The Effects of a Sensory Motor Development Programme on Selected Variables of School Readiness

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Declaration

I, the undersigned, hereby declare that the work contained in this thesis is my own original work and that I have not previously in its entirety or in part, submitted it to any university for a degree.

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Abstract

The purpose of this investigation was to determine whether a sensory motor development programme could have an effect on some of the underlying physical and perceptual abilities that support school readiness. The control group consisted of 23 children and the two intervention groups of 79 children in total. All of the children were enrolled in a pre-primary school programme in a local community. They were all six years old by the end of the intervention. The Movement Assessment Battery for Children (Henderson & Sugden, 1992) was used to assess the children on their manual dexterity, eye-hand coordination, static balance and dynamic balance. The intervention programme consisted of two phases of 10 weeks each, during which the sensory motor development activities were presented to the two intervention groups.

Results of the investigation revealed there were significant improvements for some of the children on selected variables that underlie school readiness. It can be concluded that participation in a sensory motor development programme can make a significant contribution to school readiness for many children.

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Opsomming

Die doel van hierdie ondersoek was om te bepaal of 'n sensories-motoriese ontwikkelingsprogram enige uitwerking op bepaalde onderliggende fisiese en perseptuele vermoëns wat tot skoolgereedheid by jong kinders bydra, sou kon hê. Die kontrolegroep het uit drie-en-twintig kinders bestaan. Die twee tussentredende groepe het altesaam uit nege-en-sewentig kinders bestaan. Die kinders was almal pre-primêre skoolprogramleerders vanuit 'n plaaslike gemeenskap. Teen die einde van die intrede het al die betrokke kinders sesjarige ouderdom bereik. *Movement Assessment Battery for Children* (Hendersen & Sugden, 1992) is as riglyn gebruik om die kinders se handvaardigheid, oog-hand-koördinasie, statiese en dinamiese balans te evalueer. Die tussentredeprogram het bestaan uit twee fases van tien weke elk. Die sensoriese-motoriese ontwikkelingsaktiwiteite is terselfdertyd vir die twee tussentredegroepe aangebied.

Die resultate van die ondersoek het beduidende vordering in sommige kinders getoon, spesifiek ten opsigte van bepaalde veranderlikes onderliggend aan skoolgereedheid. Hierdie bevinding dui daarop dat sodanige deelname in 'n sensories-motoriese ontwikkelingsprogram wel 'n betekenisvolle bydrae tot die ontwikkeling van skoolgereedheid in baie kinders kan maak.

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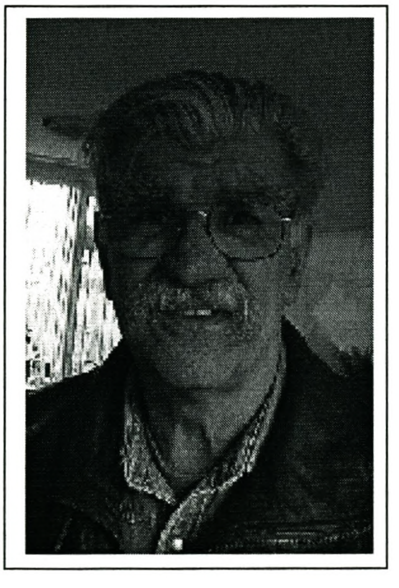
for Joop



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Acknowledgements

This work does not only mark the completion of an intervention programme, it also marks the conclusion of a quest that started more than ten years ago. During this time, I was provided by the universe with an abundance of opportunities and amazing people for which I will always be grateful. My study leader, Professor Bressan, would probably not be surprised if I handed in another fifty pages of acknowledgements but I will try to be brief.

Liz, thank you for being much more than a study leader!

The children made it all possible, they have enriched my life and their smiles and hugs helped me overcome many obstacles. It has been a dream come true.

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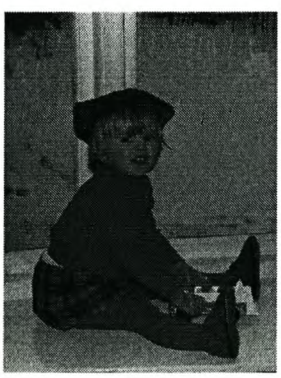

Finally, I'd like to thank my personal statistician…

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Chapter One

Statement of the Problem

The beneficial effects of physical activity on a person's health are widely accepted. In a critical review, Scully, Kremer, Meade, Graham and Dudgeon (1998) noted that the positive role that physical exercise can play in the prevention and remedy of a range of medical conditions has received a great deal of attention, with numerous high profile reports supporting the popular message that exercise is good for you. It is now generally accepted that regular exercise protects against a plethora of somatic complaints. Research also provides positive, if guarded, support for the role that exercise can play in the promotion of positive mental health. It does not make sense then, that within the school curricula, less time is spent on physical education than ever, even though evidence shows that when a substantial proportion of curricular time (14-26%) is allocated to physical activity, learning in an academic setting seems to proceed more rapidly (Shephard, 1997).

At present there is little data supporting how physical activity is related to the development of children's mental abilities in the pre-school period. Hollmann and Struder (2000) studied the relationship between physical activity and the development of the brain in terms of synaptic connections, and posed the question: which connections, if not all, are being affected? According to Hollmann and Struder (2000), children's brains should be exposed to as many motor and sensory stimuli as possible. Physical activity facilitates the development of additional synapses in the brain, which would prevent isolated neurons and the associated degeneration. This would theoretically provide a better basis for the development of intelligence through the increase of neurons and their respective synapses. They define intelligence as "the ability to analyse, synthesise, remember and invent" (p.519).

Oja and Jürimäe (2002) studied 294 six year old pre-school children in Tartu (Estonia) and hypothesised that "if children are more physically active, they are more mentally ready to go to school" (p. 408). They looked at the relationship between physical activity, motor ability and school readiness and used a

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questionnaire that was filled in by parents and teachers to establish daily physical activities of the children. They reported on the mode and duration of several indoor and outdoor activities and it was found that indoor physical activities are more closely related to school readiness scores of six-year old children than outdoor activities (Oja et al. 2002). The indoor activities were organised physical activities whereas the outdoor activities were undirected play.

Purpose of the Study

The purpose of this study was to determine the effects of participation in a sensory motor development programme on some of the underlying physical and perceptual abilities that support school readiness. To fulfil this purpose, a local school that used the South African school readiness programme (Wentzel, 1989) was approached and two groups of pre-primary children were selected. The children participated in an intervention programme comprised of carefully chosen sensory motor development activities.

Significance of the Study

Although educators may be aware of the importance of participation in movement and physical education during the pre-school years, lack of money, time and expertise seems to leave these kinds of activities low on the list of priorities. There is growing interest in restoring physical education to all levels of schooling. In Great Britain, great emphasis is placed on the importance of returning sport to the heart of school life. UK Sport and Sport England have released new research showing that the number of people participating in sport in England is likely to fall by almost a million by 2026 (a decrease rate from 52.5% to 46.3%), unless positive action is taken to address the situation (UK Sport, 2004). The Minister for Sport believes in "getting them while they're young", his department has a target of raising the average time spent on sport and physical education by 6 to 16 year olds to six hours per week by 2004. This is to be done by including two hours of physical education and sport into the formal school curriculum. Additionally, four hours of sport should be enjoyed by pupils outside of the formal curriculum time with an emphasis placed on team sport. The World Health Organisation

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recommends "30 minutes of moderate physical activity a day" (World Health Organisation, 2003).

Since 1994 a number of initiatives were attempted in South Africa to reinstate physical education and school sport. Unfortunately, the Department of Education has no policy on physical education and school sport and no personnel dealing with it specifically (van Deventer, 2002). However, these initiatives say nothing about preparation or school readiness programmes that could provide children with a sound basis for their primary school education. This intervention will attempt to provide insight into the educational contributions that may be available through participation in a physical activity programme focused on sensory motor development. If participation can promote school readiness, it may improve a child's chances of a successful transition to Grade 1 and therefore give him/her an improved chance at success in school.

Hypotheses

The following hypotheses have guided this study.

1. There will be a significant improvement in children's manual dexterity following participation in a sensory motor development programme.
2. There will be a significant improvement in children's eye hand coordination following participation in a sensory motor development programme.
3. There will be a significant improvement in children's static balance following participation in a sensory motor development programme.
4. There will be a significant improvement in children's dynamic balance following participation in a sensory motor development programme.

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Methodology

In order to improve knowledge regarding the effects of a sensory motor development programme on school readiness and motor competence, a literature search was completed on the topic of school readiness and the development of motor control. School readiness as a concept was explored in order to identify some of the underlying variables that might serve as targets for specific programme planning. The development of motor control was studied in order to identify the most productive way to approach programme design when brain development is a programme objective.

Two pre-primary experimental groups from one school participated in the intervention. Another pre-primary group of children from a different school in the same community served as a control group. The children were all six years old by the end of the school year.

This study was organised in four parts. The first part was the pre-test and the fourth part was the post-test. All the children were tested with the Movement Assessment Battery for Children (Henderson & Sugden, 1992) before and after the intervention programme. This test battery was chosen because it has been shown to be a reliable test of manual dexterity, eye hand coordination, static balance and dynamic balance. These variables were identified as part of the physical and perceptual abilities often associated with school readiness. The results were subjected to *t*-testing for small groups.

The second and third part of the study included the sensory motor development programme used as the intervention. The second part was the implementation of this programme before the winter break with the emphasis on primary movement patterns and body awareness. The third part was implemented after the winter break with the emphasis on eye hand coordination and “advanced” body awareness.

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Limitations

The following limitations may have affected the test results:

1. Absenteeism. The children were frequently absent which is why there are only 70 complete pre- and post-tests, even though the three groups had a combined total of 102 children.

2. Assessment. The use of the Movement Assessment Battery for Children (Henderson et al. 1992) is commonly used as an indicator of Developmental Coordination Disorder (DCD). Although DCD is associated with various learning difficulties and problems, it is not a test of school readiness per se. School readiness is a complex concept that includes intellectual and socio-emotional variables, as well as physical and perceptual variables. This study was therefore limited to the variables of manual dexterity, eye hand coordination, static balance and dynamic balance, all of which are proposed to be components of school readiness.

