old girl. The Special Needs Coordinator reported that this child appears to have general learning difficulties which, at the time of testing, were being investigated. During testing, she displayed timidness when attempting activities and needed constant reassurance. Her total score on the Checklist was 57, with high scores for Self Help Skills (13), Desk Skills (15) and Recreational/Playground Skills (20). Her total score on the Movement ABC Test was 29, with high scores for all sections - Manual Dexterity (10), Ball Skills (7) and Static and Dynamic Balance (12). Her Checklist score placed her in Sample 1 and the test score confirmed her place below the 5th percentile.

Subject 5 is a 5-year-old girl. This child had recently moved school from one of the other schools involved in the project and was still settling in to the new school.

During testing she was extremely nervous. Her total score on the Checklist was 45, with high scores for Self Help Skills (13), Desk Skills (12) and Recreational/Playground Skills (16). Her total score on the Movement ABC Test was 18.5, with high scores for Manual Dexterity (7) and Static and Dynamic Balance (8.5). Her Checklist score placed her in Sample 1 and the test score confirmed her place below the 5th percentile.

Subject 6 is a 5-year-old boy with learning difficulties. The school is in the process of applying for a Statement of Special Educational Need for him. During the test he needed a great deal of explanation for each activity. His total score on the Checklist was 42, with high scores for Self Help Skills (16) Desk Skills (9) and Recreational/Playground Skills (11). His total score on the Movement ABC Test was 27.5, with high scores for Manual Dexterity (15) and Static and Dynamic Balance (8.5). His Checklist score placed him in Sample 1 and the test score confirmed his place below the 5th percentile.

Subject 7 is a 5-year-old boy. This child has learning difficulties and behavioural difficulties and has a Statement of Special Educational Need. He has a teaching assistant with him for the majority of the time in school. His total score on the Checklist was 55, with high scores for Self Help Skills (15) Desk Skills (15) and Recreational/Playground Skills (16). His total score on the Movement ABC Test was 33, with high scores for Manual Dexterity (15) and Static and Dynamic Balance (12). His Checklist score placed him in Sample 1 and the test score confirmed his place below the 5th percentile.

Subject 8 is a 4-year-old boy. The class teacher commented that this child is extremely immature for his age. During testing he was easily distracted. His total score on the Checklist was 46, with high scores for Self Help Skills (15) and Recreational/Playground Skills (13). His total score on the Movement ABC Test was 23, with high scores for Manual Dexterity (7) and Static and Dynamic Balance (10). His Checklist score placed him in Sample 1 and the test score confirmed his place below the 5th percentile.

Subject 9 is a 5-year-old girl. This child finds it very difficult to concentrate and is easily distracted. During testing she was constantly wandering off to find out what was happening elsewhere and needed constant reminders to continue with the activities. Her total score on the Checklist was 42, with high scores for Self Help Skills (13) and Recreational/Playground Skills (16). Her total score on the Movement ABC Test was 21.5, with high scores for Manual Dexterity (9.5) and Static and Dynamic Balance (7). Her Checklist score placed her in Sample 1 and the test score confirmed her place below the 5th percentile.

Subject 10 is a 5-year-old girl. Her total score on the Checklist was 41, with high scores for Self Help Skills (13), Desk Skills (8) and Recreational/Playground Skills (16). Her total score on the Movement ABC Test was 17.5, with a high score for Manual Dexterity (8.5). Her Checklist score placed her in Sample 2 but the test score placed her below the 5th percentile. The Checklist score of 41 was within 1 point of the cut-off point for Sample 1 on the Checklist and the Test score was within 0.5 of the cut-off point for the 5th percentile.

Subject 11 is a 6-year-old boy who has been diagnosed as having Dyspraxia and is receiving occupational therapy from a local Child Development Centre. His total score on the Checklist was 39, with high scores for Desk Skills (8) and Recreational/Playground Skills (17). His total score on the Movement ABC Test was 14.5, with a high score for Static and Dynamic Balance (10.5). His Checklist score placed him in Sample 2 but the test score placed him below the 5th percentile.

Subject 12 is a 6-year-old boy. His total score on the Checklist was 40, with high scores for Self Help Skills (12) and Recreational/Playground Skills (16). His total score on the Movement ABC Test was 15.5, with a high score for Ball Skills (6) and Static and Dynamic Balance (7.5). His Checklist score placed him in Sample 2 but the test score placed him below the 5th percentile.

Children scoring between the 5th and 10th percentile

The group of children scoring within the range for Sample 2 included 4 children originally placed in Sample 1 and 4 children who were originally placed in Sample 2. The mean score for the Checklist for this group was 44.5, and for the Test was 13.94. The group consisted of 1 boy and 7 girls.

Subject 13 is a 5-year-old boy. His total score on the Checklist was 39, with high scores for Self Help Skills (12) and General Classroom Skills (10). His total score on the Movement ABC Test was 15, with high scores for Static and Dynamic Balance (8). His Checklist score placed him in Sample 2 and the test score confirmed his place between the 5th and 10th percentile.

Subject 14 is a 5-year-old girl. The class teacher reported that she has concerns about this child with respect to movement and said that she felt the child was ‘extremely clumsy’. Her total score on the Checklist was 40, with high scores for Self Help Skills (12) and General Classroom Skills (13). Her total score on the Movement ABC Test was 13, with high scores for Ball Skills (6) and Static and Dynamic Balance (6.5). Her Checklist score placed her in Sample 2 and the test score confirmed her place between the 5th and 10th percentile.

Subject 15 is a 4-year-old girl. Her total score on the Checklist was 38, with high scores for Desk Skills (10) and Recreational/Playground Skills (11). Her total score on the Movement ABC Test was 14.5, with high scores for Static and Dynamic Balance (10). Her Checklist score placed her in Sample 2 and the test score confirmed her place between the 5th and 10th percentile.

Subject 16 is a 5-year-old girl. Her total score on the Checklist was 37, with high scores for Self Help Skills (12) and Desk Skills (8). Her total score on the Movement ABC Test was 13, with high scores for Ball Skills (5) and Static and Dynamic Balance (7). Her Checklist score placed her in Sample 2 and the test score confirmed her place between the 5th and 10th percentile.

Subject 17 is a 4-year-old girl. The class teacher reported that this child is receiving treatment for movement difficulties. Her total score on the Checklist was 49, with high scores for Self Help Skills (13), General Classroom Skills (11) and Recreational/Playground Skills (17). Her total score on the Movement ABC Test was 14, with high scores for Static and Dynamic Balance (8.5). Her Checklist score placed her in Sample 1 but the test score placed her between the 5th and 10th percentile.

Subject 18 is a 4-year-old girl. The class teacher reported that this child is a twin, and relies very much on her sister and is happy to let her sister take the lead in everything that they do. The sister came to the test to give moral support. Her total score on the Checklist was 42, with high scores for Desk Skills (11) and Recreational/Playground Skills (15). Her total score on the Movement ABC Test was 14.5, with high scores for Static and Dynamic Balance (7). Her Checklist score placed her in Sample 1 but the test score placed her between the 5th and 10th percentile.

Subject 19 is a 5-year-old girl. The class teacher commented that she has concerns about this child's movement skills. Her total score on the Checklist was 51, with high scores for all sections – Self Help Skills (14), Desk Skills (12), General Classroom Skills (13) and Recreational/Playground Skills (12). Her total score on the Movement ABC Test was 13.5, with high scores for Static and Dynamic Balance (9). Her Checklist score placed her in Sample 1 but the test score placed her between the 5th and 10th percentile.

Subject 20 is a 4-year-old girl. The class teacher reported that this child is very much a loner and is left out of activities by many of the children in the class. In the weeks prior to the test, she has made good progress in her schoolwork. Her total score on the Checklist was 60, with high scores for all sections – Self Help Skills (17), Desk Skills (12), General Classroom Skills (13) and Recreational/Playground Skills (18). Her total score on the Movement ABC Test was 14, with high scores for Static and Dynamic Balance (10). Her Checklist score placed her in Sample 1 but the test score placed her between the 5th and 10th percentile.

The group of children scoring above the 10th percentile included 25 children from the selected sample of 45 (55%); this group was made up of the 16 children from Sample 3, 2 children from Sample 1 and 7 children from Sample 2. The mean score for the Checklist for this group was 30.28 and for the Test was 3.34. 4 of the children from Sample 2 scored 37 on the Checklist - within 1 point of the cut-off point for the random sample of children whose scores were not in the lowest 10%.

If the cut-off point for the 15th percentile had been used in place of the 10th percentile cut-off point then the picture would have been slightly different. All the children in the 5th to 10th percentile group would have scored between the 5th and 15th percentile and, in addition, 1 child from the group whose scores fell above the 10th percentile, would have also been included. This child scored 10.5 on the Test, the highest score in the group above the 10th percentile, which would have placed the child between the 5th and 15th percentile.

The Early Years Movement Skills Checklist was not specifically designed for 6 year old children, but in the light of the performance of the two 6–year-old boys, there is no apparent ceiling effect when 6 year old children are assessed using the Checklist. In addition to the two 6-year-old boys in Sample 2 there was also a child who, at the time of the Checklist assessment, was 5 years and 10 months old and when tested with the Movement ABC Test was 6 years of age. This child's score placed him in Sample 1 and his score on the Test placed him below the 5th percentile.

Gender differences in movement difficulties

As note above, the Movement ABC Test (Henderson & Sugden, 1992) identified 20 children as either displaying movement difficulties or being at risk. This group consists of 9 boys and 11 girls: 8 boys and 4 girls from Sample 1 and 1 boy and 7 girls from Sample 2. The children in Sample 1 are those who display the more severe motor problems and the ratio of boys to girls is 2:1.

Correlation of the Checklist with the Movement ABC

When the total scores of the Checklist were correlated with total scores on the Movement ABC Test, the Pearson product-moment correlations shown in Table 5.16 were obtained.

Table 5.16 Correlations of the Checklist with the Movement ABC

Movement ABC Group	Correlation with the Checklist
Sample 1	0.23
Sample 2	0.57
Sample 3	0.35
All selected sample	0.76

The correlation coefficients for Sample 2 and the whole of the selected sample are significant at the 0.01 level, and the correlation coefficients for Sample 1 and Sample 3 are significant at the 0.05 level. The correlation coefficients for the individual groups are not impressive and not totally unexpected, given the movement of children between groups. The correlation for the whole of the selected sample is encouraging. In summary, it appears that with the more severe problems there is fairly good agreement between the Checklist and the Movement ABC Test; the Checklist identified some children who were not confirmed by the Movement ABC Test, but no children were picked up by the Movement ABC Test that had not previously been identified by the Checklist.