Definitions

School Readiness

When a child is ready for school, his lateral dominance has been established, he has already developed a sense of direction, can see and hear well, can express his own needs verbally and is capable of a certain degree of abstract reasoning (Wentzel, 1989). In order to establish school readiness, a child is evaluated with regards to the following four aspects: socio-emotional readiness, physical readiness, perceptual readiness and intellectual development. Within the scope of this research, only variables associated with physical and perceptual readiness were studied.

Sensory Motor Development Programme

Based on the book by Cheatum and Hammond (2000) a two-stage sensory motor development programme was designed. In the first stage, the main objective was to ensure that primary movement reflexes were replaced by voluntary movement.

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The exercises were aimed at overcoming the effects of gravity and improving body awareness. The second stage concentrated on eye hand coordination and activities to increase body awareness further.

Summary

This intervention programme was designed to establish whether a sensory motor development programme could have a beneficial effect on school readiness of 5 and 6 year old, pre-primary children. Two groups of children were exposed to a sensory motor development programme and one group of children served as the control group. The Motor Assessment Battery for Children (Henderson et al. 1992) was used as an indicator of the progress the children made in terms of their manual dexterity, eye hand coordination, static balance and dynamic balance.

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Chapter Two

Review of Literature

There is no comprehensive definition of "school readiness" and as a concept it would seem to be rather controversial (Wentzel, 1989). She stated:

> School readiness is a process, not an event. The process leading to school readiness starts at birth and goes hand in hand with the normal stages of development of the child. A child who is provided with sufficient opportunity for healthy development, should, by the time he reaches compulsory school age, also be school ready. (p.1)

According to the Ordinance on Education it is compulsory in South Africa for a child to enter school in the year during which he turns seven, whether it be 1 January or 31 December of a given year. A child may enter school when he is five years old, provided that he turns six before 30 June of the year in which he enters school.

School Readiness

In South Africa, most children join a pre-primary group in the year before they have to go to school (grade 1) in order to become "school-ready". Much has been written and debated about school readiness. Cassidy, Mims, Rucker and Boone (2003) concluded that the pressure is often on making children ready for the school environment, instead of also making the school environment ready for children. Pre-primary school teachers have to prepare the children for school in one year or less. Most of the studies discussed in this literature review are therefore used as guidelines and "translated" into the South African school readiness as defined by Wentzel (1989).

She proposed that a child's level of development in four areas indicate whether he/she is "school-ready" or not. These areas are:

1. Physical readiness

2. Socio-emotional readiness

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3. Perceptual readiness

4. Intellectual development.

According to Wentzel (1989):

> The level of physical maturity signifies the physical growth of a child, his bone and muscular development, visual and auditory development and the development of laterality. Heredity may also play a part. A child who has not reached a given physiological maturation level usually still exhibits a great need to play. He is often not ready emotionally to meet the demands made on him, he tires easily in a formal teaching situation and is not yet work orientated. A child who has not yet reached the desired level of physical maturation is often unwilling to perform a task as required by the teacher. He often reacts in an emotional way to mask his inability when confronted with a task that is too difficult. (p.1)

The child who has achieved the required physical maturity is not only able to learn, but also willing to listen and carry out instructions. He is also more or less able to take care of his own physical needs, i.e. dressing, toilet routine, feeding himself, etc.

According to Wentzel (1989), as far as socio-emotional readiness is concerned, a child that is ready for school should:

- Wish to learn;
- Be prepared to take a risk and to attempt new situations;
- Be able to manage his own physical needs;
- Be able to communicate his needs to other clearly;
- Understand instructions and be able to execute them;
- Be able to sit still for a reasonable time, listen and pay attention;
- Already be able to be away from home for a morning;
- Be able to establish a good relationship with the teachers;
- Be able to get on well with his peers;
- Be able to start lasting friendships and maintain them.

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A child also needs a certain level of perceptual and intellectual development in order to be ready for school. The parent and the nursery school can do a great deal to help the child achieve this required level of readiness. For a child to be ready for school, for example, his/her lateral dominance should have been established, as well as a sense of direction, the ability to control looking and listening, to ability to express his/her own needs verbally and the ability to use the early stages of abstract reasoning (Wentzel, 1989).

The Development of School Readiness

Rimm-Kaufman, Pianta and Cox (2000) emphasised that the contribution of kindergarten to school readiness is found in its programme, where the statement of goals and their connections to a system of instruction create a climate of formal instruction. This is different from the less formal play school instruction that has the specific intent of raising the child's skill level. Interactions in the kindergarten classroom environment become increasingly intentional and focused on the child's academic progress and the teacher-child relationship becomes increasingly influential to the child. Rimm-Kaufman et al. (2000) suggested that the kindergarten experience, characterised by these new constraints, contributes to increased academic skills.

Early efforts in the United States resulted in the identification of the following dimensions of school readiness which have become widely accepted in the early childhood field: physical and motor development, social and emotional development, approaches toward learning (i.e. creativity, initiative, attitudes toward learning, task mastery), language, cognition and general knowledge (Kagan, Moore & Bredekamp, 1995). Recently the school readiness focus has begun to emphasise the importance of literacy and children's preparation to read as a key goal during pre-kindergarten and kindergarten. Experts in the early childhood education field recognise the importance of literacy and learning to read as well as the positive relationship between acquiring these skills and the prevention of early school failure. However, Wesley and Buysse (2003) have cautioned that the important contributions of social and emotional development to school readiness must not be neglected by an over-emphasis on cognitive development and the importance of learning to read at an early age.

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The "Ready School"

According to Rimm-Kaufman et al. (2000) there are different theoretical perspectives that can guide programmes that promote the transition to school. The Ecological and Dynamic Model of Transition emphasises the importance of the direct, indirect and dynamic effects of learning contexts on children's transition through kindergarten. This model suggests that the transition to school takes place in an environment defined by the many changing interactions among each child and the classroom as well as the family and community. In other words, a child's competence in a kindergarten classroom may not be the only and best outcome measure of a successful transition. The quality of the parents' relationships with teachers and their relationship with the child's schooling may be an equally valid indicator of the success of the transition.

The "school" or the programme designed to promote children's successful transition to school also displays certain characteristics. Wesley and Buysse (2003) found that teachers defined a "ready school" as follows:

- Transition strategies are used throughout the year, e.g. home visits, summer transition programmes, staggered student entry, etc.
- A developmentally appropriate curriculum is followed that extends early childhood practices into kindergarten, rather than pulling academic instructional strategies down from the first grade.
- The teacher's role is facilitative rather than directive and is focused more on how children learn than on documenting assessment scores.
- There is a commitment to staff development, including opening school in-service opportunities to teachers, school administrators, parents, etc.
- There are provisions made for interaction and support for families, e.g. support groups, parent meetings featuring children's programmes and displays, newsletters, etc.

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The methods of teaching are also factors in the success of school readiness programmes. Cassidy, Mims, Rucker and Boone (2003) described observation-based planning as a feature of these programmes. When planning an activity, the teachers first consider the children's interests and how these interests can be used to increase understanding and learning. The teachers then shape interest-related learning activities to accommodate specific skills that must be learned. Children can also request specific activities. The same activity can be repeated or altered to increase a child's experience and/or his involvement and to target specific skills. Such repetition is an important part of this environment and allows children to experience mastery and develop feelings of self-competence.

Rebecca Marcon (1999) noted that formal learning of math and reading skills are now frequently introduced in kindergarten rather than first grade and that these escalating academic demands have affected pre-school programmes. In her survey of 193 teachers of 4-year olds, she identified three groupings through cluster analysis that were selected as examples of the divergent pre-school models: the child-initiated model, the academically-directed model and the middle-of-the-road model.

Teachers operating within the child-directed model facilitate learning by allowing children to actively direct the focus of their learning. The children are not directly taught concepts, but rather learn them through self-directed activities. The teacher facilitates learning by (a) providing children with a wide variety of experiences, (b) encouraging children to choose and plan their own learning activities, (c) posing problems and asking questions that stimulate and extend learning, (d) guiding children through skill acquisition activities as needed, and (e) encouraging children to reflect on their learning experiences.

Teachers operating within the academically-directed model prefer more direct instruction and teacher-directed learning experiences. Lessons are (a) scripted to assure consistency in presentation across teachers, (b) carefully sequenced with task analysis and a comprehensive system for monitoring student progress, and (c) consistently focused on academic instruction. The majority of time in the school day is allocated to practice and drill in reading, language and math.

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Teachers who endorse a combination or "middle-of-the-road" approach deliver a programme that is higher in structure than child-initiated approaches, yet involves more active participation and child-directed learning than is found in the direct instruction approach.

Comparisons between the three models indicate that children in classrooms where teachers held beliefs that corresponded with a single, internally coherent theory of how young children learn and develop (either the child-initiated or the academically-directed) did better on standardised measures of development than did children whose teachers followed a "middle of the road" approach (Marcon, 1999). Receptive and expressive language skills, personal and interpersonal relationship skills and gross motor skills were lower among children taught using the academically-directed model than those where the child-initiated model were used.

Anderson, Shinn, Fullilove, Scrimshaw, Fielding, Normand, Carande-Kulis and the Task Force on Community Preventitive Services (2003) completed a systematic review of the effectiveness of early childhood development programs. These are publicly funded, centre based, comprehensive programmes that promote the well-being of young children and are designed to close the gap in readiness to learn between poor children and their more economically advantaged peers. They are intended to improve the cognitive and social-emotional functioning of pre-school children, which, in turn, is proposed to have a positive influence on readiness to learn in the school settings. School readiness programmes have been identified as particularly important for children from low socio-economic backgrounds. It is hoped that readiness programmes may help prevent early academic failure and school behavioural problems (Hertzman & Wiens, 1996).