Sensitivity and specificity

The predictive validity of assessment instruments is sometimes presented in terms of indexes referred to as sensitivity and specificity. Sensitivity, or the true-positive rate, is the likelihood that a positive test places a person in an impairment category; specificity, or the true-negative rate, is the likelihood that a negative test does not place a person in an impairment category (Burton & Miller, 1998).

Table 5.17 Sensitivity and specificity index of the checklist

Total persons 45	**Impairment present** 20	**Impairment absent** 25
Test positive 29	**True positive** 20	**False positive** 9
Test negative 16	**False negative** 0	**True negative** 16

Of the 45 children involved in the validity study, 20 of the original 29 were identified by the Movement ABC Test (Henderson & Sugden, 1992) as displaying movement difficulties. Based on this sample of 45 children, the sensitivity index of the Early Years Movement Skills Checklist has been calculated as 1.00. 16 children were originally identified as not having movement difficulties, but the Movement ABC Test identified 25 as not having difficulties. Thus, the specificity index has been calculated as 0.64. The probability of impairment if the Checklist is positive has been calculated as 0.64, and the probability of impairment if the Checklist is negative has been calculated as 0.00. In practical terms this means that if a Checklist is positive then 64 times in every 100 the child will have movement difficulties, and if a Checklist is negative then the child will never be found to have movement difficulties.

Movement-Related Behaviours

As noted in Chapter 4, one of the aims of the study was to investigate whether there was a relationship between motor skill behaviour and movement-related behaviours in young children with and without movement difficulties. In order to achieve this, Section 5, Behavioural Problems Related to Motor Difficulties, from the Movement ABC (Henderson & Sugden, 1992) was included in the Early Years Movement Skills Checklist to assess behaviours that are seen within a movement skills context. Section 5 consists of twelve items, scored on a scale between 0 and 2. Unlike the Checklist, it is not possible to score maximum points as some of the items are almost opposites. For example, item 1 is concerned with overactivity and item 2 is concerned with passive behaviour. However, it is possible to score the minimum of 0 in this section, as a score of 0 indicates that the behaviour is rarely seen.

The Main Sample

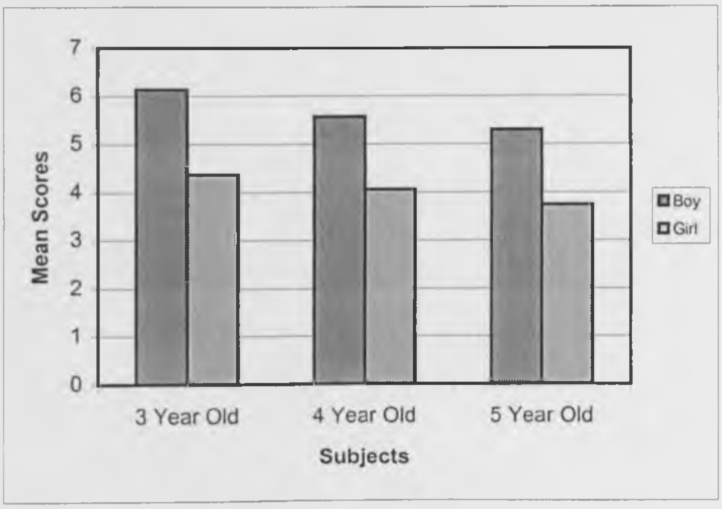
Table 5.18 gives detail concerning the mean scores for the three age groups from the main sample.

Table 5.18 Mean scores for Section 5, standard deviation, median and range

	3 Year olds		4 Year olds		5 Year olds	
	Boys	**Girls**	**Boys**	**Girls**	**Boys**	**Girls**
Mean	6.14	4.37	5.57	4.06	5.30	3.74
Per item	0.51	0.36	0.46	0.34	0.44	0.31
SD	4.74	3.97	4.34	4.11	4.60	3.94
Median	5.00	3.00	5.00	3.00	4.00	3.00
Range	20-0	20-0	17-0	16-0	17-0	17-0

As with the total mean scores for Sections 1 to 4, the total mean score for Section 5 was highest for the 3-year-old boys and thereafter decreased with age. Once again, the total mean score was lower for 3 year old girls than for 4 year old boys, and similarly for 4 year old girls and 5 year old boys. The range of scores shows a slight decrease with age.

Figure 5l Mean scores for the main sample for Section 5 by age and gender



The Selected Sample

The mean scores for Section 5 for the selected sample are shown in Table 5.19. The standard deviation, median and range of scores are also shown.

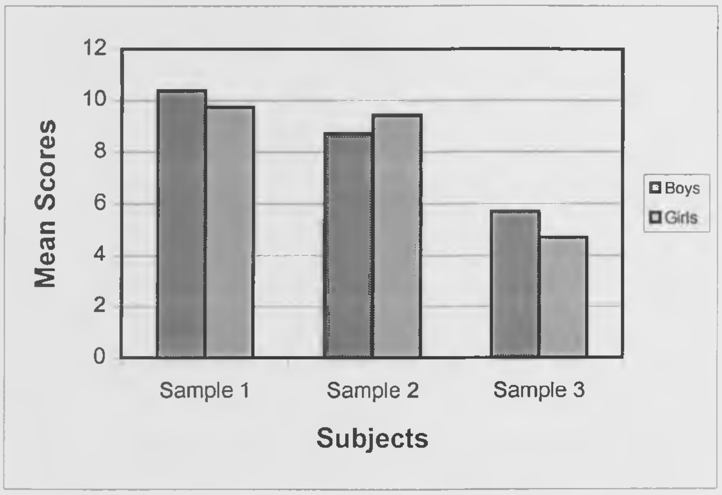
Table 5.19 Mean scores for Section 5, standard deviation, median and range for the selected sample

	Sample 1		Sample 2		Sample 3	
	Boys	**Girls**	**Boys**	**Girls**	**Boys**	**Girls**
Mean	10.38	9.71	8.71	9.43	5.70	4.67
Per item	0.87	0.81	0.73	0.79	0.48	0.39
SD	1.85	2.69	3.04	4.12	5.01	4.27
Median	10.50	9.00	10.00	9.00	4.50	3.50
Range	13-7	13-6	13-5	17-5	14-0	12-0

It can be seen from Table 5.19 that, in a similar way to the main sample, the mean scores for the selected sample decreased from Sample 1 to Sample 3 except for the girls in Sample 2. However, the standard deviation increases from Sample 1 to Sample 3, particularly for girls in Sample 2 and boys and girls in Sample 3. This is because these groups have one or two high outlying scores. This also affects the range of scores. Again, the range of scores is seen to decrease from Sample 1 to the boys in Sample 2. However, the girls in Sample 2 have one high outlying score of 17, which increases the range dramatically. Similarly, the range seen in Sample 3 is affected by two children scoring 14 and one child scoring 12.

Figure 5m shows the mean scores graphically for Section 5 for the selected sample.

Figure 5m Mean scores for Section 5 for the selected sample



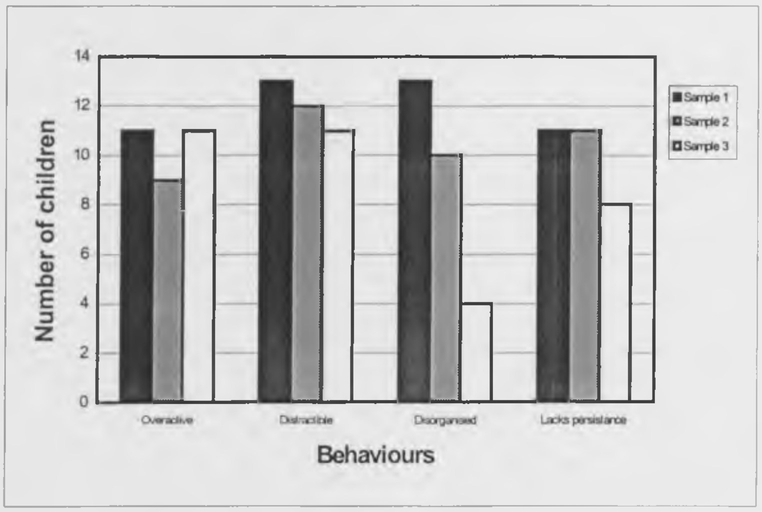
Frequency of behaviours in the selected sample

The children in Sample 1 consisted of 8 boys and 7 girls. This group had the smallest range of scores, but they were evenly distributed across the group. The highest score of 13 was scored by 2 of the 15 children (1 boy and 1 girl), and 3 of the 15 children scored 12 (1 boy and 2 girls). The lowest score for this group was 6, and one girl achieved this score. It is possible to score 0 on this section, but no children in Sample 1 scored between 0 and 5. 11 of the children in this group (73%) displayed overactivity (item1), with 7 children displaying it often and 4 occasionally. All but two of the group (87%) showed problems on item 6 (distractible) and item 7 (disorganised). For item 6, 9 children displayed this behaviour often, and 4 children displayed the behaviour occasionally. For item 7, 8 children displayed the behaviour often and 5 children displayed it occasionally. Item 8 deals with overestimating own ability and only 1 girl out of the 15 in this group scored in this section. Item 10 deals with lack of persistence and 11 of the children in this group (73%) recorded scores for this item; 7 of them often and 4 of them occasionally.

Sample 2 consisted of 7 boys and 7 girls whose scores ranged from 17 to 5, giving a range of 13. The standard deviation of 4.12 was returned for the girls and was due to one high outlying score of 17. The rest of the group scored between 13 and 5, and these scores were fairly evenly distributed. As before, even though it is possible to score 0 on this section, the lowest score for this group was 5, and two children, one boy and one girl, achieved this score. Out of the total of 14 children in this group, all but two of them (86%) showed problems on item 6 (distractible); 5 children displayed this behaviour often and 7 children displayed the behaviour occasionally. 10 children (71%) displayed problems with item 7 (disorganised); 6 children often and 4 children occasionally. As with the previous group, 11 children (79%) scored on item 10 (lack of persistence); 3 often and 8 occasionally. No children scored any points for item 12 (unable to get pleasure from success).

Sample 3 consisted of 10 boys and 6 girls whose scores ranged from 14 to 0, giving a range of 15 points. The standard deviations of 5.01 and 4.27 were high and very close to the mean score of 5.70 and 4.67 for the section and larger than the median values of 4.50 and 3.50. These were due to three high outlying scores; two boys scored 14 and one girl scored 12. The rest of the group scored between 7 and 0, and, again, these scores were fairly evenly distributed. Because of the low scoring for this group, very few items had more than 5 children who scored in a particular item. Of those items where more than 5 children scored, 11 (69%) displayed problems on item 1 (overactivity); 2 children displayed this behaviour often and 9 children displayed the behaviour occasionally. As in the other two groups, 11 children (69%) scored on item 6 (distractible) - 4 often and 7 occasionally. In addition, 8 children (50%) also registered scores on item 10 (lack of persistence), with 3 children displaying this behaviour often and 5 children occasionally. These frequently displayed behaviours are shown graphically in Figure 5n.