A body of evidence shows that early childhood development programmes have a positive effect on increasing readiness to learn (Anderson et al., 2003). The findings in their review are based on 12 studies of early childhood development programmes. Nine studies measured academic achievement through use of standardised academic achievement assessments. In six of these studies, increases were reported in children's academic achievement. Three studies used cognitive skills assessments relevant to kindergarten curricula to measure

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outcomes in terms of school readiness. All three studies demonstrated increases in school readiness.

Five studies in the Anderson et al. (2003) review examined social outcomes. Three studies documented increases in social competence, including improvements in classroom behaviour and intrinsic motivation. Two studies examined long-term social outcomes in early childhood development programmes. Both programmes demonstrated long-term decreases in social risk behaviours. Programme participants experienced significant improvements in high school graduation rates, employment status and home ownership, as well as significant reductions in teen pregnancies, delinquency, arrests and receipt of social services (Anderson et al., 2003). These studies demonstrate the effectiveness of school readiness programmes and provide evidence of their importance.

Parents, Teachers and School Readiness

Kinlaw, Kurtz-Costes and Goldman-Fraser (2001) found that a mother's valuing of her child's effort and willingness to try, were related to her encouragement of her child's autonomy, and that children who were rated more autonomous, exhibited higher levels of school readiness. They were unable to establish a relationship between parental reading behaviour and children's school readiness. Scarborough and Dobrich (1994) also found that the connection between shared book reading and literacy readiness may not be as strong as is commonly assumed.

Wesley and Buysse (2003) examined beliefs and expectations about school readiness among parents and professionals. To the question "what should children learn", they found that participants stressed the critical importance of social and emotional development, as well as language development and communication, while de-emphasising academic skills such as knowing alphabet letters and their sounds. The belief was that if children could interact meaningfully with each other and adults, follow simple rules and directions and demonstrate some degree of independence in the classroom, then kindergarten teachers could teach them other academic skills and knowledge they would need to be successful in school. Nearly every focus group raised the importance of children being able

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to separate from their parents without being upset and spoke of the value of children having group experiences prior to kindergarten. Pre-kindergarten teachers particularly, spoke of the importance of building children's confidence, stimulating their creativity, engaging their attention and being mindful of their curiosity related to various tasks.

Children living in poverty are at heightened risk for school failure, which is why Piotrkowski, Botsko and Matthews (2000) examined parents' and teachers' beliefs about school readiness in a high need community. The beliefs about children's school readiness resources were divided into two separate domains. Included in the first domain were beliefs regarding *general readiness resources* a child may have that pertain to a child's everyday life: health, peer relations, communication in his/her own language, emotional maturity, self-care, interest and motor skills. The second domain represents beliefs regarding the personal *classroom related readiness resources* that a child may have which are especially pertinent to the classroom setting: communication in English, compliance with teacher authority, compliance with classroom routines, basic knowledge and advanced knowledge. Piotrkowski et al. (2000) found that parents held remarkably similar beliefs, regardless of ethnicity or education. Parents and teachers agreed that children must be healthy and socially competent, and be able to comply with teacher authority, although parents rated this latter resource higher. Parents rated all classroom related readiness resources as more important than teachers did. They believed it was necessary for a child to be able to communicate in English and to have basic knowledge and skills, which was more important than a child's approach to learning. Pre-school teachers also believed that knowledge was more important than kindergarten teachers did.

Because kindergarten teachers are important to children's successful transition to school, it is critical to understand their expectation about what skills, behaviours and attributes are necessary for school outcomes. These expectations have a profound impact on their teaching practices and on children's success in schools. Lin, Lawrence and Gorrell (2003) made an effort to understand the factors that influence kindergarten's teachers' readiness perception. The major finding of their study was that kindergarten teachers tend to view preparing children to satisfy

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social demands of schooling as a higher priority than academic skills development. Their findings revealed that kindergarten teachers' primary concerns about children's readiness centred on the children's social behaviours in school: "tells wants and thoughts (83.9%), not disruptive of the class (78.6%), follows directions (77.5%) and takes turns and shares (73.6%)" (Lin et al., 2003). These four items are particularly interesting when seen in comparison with the low rate of emphasis placed on four academic items teachers named as being important: counts to 20 or more (14.6%), knows most of the alphabet (21.4%), names colours and shapes (32.3%) and uses pencil, brushes (36.0%). Lin et al. (2003) concluded that their sample of teachers (3,305 in the USA) placed more emphasis on children's social ability compared to their development of academic skills.

Assessment and School Readiness

Wentzel (1989) suggested the following focus for the practical evaluation of school readiness.

Physical readiness

Body image, knowledge of body parts, posture and midline crossing, lateral dominance (hand, eye, foot), directionality, gross motor skills, balance and rhythm, fine motor skills, visual motor (eye hand) coordination and eye movements.

Socio-emotional readiness

Physical self-care, maintaining pace of work, courage to dare and desire to learn, execution of tasks, maintaining attention span and concentration, listening ability.

Perceptual readiness

Colour and colour recognition, perception of form, visual analysis and synthesis, foreground-background discrimination, visual sequencing, visual memory, visual closure, spatial orientation and relationships, memory and listening skill, auditory skills (discrimination, sequencing, analysis and synthesis) and symbol comprehension.

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Intellectual readiness

Language development and reasoning (vocabulary, word comprehension, inductive and deductive reasoning, commands of words, language usage, reasoning ability), concept of number and quantity (number sequencing, number concept, mathematical concepts, mental arithmetic, figure memory)

It is important to note that upon entering school, children may have attained varying degrees of school readiness in the various areas and level. Some children may be completely ready for school, others may be partially ready, and a third group not at all, despite the fact that they have reached compulsory school-going age (Wentzel, 1989).

The Development of Motor Control

Child development specialists spent the early part of the twentieth century conducting observations of how infants gain control of their movements. Their careful observations led to descriptions of motor milestones and stages of development. The age norms they identified became the bases of development assessment tests, and their explanations of maturation were widely accepted and used as guidelines for programmes. Gesell and Thompson (1938) and McGraw (1943) provided a concept for motor development based on the description of patterns and sequences of movement that they believed emerged in orderly progressions. They hypothesised that the changes in children's motor control or coordination were directly reflected in changes in the brain and that there was a genetically driven process common to all infants (Thelen, 1995).

The pioneering studies of Bernstein (1967) proposed a shift from this maturation-based motor control hypothesis. He saw the basic problem of coordination as that of mastering the many degrees of freedom involved in a particular movement - of reducing the number of independent variables to be controlled. His premise was that muscles act to generate and degenerate kinetic energy in body segments and that the roughly 792 muscles in the human body all combine to bring about energetic changes at the skeletal joints. Inertia, reactive forces and initial postural conditions combine with active muscle forces to produce movement. This

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approach rules out a simple relationship between nervous impulses from the central nervous system and the movements themselves.

Bernstein (1967) recognised that a specific movement can be produced by a variety of underlying muscle contraction patterns and that a particular set of muscle contractions does not always produce an identical movement. He saw that actions must be planned at a very abstract level because it is impossible for the central nervous system to program all the local, contextually varying, force-related interactions specifically and ahead of time. Thelen (1995) stated Bernstein's "degrees-of-freedom" problem:

> How can an organism with thousands of cells and nearly infinite possible combinations of body segments and positions, ever figure out how to get them all working toward a single smooth and efficient movement without invoking some clever 'homunculus' who has the directions already stored? (p. 80).

She then wondered whether Bernstein's degrees-of-freedom problem could be explained through the study of dynamics. Zernicke and Schneider (1993) provided a brief description of biomechanics and dynamics. They explain that mechanics is the branch of physics that deals with the motions or states of material bodies. Mechanics is typically divided into kinematics (dealing with different forms of motion) and dynamics (dealing with the physical causes for changes in motion). The primary variables of dynamics include force, torque and power. Dynamics is divided in two parts, statics and kinetics. Statics involves systems that are in equilibrium, and kinetics deals with changes in motion caused by one or more unbalanced forces.

Bernstein (1967) summarised his position:

> The secret of coordination lies not only in not wasting superfluous force in extinguishing reactive phenomena but, on the contrary, in employing the latter in such a way as to employ active muscle forces in the capacity of complementary forces. (p. 109)

Consistent with this statement, Zernicke and Schneider (1993) stated that muscle forces can counteract and complement motion-dependent torques and that practice can alter the coordination among muscular, gravitational and motion-dependent torques.

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The Dynamic Systems Approach

One consequence of these new ideas about motor control on conceptions about motor development was the recognition of the multi-causality of action. Thelen (1995) used the new-born stepping reflex as an example and observed that new-born infants, when held upright with their feet on a support surface, perform alternating, step-like movements. Not only are well co-ordinated patterns performed at an age when infants are motorically immature, these movements "disappear" within a few months. Infants do not "step" again until later in the first year, when they intentionally step prior to walking. Thelen (1995) hypothesised that movement must arise from an interaction of processes and constraints in the child and in environment. Thelen and Fisher (1982; 1983) noted that in the first two or three months when the stepping reflex disappears, infants have a very rapid weight gain, most of which is subcutaneous fat rather than muscle tissue. Thus, their limbs get heavier but not necessarily stronger. They speculated that "the disappearing reflex could arise not by brain design but by the confluence of increasingly heavy legs and a biomechanically demanding posture". This new approach was called the dynamic systems approach.

Within the dynamic systems approach, developmental change can be seen as a series of behavioural states of stability and instability. In his ecological approach to perception, Gibson (1979) created the term "affordances" to describe the reciprocal relation, or "fit", between physical properties of actor and environment that is necessary to perform a given action. Changes in the interactions between the affordances (opportunities) and constraints (limitations) that characterise an individual in a particular environment, will determine what movements and levels of motor control emerge. The development of motor control is initiated by the loss of stability in the relationship. A change in one or more "components" in the relationship disrupts the stability so that the system (the individual) must explore and discover new patterns of coordination (Thelen et al., 1982; 1983).