Figure 5n Behaviours displayed most often in the selected sample

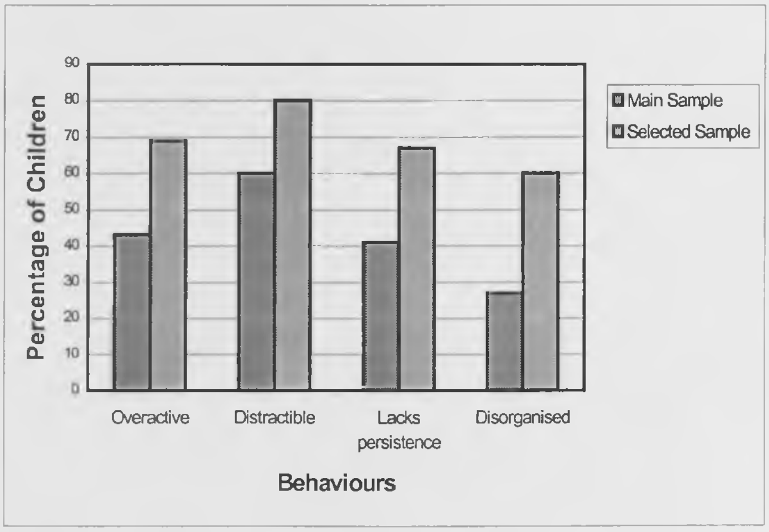


If the 3-year-old children had been included in the selected sample, then a very similar picture would have been seen with respect to movement-related behaviours. The 3-year-old children with high scores for Sections 1 to 4 on the Checklist also scored highly on Section 5. The types of frequent behaviours that they displayed are very similar to those displayed by the children in the selected sample – overactive, distractible, disorganised and lacks persistence.

Frequency of behaviours in the main sample

When the selected sample were compared with the main sample of 420 children, the following observations were noted. 43% of the main sample recorded scores for item 1 (overactivity) compared with 69% from the selected sample; similarly for item 6 (distractible) where 60% of the main sample recorded scores compared with 80% from the selected sample. 41% of the main sample recorded scores for item 10 (lacks persistence) while 67% of the selected sample scored on this item. These three item scores for the main sample are the highest for the whole section, which correspond with the three highest item scores for the selected sample. The selected sample has a higher percentage of children recording scores for each item in this section than the main sample. It would appear that, while the main sample record a high percentage of scores for the same items as the selected sample, the frequency with which they occur is not as high as for the selected sample. In addition to scoring highly on the above items, the selected sample also scored highly on item 7 (disorganised), with 60% of the children recording scores for this item.

Figure 5o Behaviours displayed most often in the main and selected samples



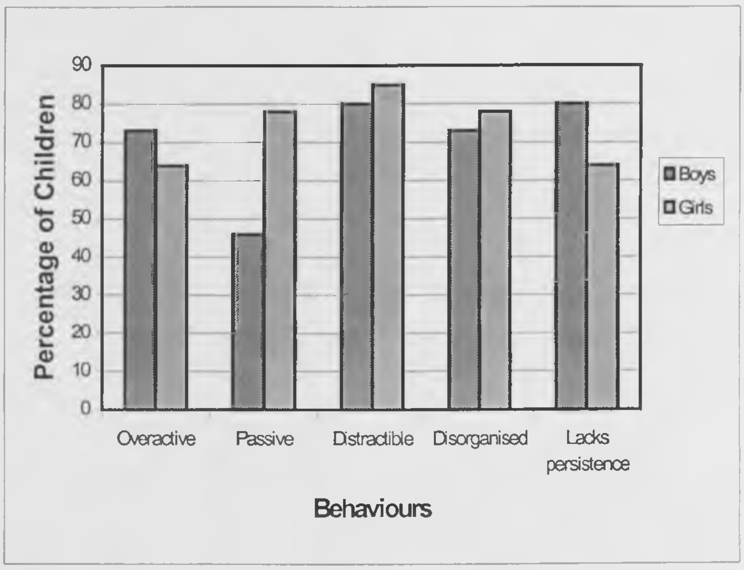
The behaviours seen most often across the three age groups for both the main sample and the selected sample are overactivity, distractibility, and lack of persistence. The behaviour of being unable to get pleasure from success was the least displayed behaviour across the groups – 8% for the main sample and 13% for the selected sample.

Gender differences in behaviours displayed

Differences between the boys and girls from Sample 1 and Sample 2 were noted. In a similar way to the main sample and the selected sample, the behaviours seen most often by boys and girls were overactivity, distractible, disorganised and lack of persistence. 73% of the boys displayed overactivity compared with 64% of the girls and 78% of the girls displayed passive behaviour compared with 46% of the boys. 80% of the boys recorded scores for item 6 (distractible), while 85% of the girls recorded scores for the same item. This group also scored highly on item 7 (disorganised) with 73% of the boys recording scores for the item and 78% of the girls recording scores. Again, similarly to the main sample and the selected sample, a large percentage of this group scored for item 10 (lack of persistence) –

80% of the boys and 64% of the girls. A large percentage of the girls also displayed timidness (85%) and tenseness (64%) and 50% of them were upset by failure. Figure 5p shows these gender differences graphically.

Figure 5p Gender differences for behaviours displayed most often in Sample 1 and Sample 2



The profile that emerges for the boys is fairly typical of that expected by children displaying overactivity. A high percentage of the boys were overactive, impulsive, distractible, disorganised and lacked persistence. In addition, 60% of the boys also underestimated their own ability. The profile for the girls is different from the profile of the boys, but they, too, were distractible and disorganised and lacked persistence. As seen above, 78% of the girls displayed passive behaviour, a high percentage were timid and tense and, in addition, 50% of them were upset by failure.

Generally, the problems displayed by the children in the selected sample were of a mixed variety, with only the distractible, disorganised and lacking persistence items being the common factor. For the whole of the selected sample, 14 boys and 9 girls displayed problems for Section 5.

Analysis of Section 5

A 3 (age) by 2 (gender) ANOVA was performed on the data for the main sample producing main effects for gender, $F(1, 269) = 14.65$ $P<0.0001$, but not for age. In each of the age groups, the boys scored higher than the girls, indicating a poorer performance and, as noted above, the 3-year-old girls scored lower than the 4-year-old boys and the 4-year-old girls scored lower than the 5-year old boys.

A 2 (group) by 2 (gender) ANOVA was also performed on the selected sample producing main effects for group, $F(2, 98.63) = 7.09$ $P<0.05$. Children in Sample 1 scored higher on this section than the other groups and children in Sample 2 scored higher than the children in Sample 3. These results indicate that children with the more severe movement problems display poorer behaviour than children without movement problems. There were no significant differences for gender.

The relationship between Section 5 and Sections 1 to 4 of the Checklist

An interesting analysis involves examining the relationship between the scores for Sections 1 to 4, with those for Section 5. The items in Section 5 are behaviours associated with movement and theoretically a child could have very different scores in this section compared with those in Sections 1 to 4. Two methods of examining this relationship are presented. The first is an analysis of the children who scored above the cut-off point in Section 5 and comparing how they performed on Sections 1 to 4. 14 children scored within the lowest 5% for Section 5 and, of those 14 children, 7 (50%) were in Sample 1 for Sections 1 to 4, 4 (29%) were in Sample 2 for Sections 1 to 4, and 3 (21%) were in Sample 3. 15 children scored in the lowest 5-10% for Section 5, and from this group 7 children (47%) were in Sample 1 for Sections 1 to 4, 5 children (33%) were in Sample 2 and 3 (20%) were in Sample 3. 16 children scored above the lowest 10% for Section 5 and, from this group, 1 child (6%) was in Sample 1 for Sections 1 to 4, 5 children (31%) were in Sample 2 for Sections 1 to 4, and 10 children (63%) were in Sample 3 for Sections 1 to 4.

A second method of examining the relationship between Sections 1 to 4 and Section 5 is to conduct correlations between the total scores for the motor component of the Checklist and the behaviour component of the Checklist. Correlations were performed on the scores obtained for the main sample for Sections 1 to 4 of the Checklist, and on the total of Sections 1 to 4. Pearson's product-moment correlations are shown in Table 5.20

Table 5.20 Correlation coefficients for Section 5 and Sections 1 to 4 of the Checklist for the main sample

	3 Year olds		4 Year olds		5 Year olds	
	Boys	**Girls**	**Boys**	**Girls**	**Boys**	**Girls**
Section 1	0.29	0.09	0.38	0.43	0.36	0.62
Section 2	0.47	0.25	0.37	0.47	0.61	0.47
Section 3	0.56	0.45	0.54	0.32	0.54	0.51
Section 4	0.55	0.29	0.37	0.46	0.41	0.48
1-4 Total	0.54	0.30	0.52	0.51	0.58	0.64

Correlations were performed for the main sample and, taken as a whole group, the correlation coefficient was 0.50, which is significant at the 0.01 level.

Correlations were also performed on the scores obtained for the selected sample for Sections 1 to 4 of the Checklist, and on the total of sections 1 to 4. Pearson's product-moment correlations are shown in Table 5.21.

Table 5.21 Correlation coefficients for Section 5 and Sections 1 to 4 of the Checklist for the selected sample

	Sample 1		Sample 2		Sample 3	
	Boys	**Girls**	**Boys**	**Girls**	**Boys**	**Girls**
Section 1	0.50	0.05	-0.46	-0.05	0.24	-0.21
Section 2	0.18	-0.73	0.74	-0.34	0.78	0.84
Section 3	0.22	-0.11	0.25	0.94	0.09	*
Section 4	0.07	-0.09	-0.17	-0.50	0.64	*
1-4 Total	0.46	-0.32	-0.06	0.76	0.87	0.23

Correlations were also performed on the data for the selected sample and, taken as a whole group, the correlation coefficient was 0.55 ($p<0.01$). There can be seen to be a moderately strong correlation between Sections 1 to 4 and Section 5 for the selected sample.

Note: * indicates that these two correlation coefficients were unable to be calculated. This group of girls all had the same total score for these sections and therefore Pearson's correlation coefficient (requiring deviations from the mean to be squared and then multiplied with the corresponding set of scores) could not be performed.