Development as a Dynamic Process

Goldfield, Kay and Warren (1993) completed a study that showed that attempts to adapt to the task challenges could become the driving force for changes in motor

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control. They proposed that spontaneous activity allows an infant to explore possible neurological organisations by allowing the free interplay of the components of movements. They supported this by placing infants in "Jolly Jumper" infant bouncers. As infants hung from a harness suspended by a linear spring, their initial kicking actions produced an entertaining effect. Then, the infants began to assemble and tune their kicking actions into a predictable and controlled kicking system. Goldfield et al. (1993) concluded that the infants' spontaneous movements within a task context, are progressively tuned to optimise the achievement of a desired result.

Within the dynamic systems approach, time is a critical variable in determining changes in control, but not in terms of a child's age (or level of maturation). The time factor is one of experience with the loss of stability in the relationships between the child and his/her environment. Piaget (1952) believed that all representational thought had its origins in infants' repeated cycles of perceiving and acting on the world, and that representational thought evolved from physical interactions with objects during infancy. More recent studies have demonstrated that infants are continually co-ordinating their movement with concurrent perceptual information to learn how to maintain balance, reach for objects in space and move across various surfaces (Thelen, 1995).

Motor Control and Learning

The perception-action relationship is a reciprocal one according to the dynamic systems theory. Just as perception helps shape action, so too does action help shape perception. The types of motor activities experienced by children are particularly critical because they provide them with means for exploring the world and learning about its properties, thus shaping their perceptions. Bushnell and Boudreau (1993), for example, contended that particular motor activities may be essential to the development of haptic and depth perception. They found that infants could perceive object properties only after their manual activities permitted appropriate haptic exploration.

This approach to motor control presents motor learning as the acquisition of self organising capabilities within the person-environment interaction. Bushnell and

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Boudreau (1993) stated that the emergence of particular motor abilities determine some aspects of perceptual and cognitive development. In the language of the dynamic systems approach, motor development itself may serve as a "control parameter" within the larger system of the whole developing organism. Infants must possess specified motor abilities in order for the corresponding perceptual abilities to emerge. Motor abilities make available certain information required for the acquisition or operation of the related perceptual abilities. A particular motor ability may not be "necessary" for specific perceptual development if the critical information provided by that motor ability is supplied via some other means or ability. On the other hand, there may be instances where a particular motor ability is critical, and therefore is genuinely the rate limiting factor for development.

Physical Activity and Academic Performance

The link between perception and action is also a link between mind and body. This link is the premise for believing that some kinds of physical activity facilitate the general learning process (not just motor skill learning). Human and animal studies have shown that brain areas involved in both movement and learning are intimately connected and that physical activity can increase the number of neural connections between the two areas (Jensen, 1998). Learning complex movement sequences stimulates the pre-frontal cortex used in learning and problem solving, and this may have a positive effect on learning. Animal studies have indicated that exercising rats have more neural connections, nourished by more capillaries, than sedentary rats. Shephard (1997) has found that physical activity may increase the level of arousal through involvement of neuro-hormonal mechanisms, which could increase level of attention among children in a classroom setting.

Thomas, Landers, Salazar and Etnier (1994) reviewed over 100 studies and concluded that physical activity is associated with selected advantages in cognitive function, specifically mathematics, acuity and reaction time (the majority of these studies were with adult subjects). Other studies have been conducted with children to determine whether training in perceptual motor skills, such as balance and eye hand coordination, can improve academic and cognitive performance. In a review of 180 studies, Kavale and Mattson (1983) concluded that any effects on

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academic or intellectual functioning were very small and not commensurate with the time devoted to the training.

Shephard (1997) examined research conducted on the potential academic benefits of participation in physical education. One was a study conducted in France in the 1950's in which physical education time was increased to eight hours per week, while academic instruction was reduced. Control schools maintained the traditional curriculum time distribution. Children in the experimental schools appeared to benefit more than children in the control schools in terms of physical health, psychological health and academic performance. However, it was found that the programme for children in the experimental schools had included daily naps and vitamin supplements, which compromised the value of the research.

Shephard (1997) also examined two other studies conducted in the 1970's. One study conducted in Canada showed improvements in fitness, psycho-motor abilities and marks received in academic classes for children who participated in a physical activity programme. Another study conducted in South Australia found no impact on academic marks until two years later. These studies are encouraging but inconclusive regarding the effects of participation in physical education on academic performance.

Sallis, McKenzie, Kolody, Lewis, Marshall and Rosengard (1999) specifically examined the SPARK (Sports, Play and Active Recreation for Kids) programme. The SPARK programme is a comprehensive approach designed to promote physical activity in and out of school. The programme is taught throughout the fourth and fifth grades (ages 9-11), and consists of three interdependent curricula. The physical education curriculum teaches activity skills and provides physical activity for all students during class. The self management curriculum promotes physical activity outside of school and the professional development curriculum trains classroom teachers in the "Trained Teacher" condition to implement the two curricula for their students.

Sallis et al. (1999) found that spending more time in physical education did not have harmful effects on standardised academic achievement scores, and that

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there was some evidence that the 2-year SPARK programme had several significant favourable effects on academic achievement. The pattern of scores does not support the hypothesis that physical activity alone enhances academic performance. Field, Diego and Sanders (2001) did find that enhancement when they administered a questionnaire to 89 high school seniors and found significant evidence that students with a high level of exercise had better relationships with their parents, were less depressed, spent more time involved in sport, used drugs less frequently and had higher grade point averages than did students with a low level of exercise.

Physical Activity and Intelligence

Of particular importance in the exercise-cognition literature is understanding the type of cognitive task that is most likely to be impacted by exercise training history. Intelligence has been broadly classified and studied as either "fluid" or "crystallised" (Dustman, Emmerson & Shearer, 1994). Fluid intelligence is reflected in tasks that require attention-demanding, step-by-step problem solving. Because fluid intelligence is supported by neurological structures that deteriorate due to aging and inactivity (Dustman et al., 1994), physical activity interventions affecting these structures are considered to be important in efforts to maintain and even enhance fluid intelligence.

According to Dustman, Emmerson, Ruhling, Shearer, Steinhaus, Johnson, Bonekat and Shigeoka (1990), research has consistently demonstrated that a high fitness status is generally related to better performance on fluid intelligence tests. They believed that aerobic exercise can have a positive influence on fluid intelligence. Aerobic activity is associated with improved neuropsychological functioning and increased neurotransmitter levels, both of which hypothetically support enhanced brain functioning and potential resources for effortful task performance. They found that rodents raised in an enriched environment with a variety of toys and food, grew to perform better than those who receive food and water but no stimulation. Part of their superior performance was related to plasticity, the ability of the brain to adapt or change in response to demands of the environment. As the rodents played with their new toys, an increase occurred in the number of connections between their neurons. Kemperman, Kuhn and Gage

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(1997) showed that significantly more new neurons exist in the dentate gyrus of rodents exposed to an enriched environment. There are many studies that have shown that, at least in rats, complex or enriched environments increase brain size and weight as well as the number of synapses per cortical neuron. This work dates back to the 1960s (Bruer, 1998).

Crystallised intelligence is reflected in overlearned knowledge (such as vocabulary) that is automatic and reletively low in cognitive demand. With the absence of disease and the presence of adequate health, crystallised intelligence should improve with formal and informal education. Aerobic exercise is not thought to impact on crystallised intelligence (Dustman et al., 1994).

Openness to experience has been examined with respect to both general intelligence and as it relates to fluid intelligence (Lochbaum, Karoly & Landers, 2002). Open individuals are characterised by curiosity about both inner and outer worlds and are believed to be more willing to entertain novel ideas. Because of their openness to novel experiences, these individuals are hypothesised to perform especially well on tests that require flexible and original thought. The research completed by Lochbaum et al. (2002) examined the relationship between exercise and fluid intelligence, taking into account the role of openness to experience. The results supported their predictions that active participants, compared to inactive participants, initially performed significantly better on the fluid intelligence task and that openness to experience was significantly related to fluid intelligence performance. They also found that the combination of exercise and openness accounted for a greater percentage of fluid intelligence performance than any single variables.

Physical Activity Programmes for Children

Gabbard (1998) suggested that physical activity may be a strong determinant in early development of many brain functions, not just in motor control. He advised that for physically rigorous movement experiences to be of maximum benefit, they should be introduced early in life and within certain “windows of opportunity”. Gabbard (1998) noted that patterns of natural development include certain “windows” that are optimal time to experience certain effects. For basic motor

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skills, the window for optimal learning appears to be from the prenatal period to around the age of five. He recommended that learning basic gross motor activities starts before the age of two. The child should be provided with a flood of sensory motor experiences.

Bruer (1998) stated that during a child's early years, synapse formation outpaces synapse elimination, but that this process was primarily under genetic control rather than experience-driven. He looked at the temporal relationships between the period of rapid synaptic proliferation and when sensory, motor and memory skills emerge and concluded that there was no known simple, linear relationship between synaptic densities and synaptic numbers on the one hand, and intelligence, the maturation of our sensory, motor and memory skills, and the ability to learn on the other hand.

McCune (1990) discovered that linguistic naming (the use of conventionalised words to name objects) only emerges after the child has acquired certain motor movements. First of all the child must have acquired what McCune calls "vocal motor schemes (VMS)". The VMS are defined as at least 10 observed instances of the child using the identical articulated consonantal syllable sound over a 3-month period. The VMS therefore, are a tendency to make and repeat similar speech movement. VMS plus pretend play are necessary, but still not sufficient. The final component necessary for the development of naming is also related to movement. Early in the first year infants will grunt while expending effort. By the middle of the first year, these grunts become communicative, they express effort to others. Only after infants acquired communicative grunts, VMS and pretend play (in any order of acquisition) does naming emerge. Fogel (1992) concluded that language is founded not only on cognition, but also on proprioception within the oral cavity, and the personally experienced linkage between self-produced sounds and self produced action. Perhaps the grunting is the first situation in which the infant can associate self-produced sounds with self-produced action, establishing the general concept that sounds can be related to actions, and can then be used communicatively.