CHAPTER 6

Summary, Discussions and Conclusions

Introduction

The purpose of this study was to construct an assessment instrument to identify and assess movement difficulties in young children, aged 3 to 5 years. Despite a renewed interest in children with movement problems during the last 15 to 20 years, there has been to date a limited number of assessment instruments available to enable primary school teachers to approach this area within the context of the daily routine of the school environment. As noted earlier, there are already available a number of instruments which assess motor behaviour as part of a larger battery of overall development. One of these instruments, the Bayley Scales of Infant Development (Bayley, 1993), provides normative information on the developmental status of children from 2 to 42 months of age in three test components, the Mental Scale, the Motor Scale and Infant Behavior. This assessment instrument was designed for depth and thoroughness and came to be considered by many scholars and practitioners as the premier early movement skill assessment instrument (Burton & Miller, 1998). This test, along with a number of others, such as the Griffiths Mental Development Scales for testing babies and young children from birth to eight years of age (Griffiths, 1967), gives a professional an overview of a child's profile of abilities. However, for a more detailed examination of motor behaviour, tests which directly address motor aspects of a child's functioning are required - motor behaviour in general and motor difficulties in particular are, in their own right, an important part of a child's functioning. It is, however, acknowledged that motor difficulties may be correlated with other aspects of a child's behaviour, such as in the syndrome DAMP (Gillberg, 1983; Gillberg & Rasmussen, 1982a, 1982b; Gillberg et al., 1982), and, as such, would be an integral part of a battery assessing perceptual, motor and attentional deficits.

There are a small number of tests which assess motor behaviour in its own right, for example, the Movement ABC (Henderson and Sugden, 1992); however, these tests do not specifically focus on young children. The Early Years Movement Skills Checklist is part of a study designed to fill this gap.

In an attempt to address the problem of movement difficulties in young children, this research study focused on the identification and assessment of movement difficulties in children aged 3 to 5 years. This chapter will summarise the results and will discuss a number of the issues raised with respect to the construction of the Checklist, performance differences between children and movement-related behaviours.

Development of The Early Years Movement Skills Checklist

This study has focused on the construction of an assessment instrument which has been designed to be used flexibly by teachers and parents to describe more accurately the problems some children are experiencing in the motor domain. However, any new assessment instrument must be shown to be reliable and valid. Burton and Miller (1998) comment that "an assessment instrument that is not valid is utterly useless. An assessment instrument that is not reliable cannot be valid. Hence, the utility of an assessment instrument is contingent upon its validity, which in turn is contingent upon its reliability" (p. 109).

Validity of the Checklist

This section will focus on the validity measures undertaken during and after the construction of the Checklist. Validity is defined as the "appropriateness, meaningfulness, and usefulness of the specific inferences from test scores" (Burton & Miller, 1998, p. 110). The specific tests include *construct validity*, *content validity*, and *predictive validity*.

Construct Validity

The Early Years Movement Skills Checklist was constructed to assess functional, everyday skills of 3 to 5 year old children and, as such, contains activities which it is believed are easily observed by teachers and parents as part of everyday activities. As a starting point in the construction of the Checklist, the literature on movement development was studied in detail to establish the movement skills of 3 to 5 year old children. In addition, professionals working in the field of early years education were consulted as to the suitability of the items in the Checklist, the specific nature of the activities and to what extent the activities are seen in the early years environment. At each stage of the construction, the developmental literature was studied and professionals working in the field were consulted and it is believed that the Checklist contains activities which are functional, everyday skills.

It is recognised that through the use of factor analysis methods more quantitative analysis could have been provided. However, this may be an avenue for future work.

Content Validity

Content validity concerns the extent to which a measurement is judged to reflect the meaningful elements of a construct or a domain of content and not any extraneous elements (Burton & Miller, 1998). In the case of the Early Years Movement Skills Checklist, to what extent do the items reflect the meaningful elements of movement skills in young children? Content validity is concerned with whether the specific motor skills selected represented skills that are frequently taught to children in pre-school and early years classes.

Again, it is believed that by consulting professionals working in the field, academics, heath service professionals and teachers, at every stage of the construction, ensured that the activities contained in the Checklist are skills which are frequently taught or seen in the early years environment.

Predictive Validity

When children in the selected sample were tested on the Movement ABC Test (Henderson & Sugden, 1992) overall mean scores reflected the groupings from the Checklist. However, when individual children's scores were examined in more detail and interpreted in the light of percentile norms, a different picture emerged. 4 children from Sample 1 moved to the 5th –10th percentile, and 2 children moved to above the 10th percentile; 3 children from Sample 2 moved to the 5th percentile and 7 children moved to above the 10th percentile; all the children from Sample 3 remained above the 10th percentile.

If the Movement ABC Test (Henderson & Sugden, 1992) scores are considered for the children who moved categories based on their Test score, then a slightly different picture emerges yet again. Examination of their Test scores indicate that they have specific difficulties in one or two areas only, which are not indicated in the overall Test score. For example, one child scored 9.5 on the Test and a closer look at this score reveals that she scored 7.5 for Static and Dynamic Balance tasks. Referring back to the Checklist scores for this child indicates that she had particular difficulties on General Classroom Skills and Recreational/Playground skills – confirming her Test score. A similar picture to this has been found for the other children mentioned above. Although movement between the categories appears to be quite dramatic, exploration of individual cases reveals that these children are not free of difficulties, but rather, their difficulties are confined to one or two areas only. It may be a case for suggesting that a two step procedure to identify children with DCD, such as that suggested by Wright and Sugden (1996b), may be required for this age group.

When considering the children from Sample 1 and Sample 2 who moved to above the 10th percentile, there are two interesting points to consider. The first concerns cut-off points for the Checklist scores. 6 of the children from Sample 2 who moved to above the 10th percentile had Checklist scores either at the cut-off point (score of 37) or within 1 point of the cut-off point. Had these children scored 1 or 2 points less on the Checklist, they would have become part of Sample 3, the randomly selected group. What is important here is that the cut-off points used in this study are completely arbitrary. Also, if the children had been categorised into the lowest 5% and the lowest 5-15% according to the Checklist scores then the groups of children would be very different from the ones in the selected sample. Similarly, if the 3-year-old children had been included in the selected sample.

The second interesting point concerns one of the children from Sample 1 who moved to above the 10th percentile. This child scored fairly highly (42) on the Checklist but scored a total of 3 on the Test. Initially there was no logical explanation for his apparent sudden development of adequate movement skills. However, the class teacher provided a few background details and it soon became clear that this child, on entering the Reception Class at the beginning of the school year, had no previous experience of a classroom environment and did not have the resources to cope with classroom demands. However, by the time the Movement ABC Test (Henderson & Sugden, 1992) was administered, this child had been in school for a few months and had very quickly learned the necessary skills to enable him to participate fully in the classroom environment.

Pearson's product-moment correlations were calculated for the Checklist total scores and the Movement ABC Test scores (Henderson & Sugden, 1992). The correlation for the whole of the selected sample was 0.76 and it appears that with the more severe movement problems there is good agreement between the Checklist and the Test. However, the Checklist identified some children who were not confirmed by the Movement ABC Test (Henderson & Sugden, 1992), but no children were identified by the Test that had not previously been identified by the Checklist.

At the moment, no 'gold standard' exists for the assessment and identification of children with DCD. However, it was decided to use the Movement ABC Test (Henderson & Sugden, 1992), as this particular assessment instrument is widely used throughout the UK and Europe and is an assessment instrument that may be used for screening or identifying children and for clinical exploration, intervention planning and programme evaluation. Used together with the Early Years Movement Skills Checklist, it gives a reasonably complete picture of a child's motor functioning by examining performance against normative data (test) and by analysing the child in different contexts (checklist).

It is perhaps not surprising that agreement between the Checklist and the Movement ABC Test (Henderson & Sugden, 1992) is less than perfect - the assessment instruments are different, they were used by different individuals and assess the child for different purposes in different settings. However, it may be beneficial to use two complimentary assessment instruments in the assessment and identification of children with DCD. A condition such as DCD is largely contextual in nature, in that it presents itself differently in different situations. In addition, motor skills are diverse and varied and, in order to tap a comprehensive range, they have to be seen in a variety of environmental contexts.

Reliability of the Checklist

This section will focus on the measures of reliability and validity that were carried out with respect to the Early Years Movement Skills Checklist and some of the issues surrounding the reliability and validity measures. The concept of reliability concerns the accuracy or consistency of scores. There are a number of ways to assess reliability - for the purpose of this study it was chosen to use *Interrater reliability* and *Test-retest reliability.*

Interrater Reliability

As noted in Chapter 5, a total of 68 Checklists were left in schools to be completed for use as an interrater reliability measure. Checklists to be used as an interrater reliability measure were returned for 37 children and correlations were performed on the scores obtained. Overall, the results of the interrater reliability are very encouraging with 61% of the scores over 0.90 and 83% of the scores over 0.80.

It was felt that because of the nature of the scoring of the Checklist, a more accurate measure of reliability would be to measure the correlation coefficient for individual items in each section. Pearson's product-moment correlations were calculated for individual items in each of the five sections. Again, the results of this are very encouraging. The stability of total scores on the Checklists was also evaluated and the results indicated 91.8% agreement for the stability of the Checklists.

However, care must be taken when interpreting these results; the Checklists were left in schools with the instruction that the interrater checklist was completed by another adult independently of the class teacher. It was taken on trust that the interrater checklist was completed independently, but there is a possibility that some collusion took place between the raters. It is difficult to know how to control for this.

Test-Retest Reliability

In the same way as the interrater reliability was carried out, Pearson's product-moment correlations were calculated for this group. Again, the overall results of the test-retest reliability are very encouraging with 60% of the scores over 0.90 and 84% of the scores over 0.80.

As above for the interrater reliability measure, Pearson's product-moment correlations were calculated for individual items on the Checklist. Again, the results are encouraging with 30% of scores over 0.80, and 74% of the scores over 0.70. The stability of the Checklists was also explored and results indicated a 92.6% agreement for the test-retest reliability Checklists.

In a similar way to the interrater reliability measure, these results must also be treated with caution. The test-retest measure was completed one month after the original checklist and there is the possibility that class teachers remembered how they had scored the original checklist. Again, it is difficult to know how to control for this.

Performance Differences

The discussion in this section will consider age and gender separately and then consider them together with respect to any interactive effect including section.

Differences in performance between ages

The Early Years movement Skills Checklist was constructed for use with children of 3, 4 and 5 years of age and therefore contains activities which it is believed are functional in nature and relevant to children of this age. Developmental differences were found between the three age groups of children on each section of the Checklist - the 3-year-old children had higher scores than the 4-year-old children, who in turn had higher scores than the 5-year-old children. Statistical analysis confirmed these differences between the three age groups: as noted in Chapter 5, a main effect for age was found with the younger children scoring higher (poorer).

The biggest difference in section scores between the three age groups was seen in Section 1 (Self Help Skills). The difference between the 3-year-old children and the 4-year-old children is the largest difference for all the total mean scores for the Checklist. Post hoc statistical analysis using Tukey's HSD test revealed that there were significant differences between the three age groups for this section. Section 1 of the Early Years Movement Skills Checklist assesses self help skills, and it is well documented that self help skills such as dressing, grooming and feeding, skills which are contained in the Checklist, require many types of movements (Keogh and Sugden, 1985).

The differences in scores for Section 2 (Desk Skills), Section 3 (General Classroom Skills) and Section 4 (Recreational/Playground Skills) all displayed a similar trend; statistical analysis revealed that there was a significant difference between the 3-year-old children and the 4- and 5-year-old children but no significant difference between the 4-year-old children and the 5-year-old children.

Given the developmental differences between the three age groups of children these results are not wholly unexpected, as from the ages of two to seven children are constantly modifying and elaborating earlier achievements. Between the ages of 2 and 7 years of age it can be argued that children achieve all of the fundamental skills that they will ever develop naturally. Children do not naturally develop any new skills after this age; they simply refine, combine, extend, play with and become more proficient in the ones they already possess. As pointed out by Sugden and Wright (1998), they will of course learn specific skills, such as skateboarding, but all the fundamental developmental skills of running, jumping, hopping, climbing, balancing, throwing, catching, striking, riding, skipping, writing, drawing, painting, and so forth are present by roughly 6 years of age. Within this period of development, the child becomes more consistent, more accurate and better coordinated, with fewer extraneous movements. In addition, force becomes more modulated, and spatial accuracy is fairly good when moving in a stable environment (Keogh and Sugden, 1985).

In view of this, one would expect 5-year-old children to be better able to perform the activities contained in the Checklist and, therefore, have better overall scores than 3-year-old and 4-year-old children. As seen above, this developmental progression is reflected in the total scores for all sections of the Checklist where the 5-year-old children scored consistently better than the 4-year-old children who, in turn, scored consistently better than the 3-year-old children. However, there was no significant difference between the scores of the 4 and 5-year-old children on any section apart from Section 1.

There appears to be a developmental trend in that there was a significant difference between the 3-year-old children and the 4-year-old children but no significant difference between the 4-year-old children and the 5-year-old children. Perhaps it can be explained in terms of the dynamic systems approach to movement development. What appears to be happening is that between the ages of 3 and 4 years children go through a developmental movement spurt: this is in line with dynamic systems theory of nonlinearity (Thelen, 1995). Nonlinearity means that change in subsystems may not be smooth and incremental, but can occur with spurts, plateaus, and even regressions. The subsystems themselves may undergo phase shifts: sudden, qualitative appearances and disappearances of behavioural forms. Illustrations abound in early development: the onset of babbling and vocabulary explosions, for example, are rapid and steplike, whereas other changes, such as postural control, are more protracted and gradual.

In this study it appears that there is a spurt of development between the ages of 3 and 4 years and a possible plateau between the ages of 4 and 5 years.

Differences in performance between genders

Statistical analysis found an interactive effect involving section and gender, where there was a difference between the scores of boys and girls in Sections 1, 2 and 3 but not in 4. In Sections 1, 2 and 3 the boys scored higher (poorer) than the girls, indicating that they were not able to perform the activities as well as the girls. However, the boys were able to perform the activities in Section 4 almost as well as the girls.

Gender differences in early movement development have been checked for many activities and for many children; Keogh and Sugden (1985) note that even though some differences have been found, they are usually small and often are not found in the next sample of children. Keogh and Sugden (1985) point out that gender differences in the control of limb movements are the most distinct in movement development reported before the age of 7 and 8 years. The explanation of gender differences in the development of limb movement control may be that girls are biologically more mature than boys. Girls reach puberty earlier and are more advanced in skeletal development and other indicators of biological maturity. The control of limb movement may thus be a general indicator of neuromotor control that would favour the biologically more mature girls. Another possibility is that these movements are culturally influenced and that girls are more likely to practise them. As Keogh and Sugden (1985) note, this might be true of children several years older but girls younger than age 5 years do not seem to engage more in movement that would lead to the development of the activities used in studying the control of limb movements. The Early Years Movement Skills Checklist contains some activities demanding limb control and this may help explain the differences in performances between girls and boys on the Checklist.

Interactive effects including section

The results for the random sample of the Early Years Movement Skills Checklist have been analysed according to age and gender. Mean scores per section and per item were calculated and, as seen in Chapter 5, differences between age and gender were found in all sections of the Checklist. The 3-year-old boys and girls showed the biggest differences in scores for each section of the Checklist and the girls scored consistently lower (better) than the boys, indicating that they were better able to perform tasks. A similar picture has emerged for the other age groups, where the biggest differences in scores between the boys and girls for both the 4-year-olds and the 5-year-olds was found for Section 1, though the differences in scores was not as large as for the 3-year-old children. In each of the age groups, the boys had more difficulties than the girls for Section 1, though statistical analysis showed there was a significant difference between the 3-year-old boys and 3-year-old girls, but not between any of the other groups.

In Section 2 (Desk Skills), again the 3-year-old boys displayed the most difficulties and again the difference between the scores for the 3-year-old boys and girls was the largest difference for all three age groups. Statistical analysis confirmed that there was a significant difference between the 3-year-old boys and the 3-year-old girls for this section, but no significant differences between any of the other groups.

In Section 3 (General Classroom Skills), the picture is similar to that in Sections 1 and 2; the girls in each of the age groups had lower mean scores than the boys. The mean score per item in this section are the lowest mean item scores for any of the sections, indicating that the children in the main sample found this section the easiest of all the sections. However, despite this, the 3-year-old boys scored considerably higher than the remainder of the random sample, but statistical analysis revealed that there was no significant difference between any of the groups for Section 3.

A slightly different picture emerges for Section 4 (Recreation and Playground Skills). As in the other three sections, the 3-year-old boys had a higher mean score than the 3-year-old girls, though the difference between these two mean scores is the smallest of all the mean scores. However, the 4-year-old boys had a lower mean score than the 4-year-old girls. Only 2 of the 4-year-old boys scored highly on this section, while the 4-year-old girls displayed more difficulties with a number of activities. However, for the 5-year-old children the picture that emerges is the same as for the rest of the Checklist – the boys had a higher mean score than the girls. Even though the 3-year-old boys and the 5-year-old boys had higher scores than the girls in these age groups, the differences in their performance scores are small and are not statistically significant.

Section 4 for the 4-year-old children is the only section on the Checklist where the boys had a lower score than the girls. This may be due in part to the nature of Section 4, involving a number of ball skills - a task which boys traditionally perform as well as or better than girls. However, this does not explain why the 3-year-old boys and 5-year-old boys did not score similarly for this section. One observation that has been noted for the 4-year-old children is that, with the exception of the mean score for Section 1, there was very little difference between the mean scores for each section for boys and girls. The total mean scores for Sections 1 to 4 also show the same trend for this group.

Differences in performance of the selected sample

The selected sample consisted of those children whose scores fell within the lowest 5%, the lowest 5-10% and a random 5% of children whose scores were not in the lowest 10%. The Checklist scores obtained for children in the selected sample followed the expected pattern - the children in Sample 1 scored higher (poorer) than the children in Sample 2 who scored higher than the children in

Sample 3. Statistical analysis confirmed significant differences between each of the groups.

This analysis of performance differences has concentrated on group data and, as noted above, the three age groups show developmental differences with the 3-year-old children scoring higher (poorer) than the 4-year-old children, who, in turn, scored higher (poorer) than the 5-year-old children. However, Table 5.5 indicates that the minimum score for each of the three age groups on the Checklist is 23. Essentially, this indicates that there are children in these age groups who are able to perform the activities as well as the 5-year-old children. An examination of individual children's scores reveals that there are children in the 3 and 4-year-old age groups who score the minimum of 23.

One explanation for this may be that a proportion of the children in the 3 and 4-year-old age groups attended private day care nurseries. Children are generally admitted to private day care nurseries from around the age of 6 months and, although this variable was not accounted for when collecting data, it is possible that it does help explain this trend in the scores. Of the 72 children in the main sample who attended private day care nurseries, 16 of them scored the minimum points and it is possible that at least some of these 16 children have attended day care nurseries for a considerable part of their lives. If this is so, then these children will have been exposed to the type of functional, everyday activities contained in the Checklist from an early age and will possibly have had greater experience of these activities than children who have not attended nursery from such an early age. It may also be possible that some of the older children in the sample also attended private day care nurseries and have had considerable experience of these activities. Certainly, the reverse of this has been seen in this study: the 4-year-old child in Reception Class who was identified by the Checklist as displaying movement difficulties was, at a later date, assessed with Movement ABC Test (Henderson & Sugden, 1992) and found to have no movement difficulties. This child had not attended any type of pre-school provision and, until entering school at the age of 4 years, had no experience of a classroom environment. However, he very quickly learned the necessary skills to enable him to participate fully in the school environment.

These findings may have had a possible effect on the results, and it may be necessary to conduct further work taking account of those children who have attended private day care nurseries and also those children who have had no previous experience of any pre-school provision. In addition, the socioeconomic status of the children was not taken into account - this may provide some important findings, particularly with respect to children's experiences and, again, further work could examine this variable.

It is also recognised that another factor may have influenced the findings. When the Checklists were taken to schools as part of the main collection of data, a random set of numbers was given to each class teacher. These random numbers were generated by a computer program and specified the 2nd, 11th and 13th named boys on the class register and the 6th, 7th and 12th named girls on the class register. These numbers are very close together and there was a possibility that the sample might be clustered amongst children with similar surnames. If this had proved to be the case, then the sample might have been adversely affected by a preponderance of children from similar ethnic or cultural backgrounds. However, analysis of the sample did not show any such problem. If this had been the case, then a stratified random sample could have been used.

As with all checklists, some teachers may have used the Early Years Movement Skills Checklist in an observational manner, checking items as they occurred. Others may have used memory in order to score the child on items. If different teachers use different methods then this could initiate a bias. One way around this would be to give specific instructions one way or the other, but this would then reduce flexibility of use of the Checklist, something that it was originally designed to provide.

Movement-Related Behaviours

Comparison between the main sample and the selected sample

While analysing the data from Section 5 it became clear that there were a number of behaviours which were occurring frequently in both the main sample and the selected sample. A high percentage of children in both groups were overactive, distractible and lacked persistence. However, while the main sample recorded a high percentage of scores for the same items as the selected sample, the frequency with which they occurred is not as high as for the selected sample.

Statistical analysis revealed that there was a significant difference between Sample 3 and Samples 1 and 2 but no significant difference between Sample 1 and Sample 2. The significant difference between Sample 3 and the other 2 groups was not totally unexpected as only 3 children from the 15 children in Sample 3 scored highly and they scored considerably higher than the rest of the group. The 3 children from Sample 3 with high scores for Section 5 scored satisfactorily on the Checklist, so it has to be concluded that their behaviour problems are not related to movement difficulties.