Fogel (1992) presented in his article the outlines of a theory of how communication facilitates the development of movement which he calls a "dynamic interactionist perspective". According to this perspective, the development of movement arises out of:

1. The identification and regulation of those parameters whose changes affect the quality and quantity of movement, and

2. The identification of the information required to co-ordinate perception and action.

Fogel (1992) used the dynamic systems approaches to movement organisation and proposes that movements are assembled from components that are loosely linked, none of which carries an explicit code for the final macroscopic form of the movement. Movements are therefore self-organising, emergent from the constraints imposed between the elements of the system as they interact with each other. Since no single component carries the instructions for the movement and since the movement as a whole has no prior schematic encoding, the main organiser of the movement is a set of parameters linking together the elements of the task, and both the physical and informational aspects linking those elements with relevant aspects of the context.

Sensory Motor Development

Cheatum and Hammond (2000) wrote a highly practical guide to sensory motor development in which the reader is taken on a child's journey through motor development. This journey starts with a newborn baby who moves and sleeps a lot. When he moves, he moves his whole body at the same time and through interaction with the environment, he progresses from global movements to cross lateral movement patterns that are found in creeping, crawling and walking. Homologous creeping and crawling is like rabbit hopping, both arms move forward and then the two legs follow. In homo-lateral creeping and crawling, the baby moves the arm and leg on the same side forward, and then moves the opposite limbs forward. Cross lateral creeping and crawling precede the movements a child will use in walking. Here the baby's right arm and left leg move forward together, as the left leg and right arm move back in opposition.

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Cheatum and Hammond (2000) stated that "some children never progress to the cross lateral stages but instead remain frozen at a stage in which both arms and legs were used together or first one side of the body moved and then the other" (p.21). A child that is "frozen" in one of these stages may, for instance, may have trouble playing catch. In the stage of development in which all four limbs are used together (quadrilateral movement), one leg and both arms move toward the ball - the other foot is planted on the ground. This makes his body collapse in the middle. If you would throw a ball to a child who favours bilateral movements (both arms and both legs must be used together), he may move to one side in order to use both hands, or there may be associated movements in the non-catching hand.

A quadrilateral movement during a kick looks like the child is swinging both legs and arms toward the ball whilst his rear end retreats. This often results in falling. Other children with learning problems seem locked in the stage of development in which both arms or both legs have to be used together. These are the same children who consistently used their two arms together and then their two legs when they were creeping and crawling. This pattern became so ingrained in their systems that catching a ball or writing without the opposite hand moving is difficult for them. Both limbs do not necessarily do the exact same movement. As children with bilateral movements try to use one hand, trace movements in their opposite hand may occur. Children who favour bilateral movements have some major problems. For instance, they have trouble developing right and left side awareness, preference for one side of the body, and cross lateral movements. The relationship between sensory motor problems and learning/school performance problems has led to the recommendation that participation sensory motor development programmes become an integral part of preparation for school (Cheatum & Hammond, 2000).

Reflexes

Reflexes are involuntary movements that are made in response to a stimulus. The stimulus may be as varied as an infant's position, a movement of the head or a touch on the cheek. Eventually, voluntary movements and motor skills replace many of these reflexes. At two months, for instance, an infant should automatically grasp and hold a finger placed in the palm of her hand (the palmar

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grasp reflex). By six months he should have the motor skills to voluntarily grasp a toy and to release that toy to pick up another. Retaining primitive reflexes however, can interfere with a child's learning to roll over, sit up, crawl, creep and walk.

There are four primitive reflexes that commonly affect learning and behaviour problems. Two are labyrinthine reflexes that are triggered by the position of the head in relation to gravity: the prone and supine tonic labyrinthine reflex (TLR). Integration of the TLR prone must occur in order for the child to gain the skills and strength necessary to lift any part of his body off the ground when prone. Retention of the reflex past the first several months will result in difficulty in any movement against the pull of gravity, including sitting, rolling over from stomach to back and standing. Integration of TLR supine must occur before a child can roll over from his back to his stomach or perform the first goal directed movement, reaching. Older children who have some carryover from the TLR may have trouble doing any movement or academic activity that requires them to move the body or a limb against the pull of gravity. Some children can remain in an upright sitting position only for a short time before collapsing. Other children seem to sprawl across the desk with their head on their arms when they are writing or reading (Cheatum & Hammond, 2000).

The two other primitive reflexes act on receptors in the neck: the symmetric and asymmetric tonic neck reflex. These reflexes are seen as infant exercise programmes to gain skills and strength. The stimulus for the asymmetrical tonic neck reflex (ATNR) is turning the child's head, which acts on receptors in the neck. This causes the arm and leg on the same side as the turned face to straighten (extend), while the arm and leg on the other side bends or flexes (Cheatum & Hammond, 2000).

Some children retain traces of extension on the face side and traces of flexion of the skull side until they are eight years old. However, excessive retention of the ATNR interferes with creeping, crawling and walking. This becomes obvious when a child starts to creep. When he looks toward one side, the ATNR will cause that side to extend, but the other side will flex, causing him to collapse. The ATNR also prevents a child from using two hands to do any activity such as catching a ball, or from using one hand to throw a ball. As he looks at the ball, the arm on that side extends. This prevents him from being able to bend the elbow in preparation for the throw. The only way this child could throw a ball is not to look at the ball. Yet, we all tell children to look at the ball! In an older child, retention of the ATNR may interrupt classroom activities, especially writing. Every time he looks at the pencil, there is a slight extension of the arm. When he looks away, the arm flexes. This creates a back and forth action on the pencil, which results in poor penmanship. To counteract this reflex, children with retention of ATNR usually try to look away from the writing area and view the pencil only out of the corner of their eyes or they hold their head with the opposite hand. The child appears to be just resting his head in hand, but in fact, he is using a technique that helps him write (Cheatum & Hammond, 2000).

Children with specific reading difficulties have problems that extend beyond the range of underlying language-related deficits (e.g., they have difficulties with balance and motor control). McPhillips, Hepper and Mulhern (2000) investigated the role of persistent primary reflexes (which are closely linked in the earliest months of life to the balance system) in disrupting the development of reading skills.

A particular focus of this study was the asymmetrical tonic neck reflex (ATNR). As we have seen above, this reflex is elicited by a sideways turning of the head when the baby is supine. The response consists of extension of the arm and leg on the side to which the head turns, and flexion of the opposing limbs. The ATNR is involved in the orientation of the neonate and, because the reflex is present when near-point fixation is developing, it has an important role in visuo-motor development. This reflex should be inhibited at around 6 months of age, and persistence is a clinical indicator of abnormal development. Early movements are now viewed as interactive, that is, having a reciprocal effect on the underlying structure and function of the central nervous system. Thus, the rehearsal and repetition of primary-reflex movements may have a part in the inhibition process itself. McPhillips et al. (2000) examined the effects of a specific-movement programme, which replicates the reflex movements of the primary-reflex system, on the inhibition of persistent primary reflexes, specifically the ATNR, and the educational performance of a clearly defined group of children with reading difficulties. The results suggest that the repetition of primary-reflex movements plays a major part in the inhibition of primary reflexes and that inhibition can be brought about at a much later stage in development than is generally accepted. The results confirm that the effects of persistent primary reflexes (in particular the ATNR) extend beyond the obvious disruption of motor development into cognitive areas. The reading gains achieved by the experimental group in this study are clinically significant.

The other primitive reflex which acts on receptors in the neck is the symmetric tonic neck reflex (STNR). As a child's head is bent forward (toward the chest) his arms will flex and legs extend. When the child looks up, his arms extend and legs flex. It helps to remember that the arms will do the same type of movement as the head, while the legs do the opposite of the head and arms. The STNR is active during the fourth to the seventh months and is yet another type of exercise programme for infants. This particular reflex develops strength and coordination; strength is needed in a child's arms and legs in preparation for creeping and crawling, coordination enables him to develop the ability to use both arms or both legs together for purposeful activity, replacing the random arm and leg movements of an infant. Retention of the reflex after eight months however, causes some problems. Children are unable to progress to activities in which they use the arms separately or in opposition. When attempting to creep and crawl they may have to use both arms to pull the body forward, and then push with both legs (homologous creeping and crawling). This action resembles an inchworm's scooting or a rabbit's hopping. One of the biggest concerns is that retention of the STNR will restrict a child to mostly bilateral movements, that is, he will be unable to use one arm without some movement of the other arm (Cheatum & Hammond, 2000).

Some gymnastic movements are particularly difficult to perform, e.g. a forward roll. Another problem that arises from the retention of STNR is the inability to perform oppositional movements. This is a skill in which one side of the body must do a movement that is the opposite of the other side's. Lacking this skill is the reason why some children cannot open lids that twist off, including those on pop bottles or juice cans. Even cutting food with a knife and fork requires the hands to do

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different motions and is beyond the skill ability of these children. They also find it difficult to use one hand to hold the writing paper steady while trying to write with the other hand.

Body Awareness

An important part of sensory motor development is body awareness, This awareness refers to a range of concepts, such as:

- Body image - self image,
- Body concept - knowledge of body parts,
- Body schema - kinaesthetic awareness,
- Laterality - knowledge that there are two sides to the body,
- Lateral preference - being able to use one side of the body more proficiently than the other,
- Midline - reaching across the body,
- Directionality - right and left, up and down, before and behind.

Problems in any of the above concepts affect motor development one way or the other (Cheatum & Hammond, 2000). Body schema problems, for instance, may show up in a child's movement and activity. Children with schema problems have trouble with coordination, which spills over into an inability to play activities and sports with peers. A child who has problems with laterality, will have trouble with the concepts of reading and writing from left to right. Even understanding many of the academic and physical education instructions will be difficult. A child who has developed lateral preference will have a different feeling in the side of the body that he favours. This innate feeling enables him to automatically know which hand, foot or leg to use for a particular academic or motor task. Children who have not established lateral preference have difficulty using the non preferred hand to assist the other.

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Cheatum and Hammond (2000) stressed that once a child has developed a well defined sense of laterality and knowledge of the body, he/she can build directionality. During this developmental step, the youngster transfers knowledge of the right and left sides of the body into space. Directionality involves three references: right and left, up and down, and before and behind (in front of and in back of, or forward and back). A child first learns all three of the directional references in relation to his/her own body, and then projects this knowledge into space and onto other objects. Knowledge of directionality allows a child to feel like the centre of the universe.