These findings are in line with current views on movement difficulties and associated or concomitant difficulties. In addition to the movement difficulties seen in children with DCD, there is evidence that in comparison to non-DCD children, the disorder is accompanied by social and emotional difficulties, such as behaviour problems (Gillberg & Gillberg, 1989; Losse et al., 1992), low self-esteem (Schoemaker & Kalverboer, 1994), poor goal setting, low self-concept with a reduced inclination to accept responsibility (Henderson et al., 1989), lack of concentration (Lytinnen & Ahonen, 1989), and poor social competence (Knight et al., 1992).

Although much of the research that has taken place in this area studied children with DCD who were 8 years of age or older, Schoemaker and Kalverboer (1994) were interested to see if children with DCD had various social and affective difficulties earlier in life. They found that even by the age of 6 or 7 years, children with DCD had fewer playmates and were asked to play less often than their peers. There appears to be a relationship between movement difficulties and associated behaviour difficulties and the selected sample that have been identified in this study appear to be experiencing the same difficulties as older children with DCD.

Conclusions

This section will highlight the conclusions from the research study and, in addition, make some recommendations from the findings.

- The Early Years Movement Skills Checklist was constructed using functional, everyday skills appropriate for 3 to 5 year old children and is organised into 4 sections, each one focusing on a specific area of functional, everyday activities. In this way, children's difficulties are identified and assessed appropriately. For some children, their difficulties encompass all areas of functioning, while for others their difficulties may be apparent in one or two areas only - the Checklist is able to distinguish between these children and can pinpoint exactly the nature of the difficulties experienced by each individual child. In addition, reliability data has demonstrated the reliability of the Early Years Movement Skills Checklist. Interrater reliability and test-retest reliability have been found to be encouraging, with overall correlations of 0.96 and 0.94 respectively.

- The Early Years Movement Skills Checklist is able to differentiate between children with movement difficulties and those without movement difficulties. The children identified as displaying movement difficulties were found to be a significantly different group from their well coordinated peers. In addition, it shows developmental progression of children aged 3 to 5 years - overall scores for 3-year-old children are higher (indicating poorer performance) than overall scores for the 4-year-old children which, in turn, are higher than overall scores for the 5-year-old children.

- The Early Years Movement Skills Checklist is able to assess the nature of movement difficulties in individual children. The Checklist has 4 sections, namely Self Help Skills, Desk Skills, General Classroom Skills and Recreational/ Playground Skills, which relate to four distinct areas of functional, everyday activities. From these sections it is possible to identify specific environments in which a child experiences difficulties. Confirmatory evidence of the difficulties that children with movement difficulties experience can be gained by examining the data collected for those children with movement difficulties and comparing it with data collected for the selected sample of children not displaying any difficulties. In this study, distinct differences were found between the two sets of data on each section of the Early Years Movement Skills Checklist.

- Comparing the data collected from the Early Years Movement Skills Checklist with data from a normative motor skills test from the Movement ABC Test (Henderson & Sugden, 1992) relates to the predictive validity of the Checklist. While the Movement ABC Test (Henderson & Sugden, 1992) did not confirm all the children identified by the Early Years Movement Skills Checklist as displaying difficulties, it shows that the Checklist is reasonably valid, having a correlation value of 0.76. In addition, the sensitivity index has been calculated as 1.00 and the specificity index has been calculated as 0.64 and it is concluded that in relation to the validity issue the Early Years Movement Skills Checklist is a useful assessment instrument.

- Combining the two sources of information, the Early Years Movement Skills Checklist and the Movement ABC Test (Henderson & Sugden, 1992), it was noted that 4% of children were found to have serious difficulties with movement skills and a further 3% were found to be 'at risk'.

- Significant differences were found in relation to movement-related behaviours between children with and without movement difficulties. The children in the main sample displayed similar behaviours to the children in the selected sample, but the frequency with which they occurred is not as high as for the selected sample. In addition, the children in Sample 1 and Sample 2 showed no significant differences between the type and frequency of behaviours displayed, showing that the severity of movement difficulty is not directly related to the severity of movement-related behaviours. These findings are in line with current views on movement difficulties and associated or concomitant difficulties.

- While this study has highlighted the positive contribution that the Early Years Movement Skills Checklist can make in the process of identifying and assessing young children with movement difficulties there are some limitations which have been noted with regard to this study. When the Early Years Movement Skills Checklists were taken to schools for the main collection of data, it was requested that the class teacher also complete a Checklist for a child he or she regarded as displaying movement difficulties. Unfortunately, the majority of teachers did not take up the invitation to do this and an analysis of a teacher selected sample was not carried out. A teacher selected sample would have provided more evidence of the teacher's ability to identify children with movement difficulties. In addition, various factors have been noted in this discussion which may have influenced the findings; experience in preschool provision, socioeconomic status, random number selection and reliability measures. However, future work in this area could address these issues.

- It has also been noted that the gender differences in this study do not correspond with the gender differences reported for older children with DCD. Sugden and Henderson (1994) reported that the prevalence of boys is higher than girls with the ratio usually around 3:1. This was confirmed by Wright and Sugden (1996a) who found similar prevalence rates amongst 6 to 9 year old children in Singapore. In this study, of the 20 children identified by the Early Years Movement Skills checklist and confirmed by the Movement ABC Test (Henderson & Sugden, 1992) as displaying movement difficulties, 9 are boys and 11 are girls. However, of the children scoring at or below the 5th percentile on the Movement ABC Test (Henderson & Sugden, 1992) and thus indicating severe movement problems, 8 are boys and 4 are girls. The children displaying more severe movement problems have a boy:girl ratio of 2:1 which is far closer to the ratio found by Sugden and Henderson (1994) and Wright and Sugden (1996a).

- The Early Years Movement Skills Checklist is a procedure that examines the functional, everyday skills of 3 to 5 year old children and, as such, it is able to identify and assess movement difficulties in this age group. It is able to distinguish between children who display movement difficulties and those who do not display movement difficulties and it is also able to show the developmental progression of movement skills of 3 to 5 year old children. Using the categorisation into four distinct areas of movement skills, it is also able to assess the context in which movement difficulties occur. When combined with the Movement ABC Test (Henderson & Sugden, 1992), the information which is gained gives a reasonably complete picture of the difficulties individual children experience.

- Overall, it is concluded that the Early Years Movement Skills Checklist can be used as a screening procedure. As noted above, all of the children identified by the Checklist as not having movement difficulties were confirmed by the Movement ABC Test (Henderson & Sugden, 1992) as not displaying difficulties. However, some children identified by the Early Years Movement Skills Checklist as displaying movement difficulties were not confirmed by this standardised procedure as displaying movement difficulties. Therefore, it is suggested that the Early Years Movement Skills Checklist can be used carefully by teachers, parents, physiotherapists and occupational therapists not as a definitive diagnostic instrument, but rather as an instrument to give an indication of the problems a child is experiencing.

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APPENDIX 1

Feedback for List 1

Movement for Self

Put on and take off articles of clothing (sweater, T shirt, coat)

Overarm action will be difficult for 3-year-olds. Possibly keep it to open clothing such as a coat.

Young children find it easier to take off clothing rather than put on clothing. 5-year-olds should be able to do both.

This depends on the experience that individual children have had in dressing/undressing themselves.

Nursery age children should be able to take off "easy" clothes (unbuttoned coat, apron for painting). Some will put on coats upside down etc.

Can take off lower part of body, but not over head.

Replace T shirt with trousers or socks.

Consider splitting the item 'put on and take off articles of clothing' into two separate items (putting clothes on can be more difficult for children than taking them off).

Unbutton accessible buttons or undo zip

3-year-olds cannot undo buttons.

Only about a third of children at age 3 will be able to undo zips.

Expectation is that they will all be able to do this, in reality does not happen.

Needs to be large buttons with large button holes.

Easier to do on someone else.

Change to "fasten accessible buttons or zip".

Consider splitting this item into two.

Wash and dry face and hands, and brush teeth

Possibly reciprocal action only.

Children don't brush teeth in LEA nurseries, only in private ones.

Suggest add "make good attempt at . . ." and also maybe include brushing hair.

Feed self, using cutlery (e.g. use knife and fork to cut fish finger)

Many children have not been given a knife and fork preschool (Sheridan (1991) Age 3 Eats with fork and spoon (p. 54)).

Probably more likely to observe using a spoon, so include as an example.

Know few three year olds who eat with knife and fork. Consider asking about the child's competence in using one or two utensils at the same time.

Use cup/beaker competently

Very, very few still using a feeding cup by nursery school age.

Mention cup only, as beaker may be interpreted as one with a lid.

Demonstrate good posture when sitting or standing

Important. What about good posture when playing?

Should also be able to cross legs and sit on the floor.

Needs explanation. May mean different things to different people.

Can be quite difficult to judge for people who are not used to observing children in such a detailed way. Adding a small example, such as 'keeps back straight; does not drop shoulders' etc. maybe of help.

Copy/trace simple figures (circle, cross, square)

3-year-olds will only be able to copy a circle; some 3y 6m children will be able to copy a cross but not a square (usually about 5).

5-year-olds should be able to copy all 3 figures.

Should be able to trace figures. Would expect 5-year-olds to be able to trace a square.

Copying/tracing needs to be simple.

If have to copy something already done, children have to plan their movements.

Not sure about putting copying and tracing together, might be useful to say "make recognisable copies of simple figures e.g. . . .".

Consider splitting this into two separate items.

Pick up and manipulate small objects (Duplo, Lego, Megablocks)

Should be able to pick up smaller objects, such as beads etc.

There should be no problems here. 3-year-olds should be able to do this easily.

Megablocks are not small, better to keep this item for really small objects e.g. pegs, raisins.

It would be nice to elaborate on the type of object. You could think about different shapes (marble, small wooden block, etc.) which may require different manipulation. Or sub-divide on whether the object consists of one or more parts (e.g. small box with lid versus small piece of paper).

Plan and construct models from Duplo, Lego, Megablocks

More for 3y 6m and upward; 3-year-olds will probably have some difficulty with this.

3-year-olds will be able to construct models, but not plan; they do it as they go along.

Those children with good imaginations will get on better with the planning.

Better to say plan and construct simple models.

Name/recognise body parts (wrist, elbow, ankle)

3-year-olds - only about half will be able to name these.

3-year-olds have a good idea. Play body games and sing body songs.

Not an unreasonable expectation.

Too difficult for 3-year-olds. Needs to be eyes, nose and face etc.

Maybe use more simple parts - head, tummy.

Nice idea to include this as movement is an integration of many processes including that of body awareness (comment also refers to "Demonstrate an understanding of directional commands (forward/backward; over/under; in/out)).

Use playground equipment competently (climbing frame, slide)

Some 3-year-old children will be able to use a slide. They will probably not be able to use a climbing frame unless supervised (safety factor).

3-year-old children will make a good attempt to use a climbing frame. By 4 years of age they should be OK.

Most children from this age are fairly confident on play equipment; though some children are physically cautious.

Demonstrate an understanding of directional commands (forward/backward; over/under; in/out)

Language is important in preschool children, even if only an understanding at this age.

3 to 4-year-old children are only just beginning to get the gist of this. 3-year-olds will probably understand in/out only.

They all should be able to understand commands.

"Get under the chair" and "Put the teddy under the chair" are different concepts.

A child needs to organise itself to get under the chair.

Nice idea to include this as movement is an integration of many processes including that of body awareness.

Throw ball to hit a stationary target

Need to specify size of target.

4 and 5-year-olds definitely, not sure about 3-year-olds.

About half of the 3-year-olds will be able to do this.

Not really expect nursery children to be able to do this.

An example might be needed here - e.g. size of ball/target.

Hop 1 - 3 times on preferred foot

3-year-olds can't hop, some can at 3y 6m, but not on alternate foot.

3-year-olds should be able to hop once.

Difficult, very few will be able to do this.

Suggest put 3 times.

Run and jump over low stationary object

4 and 5-year-olds will have no problem, 3-year-olds may be able to jump over something very low, such as a toy car.

Some 3-year-olds cannot do this at all.

Yes, if only for avoidance.

By jump do you mean two feet together? If not, might be better to say leap. Also, perhaps give size of object e.g. size of brick.

Balance for 5 seconds on one leg

Same type of thing as in music and movement.

Should be able to do this at nursery age.

4 and 5-year-olds only.

Movement with Others

Move around classroom/school avoiding collision with other moving persons

The majority of young children do well at this.

Move around tracking/staying with a person in playground e.g. tig/tag

4 and 5-year-olds will be OK, but 3-year-olds will probably not get the idea and run off in the opposite direction.

This evolves from natural play.

Wouldn't expect this at nursery age.

Give examples of following/chasing games.

Move to intercept and stop a moving object (ball, toy car)

3-year-olds will make a good attempt at it.

Only some will be able to do this.

Children of this age will automatically do this.

Ride moving vehicles (pedal car, tricycle)

Lots of 3y 6m children cannot pedal, very variable at 3 years of age.
3-year-olds should be able to pedal a tricycle, but does vary.

Clap hands/tap feet in time to a musical beat

Does this depend on musical ability? Some adults can not keep time to a musical beat.
Would expect children to be able to keep a beat.
Not appropriate at 3 years of age. Some adults can't clap in time to music, but it doesn't indicate that there is a problem, similarly with a child.

Catch a large approaching bouncing all with two hands

Most 3-year-olds will have the general idea, but may not be able to actually catch it.
Don't expect them to be able to do this.

Additional skills to include in the Checklist

- Sits with knees crossed
- Uses index finger consistently to press buttons etc. and to point at details in pictures
- Uses scissors to snip
- Toileting
- Mimicking adults - dusting, hoovering
- Climbing in and out of bed
- Butter piece of bread
- Drawing long and short lines (copying)
- Differentiate - big/little
- Sitting on a chair
- Brush hair
- Dance to music
- Pouring (e.g. cereals into a bowl)
- Opening bottles
- Demonstrate skills to peers
- Carrying things (toys, books)
- Playing with jointed toys
- Using a swing
- Painting
- Standing on tip toe
- Play in a sand pit/paddling pool
- Demonstrate good pencil control
- Put on apron for painting (required to do this almost every day)
- Demonstrate ability to participate in imaginative play
- Turn pages of a book
- Skipping/galloping
- Kick a stationary ball
- Kick an approaching ball
- Strike a moving ball e.g. when rolling - golf/hockey type stick.

- Imitation of gestures
- Imitation of everyday life motor activities
- Specific item on running

Further comments on the Checklist

Suggestion to change the headings of the two categories *Movement for Self* and *Movement with Others* and replace with *Spontaneous movement/nondirected movement* and *Directed movement*, thus balancing the number of items in the two categories.

The position of the child in the family affects their skill level i.e. a child with a number of older brothers and sisters is likely to have well developed skills at a young age compared with those of an only child.

Quite dangerous to have a checklist without knowing the child.

A lot depends on experience, particularly at this age. If they've been at home may not have such a broad experience as if they have been at nursery; also affected by siblings.

We could actually be doing a checklist on the parents.

Checklist needs to be broken down into smaller steps. It's disorganised and there is a need for far more explanation.

What about children who avoid doing things?

Social/cultural differences?

A lot of items are dependent on language; nothing that looks specifically at language or hearing. How do we know that because a child isn't complying it isn't because they don't understand, they may have a problem hearing etc.?

With respect to the list of behaviours - a lot of these could be symptoms of a very serious problem, not a motor problem.

If you add the item "walks up/down stairs" would suggest that you say in what way you would expect the child to do so. However, it may be a tricky item to include since not all schools will have a staircase so you could get many "do not know" responses which may complicate the composition of a total score.

APPENDIX 2

CHECKLIST 2

SELF HELP SKILLS

Put on and take off articles of clothing (sweater, T shirt, coat)

Unbutton accessible buttons or undo zip

Wash and dry face and hands

Feed self using spoon and fork together

Use cup competently

Puts on apron for painting

Make first item 'Put on and take off articles of clothing' into two separate items

EYE HAND COORDINATION

Copy a circle and cross (when shown)

Pick up and manipulate small objects (pegs, marbles, small wooden blocks)

Construct models from Duplo, Lego, Megablocks

Catch a large approaching bouncing ball with two hands

Uses index finger consistently to press buttons etc. and to point at detail in pictures

Uses scissors to snip

Turn pages of a book (?singly)

Screw/unscrew lids appropriate for hand size/Turn taps on and off

Builds a tower with 8+ blocks

Thread large beads on a shoe lace

CLASSROOM SKILLS

Walk around the classroom/school avoiding collision with stationary objects/persons

Demonstrate an understanding of directional commands (forward/backward; over/under; in/out)

Move around classroom/school avoiding collision with other moving persons

Sits with knees/legs crossed

Carry things (books, toys)

GROSS MOTOR SKILLS (PLAYGROUND ACTIVITIES)

Use playground equipment competently (climbing frame, slide)

Throw a ball

Hop

Run and jump over low stationary object

Balance momentarily on one leg

Move to intercept a moving object (ball, toy car)

Ride moving vehicles (pedal car, tricycle)

Kick a stationary ball

Stand and walk on tip toe

Kick an approaching ball

Rise from kneeling on the floor, without using hands

Walk forwards, backwards, sideways (when shown)

APPENDIX 3

PRE-SCHOOL MOTOR CHECKLIST

- The aim of this Checklist is to aid in the identification and assessment of young children with motor difficulties such that the nature of these difficulties can be determined leading to appropriate intervention strategies where necessary.

- The Checklist is constructed for the child who is 3 to 5 years of age and contains items which are functional in nature relating to the child's everyday life. The thinking behind this involves a belief supported by the relevant literature (from disparate sources such as dynamical systems and ecological psychology and those relating to other developmental disorders such as autism) that both assessment and intervention should be as close as possible to the child's daily experiences and interests. Assessments should take place in contexts of predictable routines examining functional movements that include activities which are regularly encountered and are deemed important by those carers surrounding the child.

- The Checklist is not constructed to measure 'abilities' that purportedly underlie skilled movement, such as various aspects of sensory motor integration or kinaesthetic abilities. The items contained in the Checklist will require some of those abilities for their successful execution but there is no attempt to isolate them. We are more convinced by the literature surrounding functional assessment in meaningful and realistic contexts than we are of isolating abilities with a view to assessing and remediating those abilities.

- We have analysed various scales, tests and talked to a number of professionals and analysed the literature and from these 4 areas have emerged:

  Self help skills
  Desk skills
  General classroom skills
  Recreational and playground skills

- The proposed scoring system is shown below.

Can Do		Cannot Do	
Well	Just	Almost	Not close
1	2	3	4

- We recognise that there will be overlap of 'abilities' in these areas; different and relevant functional skills are tapped across these areas.

- A description of each class of items making up the area is shown. These items were chosen to cover as much of the area as possible. We have taken classes of items and identified actions within them. We are interested in which particular item best represents that class.

- It is hoped that all items can be attempted by 3 years olds (some completed by that age group) and the majority accomplished by 5.

Can Do		Cannot Do	
Well	Just	Almost	Not close
1	2	3	4

SELF HELP SKILLS

CLOTHING. Items which demonstrate the planning and motor control involved in putting on and taking off clothes - T-shirt, jumper, trousers. Others?

Suggested item
Is able to put on and take off a T-shirt without assistance

SMALL FASTENERS. Items which demonstrate dexterity in bimanual control and fine motor control in fastening and unfastening - buttons, zippers. Others?

Suggested item
Can fasten/unfasten accessible buttons

FEED/DRINK. Items which demonstrate competence (bimanual control and coordination) in feeding oneself - using fork, spoon, drink from a cup. Others?

Suggested item
Can feed self using fork and spoon, and can drink from a cup

WASHING ETC. Items which demonstrate competence in washing which involves bimanual control and repetitive movements. Wash and dry face, hands. Others?

Suggested item
Is able to wash and dry face and hands

If there are any other items in this category you feel have been omitted and are superior to the ones above, please include them.

Can Do		Cannot Do	
Well	Just	Almost	Not close
1	2	3	4

DESK SKILLS

REPRESENTATION (CIRCLE/CROSS) Items which show competence in representation skills that is writing, drawing and copying involving planning and organisation as well as manual control. Copy circle, cross. Others?

Suggested item
Can copy a circle and a cross

SMALL OBJECT MANIPULATION (BEADS/ PUZZLES/ PEGBOARDS) Items which show manual dexterity and control together with eye hand coordination. Pick up and place pegs in peg board; place pieces in a jigsaw puzzle, thread large beads on a shoelace. Others?

Suggested item
Can pick up and place pegs in a peg board, and place pieces in a jigsaw

PAGE/PAPER MANIPULATION Items which demonstrate manual dexterity and eye hand coordination with non resistant materials such as paper. Turn pages of a book, give sheets of paper to teacher/child. Others?

Suggested item
Can turn single pages of a book

CUTTING AND GLUEING ETC. Items which demonstrate manual dexterity and control together with eye hand coordination. Can cut out any whole shape using scissors, and uses glue to complete an appropriate task. Others?

Suggested item
Can use scissors to cut out any whole shape and use glue to complete an appropriate task

CONSTRUCTING MODELS Items which demonstrate planning, manual dexterity and control together with eye hand coordination. Construct simple models using duplo, lego, megablocks, build a tower with 8+ blocks. Others?