Children learn visual constancy through experience in the environment. Perceptions of common objects become constant. That is, a chair is a chair, even if it is upside down or on its side, or represented by a picture in a book or image on the TV screen. Constancy is challenged when children start to learn the alphabet. When you look at the letters p, q, b and d, the letters all appear to be similar, except for facing different directions. Teachers talk about the straight line going in one direction, with the rounded part facing another direction. Children who can discriminate between shapes and directions begin to understand what the teachers are talking about - but those who cannot discriminate have difficulty progressing with reading (Cheatum & Hammond, 2000).

Eye hand coordination

The inclusion of eye hand coordination activities in a sensory motor development programme focus on the development of handedness as well as visual skills. Bradshaw et al. (1993) provided some insight into the historical context in which "handedness" has been considered:

> The fact that left-handers have everywhere always been very much in the minority may account for the denigration of sinistrality. Indeed, pejorative associations with sinistrality are almost universal (the term itself, associated with 'sinister', not excepted) (p. 7).

Thus it is no accident that 'right' also means 'correct' in many languages. In many cultures, the left is the 'unhygienic' hand. The political left and right date from the pre-revolutionary French assembly where aristocrats sat on the right and the peoples' leaders sat on the left - the left and the right wings.

Participation in locomotor activities is important for the development of visual skills that will ultimately contribute to eye hand coordination. According to Haehl, Vardaxis and Ulrich (2000), cruising represents one of the short-term solutions to locomotion discovered by infants. By definition, cruising is walking with support. Usually the steps are sideways, rather than forward, enabling the infant to use both arms and legs for support and control. Infants typically acquire this skill after they learn to crawl and before they walk independently, near the end of the first year. Cruising is an important behaviour because it enables the child to learn about the flow of perceptual information in the upright posture, and it provides opportunities to improve strength and postural control.

When infants cruise, they have added support for their thorax via their arms. Multiple biomechanical linkages created by muscles and joints in the shoulder girdle, spine and pelvic girdle assist in stabilising movements between the arms and thorax, the thorax and pelvis, and between the pelvis and lower extremities. As infants discover more effective solutions to control and co-ordinate their bodies, they reduce the use of their arms for support. At the onset of independent walking infants have sufficient control and coordination of the thorax and pelvis to allow medial–lateral weight shifting, forward propulsion, and single limb stance.

Haehl et al. (2000) predicted that the developmental patterns infants demonstrated when learning to cruise and walk would reflect the process Bernstein (1967) proposed for adult learning. Bernstein's idea was that skill acquisition proceeds from, freezing degrees of freedom to freeing degrees of freedom in order to explore differentiated patterns of movement or synergies, and eventually selecting the most efficient or economical movement patterns. They believe, however, that when truly novel or very difficult tasks are being learned an additional phase may occur at the onset of practice. They call this the "wobble phase". This would occur before infants had sufficient control to freeze the degrees of freedom. For newly cruising infants, this diminished ability to control the joints would result in wobbling movements of the thorax and pelvis, and limited motions of the arms and legs (lifting only one arm or leg at a time).

Eventually, the infants would be able to sufficiently control the joints to freeze the degrees of freedom moving the thorax and pelvis en bloc. This "frozen phase"

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would result in improved stability in the trunk and allow infants to begin to lift an arm and a leg simultaneously. During a "freeing phase" infants would free the degrees of freedom and explore a variety of movement patterns. Eventually, as infants become skilful cruisers, they would discover economical preferred movement patterns. Improved trunk control would allow infants to spend a larger percentage of the cruising cycle lifting an arm and leg simultaneously. This leads the infant toward complete freedom from arm contact with the support surface and, thus, independent walking. At the onset of independent locomotion, the increased demands of the new task would require the infant to once again attempt to bring the degrees of freedom under functional control, resulting in moving the thorax and pelvis en bloc (Bernstein, 1967).

Sensory-motor development programmes aimed at the development of eye hand coordination, then, must not only consist of activities where throwing, catching and aiming are involved, but also must attend to the development of handedness and the inclusion of locomotor activities that will contribute to the development of underlying visual skills.

Static and Dynamic Balance

The vestibular system is the sensory system considered to have the most important influence on the other sensory systems and on the ability to function in everyday life. It is the system that modifies and co-ordinates information received from the visual, proprioceptive, auditory and tactile systems. Without an individual being conscious of it, the vestibular system informs the nervous system where it is in relationship to the pull of gravity so that the person can maintain equilibrium. The vestbular system has a strong influence on the muscles that control posture. We often take postural muscle control for granted, but a child must have the automatic control of his or her skeletal muscles in order to sit or stand still. The youngster must be able to stabilise the body to move an arm, hand, leg or foot independently during fine and gross motor activities (Cheatum & Hammond, 2000).

The proprioceptive system plays a key role in helping a child maintain equilibrium, progress through the motor development stages, and later perform complex motor

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skills. This applies to both static and dynamic balance. Proprioceptive applies to the actual awareness of sensations that come from receptors in the muscles, joints, skin, tendons and underlying tissue. The system acts in co-operation with the vestibular and visual systems, to keep his body upright and balanced. These three systems are so intricately related that when one system is not working, the other two systems can provide sufficient information to the brain to keep the body in an upright position.

Lack of the ability to use the proprioceptive system effectively results in clumsy or unco-ordinated movements, and it has been associated with low academic achievement. These children fall a lot, touch other students, run into walls and have difficulty participating in games with other children. Typically, a proprioceptive problem is related to body awareness, laterality or directionality or to some combination of these concepts (Cheatum & Hammond, 2000).

Summary

From the literature it can be concluded that the importance of school readiness is commonly accepted. In order for a child to become ready for school, both the parents and the teachers need to be involved and communicate with each other. As far as teaching methods are concerned, the teachers would either use the child directed model or the academically directed model as suggested by Marcon (1999). Following Bernstein's (1967) recognition that a specific movement can be produced by a variety of underlying muscle contraction patterns and that a particular set of muscle contractions does not always produce an identical movement, it is important that children, from an early age, are exposed to as many different movements as possible. The sensory motor development of a child would benefit from this exposure, more connections between neurons would be created and school readiness could be enhanced.

This literature review has provided a multitude of inspiring insights, which have added substance to the intervention programme and provided explanations for the results.

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Chapter Three

Methodology

This investigation examined the effects of a sensory motor development programme on some of the physical and perceptual variables that underlie school readiness among five and six-year old children. Included in this chapter are the design of the study, a description of the tests and observations used to gather insight into programme planning, a description of the intervention programme and a description of the analysis of results.

Design

The design followed was experimental, with two experimental groups and one control group. The reason for two experimental groups was because two separate classes of pre-primary children were exposed to the intervention programme. These two classes were at the same school. The control group was identified in another school in the same community. The two schools were almost next to each other and were selected because they both followed a South African school readiness programme (Wentzel, 1989).

Procedures

Selection of Subjects

The headmaster of the experimental groups' (n=79) school was approached and asked if he would be willing to incorporate the sensory motor development programme as an integral part of the pre-primary curriculum. He was enthusiastic and asked the two pre-primary teachers, who were also keen to include the additional instruction as part of their yearly programme.

The headmaster of the control group (n=23) school was approached and asked if he would be willing to allow his pre-primary children to take the pre-test at the beginning of the year and the post-test at the end of the year. He and his teachers were also enthusiastic because they were interested in the results of the research.

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Selection of an Assessment Instrument

Henderson and Sugden's (1992) Movement Assessment Battery for Children (M-ABC) was used to assess the children's manual dexterity, eye hand coordination, static balance and dynamic balance. These are the four variables that were proposed to underlie school readiness.

The M-ABC is a test battery that has proven to be reliable in a variety of settings. It was developed to identify children with the kinds of coordination difficulties that are often associated with learning problems in school. The Movement Assessment Battery for Children (M-ABC) was developed by Henderson and Sugden (1992) and is the result of a process that began in 1966. It is a formal standardised test and provides both a quantitative and a qualitative evaluation of the child's motor competence in daily life across a wide range of motor skills. The M-ABC consists of four age-related item sets. Each set is built up of eight items that measure different aspects of motor competence: three items measure manual dexterity, two items measure ball skills (eye hand coordination), one item that measures static balance and two items that measure dynamic equilibrium. Children can score between 0 and 5 on each item. The M-ABC relates well to a number of other instruments designed to measure similar constructs. A deeper understanding of the M-ABC is necessary to justify its selection for use in this research.

Rationale for Using the Movement ABC Test Battery

The M-ABC is the preferred assessment instrument for the identification of children with Developmental Coordination Disorder (DCD). This term was introduced by the American Psychiatric Association (1987) to describe a developmental disorder of movement skill, or children formerly described as being "clumsy." The motor coordination difficulties of these children are sufficiently severe that they affect daily activities at home and school. In children with DCD, the connection between structural abnormalities of the brain and motor dysfunctions is rather ambiguous and indications for pre- and perinatal brain damage can be found in one third of the children with minor motor dysfunctions. The motor problems of the remaining majority of "clumsy" children may be based

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on dysfunctions at the microscopic level of the nervous system, such as abnormalities in the neurotransmitter or receptor system (Hadders-Algra & Groothuis, 1999).

The American Psychiatric Association (1994) defined DCD as "... a marked impairment in the development of motor coordination ... (which) significantly interferes with academic achievement or activities of daily living in the absence of any medical explanation ..." (p.53). Children with DCD may display deficiencies in the processes of selection as well as motor execution. Selection can be hampered by impairments in the processing of proprioceptive, tactile or visual information. According to Hadders-Algra (2000), they are hampered by two problems:

1. A limited repertoire of motor strategies.
2. Impaired sensory processing which interferes with the process of selection of the best motor solution for specific motor tasks.

This would imply that children with DCD have difficulties in adapting their motor behaviour accurately to specific conditions, like adjusting the force of their fingers during object manipulation or adapting the velocity of a reaching movement.

Dewey, Wilson, Crawford and Kaplan (2002) investigated the problems of attention, learning and psychosocial adjustment evidenced by children with DCD. Parents of children with DCD reported that their children had more difficulties attending to and concentrating on tasks. In terms of learning problems, the children with DCD displayed significantly poorer performance on measures of reading, writing and spelling. These findings suggest that children with DCD are more likely to have learning problems in a number of different academic areas. Thus, children with DCD are at significant risk for school failure, and intervention in both motor and academic areas may be essential to improve academic outcomes in this population. Powell and Bishop (1992) supported this perspective:

> It seems more likely that a wide range of learning disabilities can be caused when early development of the brain is disrupted, but the specific pattern of cognitive deficits will depend on the extent and the location of the underlying neurological abnormality. (p. 762)

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Hoare (1994) and Wright and Sugden (1996) attempted to identify "sub-types" within DCD by seeking out clusters of children who shared similar characteristics and distinguished five different subgroups. In their analysis of clinical trial data, Macnab, Miller and Polatajko (2001) refined the 5 different subtype profiles of DCD.

- The first subtype included children with better gross motor than fine motor skills, although both were still below normal. Standing balance and visual-perceptual skills were both within normal ranges.
- Children in the second subtype scored high on measures of upper-limb speed and dexterity, visuo-motor integration, and visual-perception skills, but they demonstrated poor performance on measures of kinesthetic ability (accuracy in discriminating movement and position of the upper limbs) and balance.
- Children in subtype three had difficulty with both kinesthetic and visual skills.
- Children in subtype four performed well on kinesthetic tasks but demonstrated poor performance on tasks requiring visual and dexterity skills.
- Children in subtype five demonstrated poor performance on measurements of running speed and agility compared with their peers with DCD. However, they performed well relative to their peers with DCD in the tasks involving visual-perception skills.

In Kadesio and Gillberg's (2001) study, 818 children with DCD were tested for reading comprehension at age 7 years and then again at age 10 years. A positive correlation in poor reading comprehension existed for children with DCD at 7 and 10 years of age. A follow-up study was conducted on 22-year-old individuals (N=55) who at age 7 years had either DCD or attention-deficit/hyperactivity disorder (ADHD), or both (Rasmussen & Gillberg, 2000). The children with DCD and those with both DCD and ADHD had poorer outcomes than their similarly aged peers without DCD and children with ADHD only. The children with DCD

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and those with both DCD and ADHD were found to have had more criminal offences, more incidences of substance abuse and other psychiatric disorders, and lower levels of schooling.

Johnston, Burns, Brauer and Richardson (2002) also recognised DCD as a condition characterised by significant functional problems in motor skill. Poor upper-limb coordination is a common problem for children with DCD and poor postural muscle function is a hypothesised contributor to this problem. This study investigated postural muscle function in muscle groups of the shoulder and trunk and resultant arm motion in children with DCD. Results showed that children with DCD took significantly longer to respond to visual signals and longer to complete the goal-directed movement than children of the same age who did not meet the criteria for DCD. Children with DCD also demonstrated altered activity in postural muscles that function to provide a stable basis for the movement. In particular, posterior trunk muscles and three of four shoulder muscles demonstrated early activation, whereas anterior trunk muscles demonstrated delayed activation. In children with DCD, anticipatory postural activity was absent in three of four anterior trunk muscles. These differences supported the hypothesis that in children with DCD, altered postural muscle activity may contribute to poor proximal stability and poor arm movement control when aiming for specific targets.

Zoia, Pelamatti, Cuttini, Casotto and Scabar (2002) found that children with DCD appeared to have two main problems:

1. Difficulty integrating information deriving from different sensory systems (hearing, kinetic, touch, vision) into a stable motor representations.

2. Difficulty using verbal input.

It was found that better use could be made of visual information than of verbal information for recalling correct gestural planning from motor memory, as was also shown in normally developing children. Kinaesthetic information alone can also be used to reproduce a gesture but the imitation modality might require a lower memory code. Whereas when kinaesthetic, tactile, and visual information needed to be integrated the retrieval of a gestural representation was always limited. In these children, verbal access to gestural representation remained severely limited

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too, suggesting that the implementation of symbolic gestural representations is more difficult when there is also an underlying deficit in forming integrated gestural representations based on tactile, kinaesthetic, and visual information.

Handwriting requires a high level of coordination and high precision force regulation and children with coordination disorders lack the normal redundancy in movement strategies. Not surprisingly, writing problems are frequently mentioned symptoms in children with DCD. Smits-Engelsman, Niemeijer and van Galen (2001) found that children with poor handwriting are most typically characterised by spatially inconsistent motor behaviour and by fine motor deficits.

Jongmans, Smits-Engelsman and Schoemaker (2003) stated that the two most commonly mentioned comorbid disorders of DCD are attention-deficit/hyperactivity disorder (ADHD) and learning disabilities (LD). For example, the rate of comorbidity between DCD and ADHD has been reported to be approximately 50% and estimates for the rate of comorbidity between DCD and LD are of a similar magnitude. In the past, the term deficits in attention, motor control, and perception (DAMP) has been applied to describe children with a combination of DCD and ADHD (Landgren, Kjellman & Gillberg, 1998). Moreover, the three conditions (DCD, ADHD and LD) frequently show comorbidity (Dewey, Wilson, Crawford & Kaplan, 2000).

Summary of the M-ABC

In summary, DCD is often associated with problems in attention and learning. In addition, these children frequently have difficulties in social relationships. This suggests that children with DCD frequently display other disorders of development. One of the most common problems experienced by children with DCD is difficulty with skilled upper-limb movements. Skilled movement is characterised by precise control of voluntary movement initiation, execution and completion. Accompanying skilful voluntary movement are postural adjustments, complex patterns of postural muscle excitation and inhibition, which contribute to the efficiency of task performance. Postural muscle activity controls the position of the body in space, for the dual purpose of stability and orientation (relationship of body segments and environment) (Shumway-Cook & Woollacott, 1995). Postural

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muscle activity provides a foundation for movement and is an important part of the neuro-physiological mechanism that underlies motor coordination. The relationship between the problems associated with DCD and the concept of "school readiness" is proposed to be in some of the common underlying variables that are measured in DCD assessments (Henderson & Sugden, 1992) and are cited as critical physical and perceptual components of school readiness (Wentzel, 1996). Based on this association, the M-ABC was chosen as the method for assessing manual dexterity, eye hand coordination, static balance and dynamic balance.

Pre-test

The pre-test was administered to all children in the experimental groups over a two week period at the beginning of the intervention. The children in the control group were tested in the week after. The procedures followed were those described by Henderson and Sugden (1992). Eight different test "stations" were set up in a class room and the children moved from station to station. On two days, sport science students helped with the testing.

Approach Adopted in the Intervention Programme

Treatment approaches used by occupational therapists and physical therapists can be broadly categorized into either bottom-up or top-down approaches. Bottom-up approaches are based on hierarchical theories of motor control. These theories tend to explain the remediation of motor dysfunction through activation of higher levels of neuronal functioning in a child. The bottom-up approaches frequently used in managing children with DCD are sensory integration, the process-oriented treatment approach, and perceptual motor training (Mandich, Polatajko, Macnab & Miller, 2001). In sensory integration therapy, the child is provided sensory stimulation designed to promote motor development and higher cortical learning. A child undergoing sensory integration therapy may show some gains in motor development, but these gains often do not generalize to functional skills.

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Top-down approaches typically use a problem-solving approach to motor skill development and have been greatly influenced by the dynamic systems approach to motor learning and control. This approach suggests that motor skills develop from an interaction of many systems, both internal and external to the child (Mandich et al., 2001). Top-down approaches also emphasize the context in which motor behaviour occurs. Task-specific intervention and cognitive approaches or strategies are the two most commonly used.

The Neuronal Group Selection Theory can provide a framework for interpreting the differences in reported outcomes among the various approaches. While children with moderate to severe cerebral palsy (CP) have a limited repertoire of primary neuronal networks, which guide crude, non-specific movements, children with DCD are believed to experience difficulty at the level of secondary variability, that is, in selecting and reinforcing the most efficient and effective pathways for a given situation (Hadders-Algra, 2000). During normal postnatal development, experience plays a primary role in the neuronal group selection process that establishes the circuitry necessary for efficient, goal-directed and co-ordinated movements (Edelman, 1993). According to the Neuronal Group Selection Theory, this refinement of motor skill occurs during the stage of secondary variability as a combined result of trial-and-error exploration of neuronal groups, selection of specific neurons within each group, repetition of synaptic firing within and among neuronal groups, and sensory experience.

Functional synaptic connections, which act in parallel and involve cortical and subcortical structures, form following exposure to a variety of motor experiences. Formation of these connections is highly dependent on sensory information. Bottom-up approaches such as sensory integration, process-oriented treatment, and perceptual motor training emphasize sensory experience, with less emphasis on cognitive processing and cortically driven motor programming. Although an intervention based entirely on information processing may provide the experience necessary to select the most effective neuronal networks, bottom-up approaches may not provide sufficient opportunity for motor practice of cognitively initiated and goal-directed tasks in order to reinforce and establish these connections. Top-down approaches focus less on the specific impairments contributing to decreased

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coordination and more on the gestalt of coordinated movement, that is, the dynamic interrelationships among a number of CNS structures and systems and the environment within which the task is performed (Edelman, 1993).

Rationale for Providing a Sensory Motor Programme

The word "gesture" has been used in developmental studies to indicate the ability to execute a purposeful motor action and to use implements (Hill, 1998). In a study by Zoia et al. (2002), they concerned themselves primarily with the role of sensory-motor information in relation to conceptual knowledge. In their opinion, in addition to its role in controlling action during gestural production, sensory-motor information also plays an important role in planning. They also believe that perceptual and visual information, as well as information of a tactile and kinaesthetic nature, may have a primary role in gesture representation compared with lexical and semantic knowledge, especially in young children. They introduced the use of two additional modalities (visual and visual plus tactile) to test whether gestural performance in children with DCD could be explained in terms of difficulties of integration between different input modalities and motor representation. Their aim was not to make a specific contribution in evaluating the motor memory process but to add to existing knowledge about the kind of information needed to make gestural representation possible.