Suggested item
Can construct simple models using duplo, lego, megablocks

If there are any other items in this category you feel have been omitted and are superior to the ones above, please include them.

Can Do		Cannot Do	
Well	Just	Almost	Not close
1	2	3	4

GENERAL CLASSROOM SKILLS

SITTING APPROPRIATELY Items which demonstrate postural control and static balance. Demonstrate good posture when sitting on a chair, at a desk, sitting on the floor with legs crossed and back straight. Others?

Suggested item
Is able to sit on the floor with legs crossed and back straight

CARRYING Items which demonstrate the motor control and planning involved in carrying objects around the classroom. Carries books and toys across the classroom. Others?

Suggested item
Can carry books and toys across the classroom in order to put away

MOVING AROUND NOT BUMPING INTO PEOPLE/OBJECTS Items which demonstrate the motor control, planning and perception involved in avoiding collision with other people and objects when moving around. Moves around the classroom/school avoiding collision with stationary or moving people/objects. Others?

Suggested item
Is able to move around the classroom/school avoiding collision with stationary or moving people/objects

DIRECTIONAL COMMANDS (FORWARD, BACKWARD, IMITATION) Items which demonstrate the motor control, coordination and planning in moving in various directions. Is able to walk forward, backward, sideways, over, under, in, out, through, around when shown, can imitate simple movements. Others?

Suggested item
Can move forward, backward, sideways when shown

If there are any other items in this category you feel have been omitted and are superior to the ones above, please include them.

Can Do		Cannot Do	
Well	Just	Almost	Not close
1	2	3	4

RECREATIONAL/PLAYGROUND SKILLS

USE OF PLAYGROUND EQUIPMENT Items which demonstrate competence in motor control, coordination, and planning together with static and dynamic balance. Uses playground equipment such as climbing frame, slide and swing. Others?

Suggested item
Can use playground equipment (climbing frame, slide, swing etc.)

MOVING ETC. Items which demonstrate postural control, coordination, and planning together with dynamic balance. Rides a variety of moving vehicles (pedal car, tricycle, scooter). Others?

Suggested item
Is able to ride a variety of moving vehicles (pedal car, tricycle)

BALL SKILLS Items which demonstrate motor control, eye hand coordination together with static and dynamic balance. Kick a large stationary ball, throw a large ball overarm, throw a large ball to hit a stationary target, kick an approaching ball, catch a large ball. Others?

Suggested item
Is able to kick a large stationary ball, and throw a large ball overarm using both hands

RUN/JUMP/HOP ETC. Items which demonstrate competence in motor control, dynamic balance, coordination and planning. Joins in playground activities demonstrating running and jumping, hopping. Runs fast and is able to change direction. Others?

Suggested item
Can join in playground activities, demonstrating running and jumping

BALANCE Items which demonstrate postural control and static or dynamic balance. Walks on tip toes, stands on one leg momentarily. Others?

Suggested item
Is able to walk on tip toes for 4 steps

If there are any other items in this category you feel have been omitted and are superior to the ones above, please include them.

APPENDIX 4

Feedback on Checklist 3

SELF HELP SKILLS

CLOTHING

Suggested item *Is able to put on and take off a T-shirt without assistance*

Putting on and taking off articles of clothing needs to be two separate items. Children usually gain confidence with taking off clothes before putting them on. With garments that go over the head, there could also be problems for children who have a big head or have garments without buttons at the neck. The overall size of the garment in relation to the child can make a great difference to the child's success.

SMALL FASTENERS

Suggested item *Can fasten/unfasten accessible buttons*

What size of button - shirt buttons or coat buttons?

This question should be in two parts. Unfastening buttons usually comes before being able to fasten them. There are a number of variables to be considered such as the size of the buttons, the size of the button holes in relation to the size of the buttons and the fabric from which the garment is made i.e. is there any elasticity in it? All these elements can affect the ease with which a child is able to manage buttons.

FEED/DRINK

Suggested item *Can feed self using fork and spoon, and can drink from a cup*

This statement should be more explicit. Is all that is necessary to hold a fork and spoon in either hand or is the child expected actually to use them simultaneously whilst dealing with food on the plate? There is also the question of the size of the spoon and fork and the type of cutlery the child is used to.

ADDITIONAL SKILLS TO CONSIDER INCLUDING

Socks - with shaped heels

Adjusting clothing after using the toilet, tights are always difficult for girls, plus jeans buttons.

Time is often an issue with the older child - some normative data would be useful.

DESK SKILLS

REPRESENTATION (CIRCLE/CROSS)

Suggested item *Can copy a circle and a cross*

For the younger child it is worth distinguishing between imitating and copying. Imitation of forms comes first (see also developmental sequence - Beery Test of Visual Motor Integration).

It needs to be stated whether this is copying from a complete example which is presented to the child or copying from a demonstrated example. Children are usually able to copy demonstrated examples before they are able to copy a previously completed example.

SMALL OBJECT MANIPULATION (BEADS/ PUZZLES/ PEGBOARDS)

Suggested item *Can pick up and place pegs in a peg board, and place pieces in a jigsaw*

Are the puzzles form boards or interlocking? Form boards are easier. If interlocking, how many pieces?

Not convinced what this will actually tell the examiner for there are so many elements in being able to place pieces in a jigsaw such as eye hand coordination, manipulation, perceptual skills, completeness etc. etc. Therefore, inability to do so could be because of any one of many difficulties.

CUTTING AND GLUEING ETC.

Suggested item *Can use scissors to cut out any whole shape and use glue to complete an appropriate task*

What shapes?

Developmental sequence of using scissors is not as well documented as some other skills. Most literature refers to being able to cut across a 1" strip, 4" strip and 8" strip within 1/2" - 1". The child then moves to shapes - square, triangle, oval and circle.

Clarification would be useful as a 3-year-old would certainly be compromised if asked to cut out a circle.

CONSTRUCTING MODELS

Suggested item *Can construct simple models using duplo, lego, megablocks*

Miller and Sheridan both refer to block designs, and as such have age norms. A 'bridge' (3 years, 3 months), 'steps' (4 years, 6 months), and 'rocket' (5 years, 6 months), may be more useful to measure.

Probably using simple 2.5 cm cubes would give far more information about the child's abilities as with these it is easier to pick up on problems such as tremor and any unsteadiness. It is also easier to analyse the grip placement and release.

ADDITIONAL SKILLS TO CONSIDER INCLUDING

What about a simple maze for pencil control between two lines or colouring?

A posting activity

GENERAL CLASSROOM SKILLS

SITTING APPROPRIATELY

Suggested item *Is able to sit on the floor with legs crossed and back straight*

This is a doubtful item for some children have tight hamstrings and have difficulty with this task.

DIRECTIONAL COMMANDS (FORWARD, BACKWARD, IMITATION)

Suggested item *Can move forward, backward, sideways when shown*

You could combine this with testing some of the basic prepositional concepts required as a pre reading and writing skill (on, under, up, down etc.).

The position of the person giving the instruction needs to be clarified.

ADDITIONAL SKILLS TO CONSIDER INCLUDING

Ability to stand in line

RECREATIONAL/PLAYGROUND SKILLS

USE OF PLAYGROUND EQUIPMENT

Suggested item *Can use playground equipment (climbing frame, slide, swing etc.)*

This item is too vague. The climbing frame is a static piece of equipment. On a slide, a child momentarily loses control of self and a swing is a moving object. There are also so many varieties of the same equipment. A child may feel competent with one style of item and not with another.

ADDITIONAL COMMENTS ON CHECKLIST

If each item on the checklist was administered in a standardised way to a group of 'normal' children the information gained would be really useful.

SCORING Will you be giving instruction to the user as to the criteria of each heading? I appreciate that it is a checklist, but I feel as it stands, it is a little too open to wider interpretation i.e. what is somebody's 'can do well' is another's 'can only just do'.

You are assuming that activities are going to be known to all children. I am a little bit worried that to approach competence in some activities you have to collapse the child's experiences with the child's abilities. A child who has had little experience with ball throwing may be poor on ball skills but may be perfectly competent after exposure to ball games. This seems trivial, but in our primary school sample we had children whose lack of motor skill did seem to be a lack of experience (some were in one room bed and breakfast accommodation when at home, for example). Such children may also be short of drawing and cutting experience (desk skills), and some children do not get exposed to tricky fasteners if parents are rushed and find T-shirts easier. (Think of a reception class after PE - 30 plus 4 year olds all trying to button five or six buttons down the front of their shirts. It is a very slow process and many children cannot do it at this age).

I wonder if there is a place for a 2 stage approach to the checklist. The first is "can't do it" and the second is "still can't do it" when the teacher knows that some relevant experience has been provided and, most importantly, that other children who couldn't do it at first now can do it.

APPENDIX 5

CHECKLIST 4 (DRAFT CHECKLIST)

PRE-SCHOOL MOTOR CHECKLIST
EARLY YEARS MOTOR CHECKLIST

Name .... Gender .... Date of birth ....
School .... Age ....y .... m
Assessed by .... Date of Test .... Class ....

Can Do		Cannot Do	
Well	Just	Almost	Not Close
1	2	3	4

SECTION 1 Self Help Skills

The child can

- Put on a T-shirt without assistance ....
- Take off a T-shirt without assistance ....
- Fasten accessible coat buttons ....
- Unfasten accessible coat buttons ....
- Feed self using fork and spoon, and drink from a cup ....
- Wash and dry face and hands ....

Section 1 Total ....

SECTION 2 Desk Skills

The child can

- Copy a circle and a cross from a completed example ....
- Pick up and place pegs in a peg board, and place pieces in an interlocking jigsaw ....
- Turn single pages of a book ....
- Use scissors to cut across a piece of paper (e.g. 4" strip) ....
- Construct simple models using duplo, lego, megablocks ....

Section 2 Total ....

Can Do		Cannot Do	
Well	Just	Almost	Not Close
1	2	3	4

SECTION 3 General Classroom Skills

The child can

- Sit on the floor with legs crossed and back straight ....
- Carry books and toys across the classroom in order to put away ....
- Move around the classroom/school avoiding collision with stationary or moving people/objects ....
- Move forward, backward, sideways, under and over when shown ....

Section 3 Total ....

SECTION 4 Recreational/Playground Skills

The child can

- Use fixed playground equipment (e.g. climbing frame, slide) ....
- Ride a variety of moving vehicles (e.g. pedal car, tricycle) ....
- Kick a large stationary ball, and throw a large ball overarm using both hands ....
- Join in playground activities, demonstrating running and jumping ....
- Walk on tip toes for 4 steps ....
- Catch a large (10") ball with two hands ....

Section 4 Total ....

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