Framework of the Intervention Programme

The intervention programme covered two ten week periods. Each session consisted of a warm up, an aerobic component and a skills component. To give the children a feeling of routine and the chance to improve, the warm up and the emphasis of the aerobic component stayed the same in every session.

The sequence of focus and sample activities in the intervention programme in the first ten weeks was as follows:

Warm up (introduction to physical activity) - 10 minutes

Make a circle: bend knees and touch floor, stretch and touch sky (x10);
march in circle: slow, fast, faster;
jump on two legs, still in circle, moving forwards and back;

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hop on right leg, hop on left leg;

jumping jacks without arms, jumping jack arms only;

stretch

Aerobic component (awareness) - 10 minutes

This was based on different activities and interspersed with regular breaks. Use of rhythmic action, "mirror" activities, relay races. Children were especially made aware of the fact that their bodies felt different when exercising, i.e. check heart rate, notice breathing, sweating, etc..

Skills component (10 minutes)

Focus	Sample Activities
Week 1 and 2: Body awareness	All children lie down on the floor, all to lift right arm straight up, left arm, right leg, left leg, roll onto stomach to the right, push bottom in the air, roll onto back to the left, push stomach in the air, lift right arm and left leg, lift left arm and right arm. All children stand in a circle and hold hands: sit up at the same time, stand up at the same time.
Week 3 and 4 Body awareness, Primitive movement patterns	Divide children into two groups: first child to walk to other side on hands and feet, rolling ball forward with head, bottom in the air, legs straight. Children to sit in a line, team who finishes first with all children sitting neatly in a straight line, arms folded is the winner.
Week 5 and 6 Body awareness, Primitive movement patterns	Teach crab walking. Do it slowly, fast, exaggerated. Divide children in groups of five, stand in straight line behind each other. First child to crabwalk to other side of area with beanbag on stomach and back again, pass on beanbag to next child and join end of the queue.
Week 7 and 8 Spatial awareness	Use of force and direction. For instance, make a long snake across and all over the field. Spread legs, each child rolls ball between legs of child in front (or behind) and becomes head of the snake. Make sure legs are wide and straight and snake is not a straight line. Make space between children bigger every time. Week 8: make two or three snakes and race each other. Option: follow ball on hands and knees.
Week 9 and 10 Memory	Respond to external stimuli; one clap = take one step, two claps = two steps, etc. Whistle once = jump high, twice = touch floor, three times = jumping jack, etc.

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The sequence of focus and sample activities in the intervention programme in the second ten weeks was as follows:

Warm up (discipline and memory) - 10 minutes

In a circle: walk, make yourself small like a mouse, take small steps,
walk on your toes, make yourself as big as you can;
walk with your legs wide/narrow, arms wide/narrow;
walk "pretty", wiggle your bottom, make a pretty face;
run, big steps, small steps, swing arms, etc.
stretch

Aerobic component 15-meter shuttles (fitness and increased awareness) - 15 minutes

The children ran for 5 minutes between shuttles that were 15 meters apart on a rectangular concrete area. They ran one way as fast as they could, waited for all the children to finish and ran back doing different exercises, for example:

run one way, skip back, run, skip normal and with accentuated movements, run, shuffle right, run, shuffle sideways left, run, jog with big steps, run, jog four steps, run, two double leg jumps, run, dance with a friend.

Skills component - 15 minutes

Focus	Sample Activities
Week 11 and 12 Spatial awareness	Learning to bounce a ball, experience the effect of different size balls, different angles and speeds, throwing scarves, balloons.
Week 13 and 14 Body awareness	Run and kick heels against bottom or knees against hands, piggy back, crawl between other children's legs, wheelbarrow race.
Week 15 and 16 Memory	Counting and clapping; count to four, clap on one, clap on one and three, etc. Counting and stomping. Walking, counting and clapping/stomping. Sequence: jump on one, touch the floor on two, turn around on three, wiggle on four.

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Week 17 and 18 Spatial awareness	Hop scotch: divide children in groups of six, each group to have their own diagram. Meditation and relaxation.
Week 19 and 20 Spatial awareness	Circuit training in teams - five stations: push ups, sit ups, tricep dips, squats back to back with friend, jump over a pile of bricks.

Post-test

The post-test was administered to all children in the experimental groups over a two week period at the end of the intervention. The children in the control group were tested in the week before. The procedures followed were those described by Henderson and Sugden (1992). Eight different test "stations" were set up in a class room and the children moved from station to station. The tests were all done by the researcher.

Additional Formative Evaluation Methods

The children were timed and observed during a running activity which was done at the beginning of the intervention. The children were also observed crawling and doing a colours and counting activity. Before the winter break, in the middle of the intervention, the children played a Dutch game called Mini Loco. At the end of the intervention the Controlled Drawing Observation (Krogh, 1977) was used to get information about manual dexterity and the children were taken to a local arcade where they played a game called "Boppin' Bugs" in order to see how they applied their eye hand coordination abilities. These "test-like" experiences were used as formative evaluation to give the investigator insight into how the children were progressing in their learning.

Running

The children ran, one by one, around the penalty box of a football field with the corners marked off with hula hoops. Times were recorded.

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Crawling

The children were observed crawling on all fours and whilst walking on hands and feet in a controlled setting. Children whose crawling or walking on their hands and feet looked odd (use of hand and foot on same side of the body) compared to the rest of the group, were marked on a list and the observations were added to the "colours, counting and position" observation. More than two marks out of five meant that the child "needed help". Crawling was done indoors on one day and walking on hands and feet was done outside on a different day.

Colours and Counting

Each child was given a bowl of coloured beads and were told to put them on a board with nibs as follows:

- Take seven blue beads and make a line in the middle of the board,
- Take five red beads and make a triangle underneath the blue line,

- Take six green beads and make two triangles above the blue line,
- Take four pink beads and make a line above everything else,
- Take five beads, three purple and two yellow, and make a line next to everything else,
- Take another five beads, three purple and two yellow, and make a line next to everything else.

The children were tested in the classroom, three at a time and were scored on position, colour and counting.

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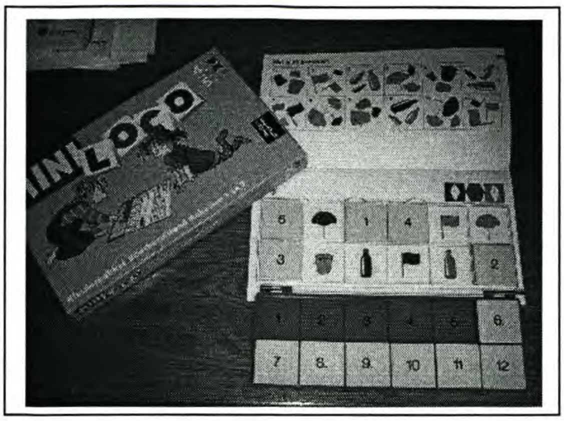

Mini Loco

Mini Loco is a game designed to help children learn to combine and discriminate and develop their reading and counting skills. The book is put down flat and the box with squares put open with the see-through lid over the bottom page with the answers (see picture). The child picks up square number one, looks at picture number one and puts the square on the corresponding answer. When all the questions are answered, they close the box and turn it around so that a pattern can be seen. The pattern that should be seen is in the right hand corner of the answers page.

The version used in this study was the "*kleuterpakket voorbereidend rekenen 1 en 2*" for four and five year olds (Wolters Noordhoff, 1997). Six arithmetic games were used in this study: 1. find the least, 2. find the most, 3. find the same one, 4. add up to five, 5. find the smallest and 6. find the largest. The disadvantage of the game is that when one error has been made, a second error follows automatically. So instead of using the actual game, the above six games were photocopied in colour and the children just had to point at the right answer, which was then recorded. A template was made so that the children could only see the picture that needed to be seen. The children were tested in the classroom, one at a time at the end of the second term.

Because the teacher of experimental group 2 had not dealt with adding up, the scores of the "add up to five" test were not taken into consideration. The most basic test was "find the same", children who made errors in that test lacked very basic skills. The next level was the "smallest" and "largest" test. All children were expected to be able to recognise the difference in size. The other two tests included being able to count.

All the results were tabulated and children with more than a total of six errors in the five tests were considered not school ready by the middle of the school year.

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Drawing Observation (Oja et al. 2002)

In their article on physical activity, motor ability and school readiness of 6-yr old children, Oja et al. (2002) used a test, based on the Controlled Drawing Observation (Krogh, 1977). The test has three parts: 1. preparation of the sheet of paper for drawing, 2. drawing mathematical figures and 3. drawing every day objects. The last two parts were differentiated according to the ideas of Vygotsky (1994) based on the differences between scientific and everyday concepts. There are 11 subtasks on the test. The instructions were as follows:

Preparation of the sheet of paper for drawing:

1. Ball: draw a small ball in the centre of the paper.
2. Corners: draw a line to one of the corners. Draw lines to all the other corners.
3. Sides: draw a line to one of the sides. Draw lines to all the other sides.

Drawing mathematical figures:

1. Lines: draw three lines in one of the boxes. The lines are not the same length.
2. Triangles: draw three triangles in the second box. The triangle in the middle is the smallest
3. Circles: draw four circles in the next box. Two of the circles are of equal size.
4. Squares: draw four squares in a row. The last square is the biggest.

Drawing everyday objects:

1. Tree: draw an apple tree in the next box. There are three apples in the tree and five on the ground.
2. House: draw a house. There are three windows and a door in the house. The roof is slanting. There is smoke coming from the chimney. Next to the house is a flag. The sun is shining.
3. Draw a human.
4. Draw a cat.

Subtasks 1 to 8 and 10 were coded on a 3-point scale; the draw-a-house subtask on a 6-point scale and the draw-a-cat subtask on a 2-point scale. Ratings criteria

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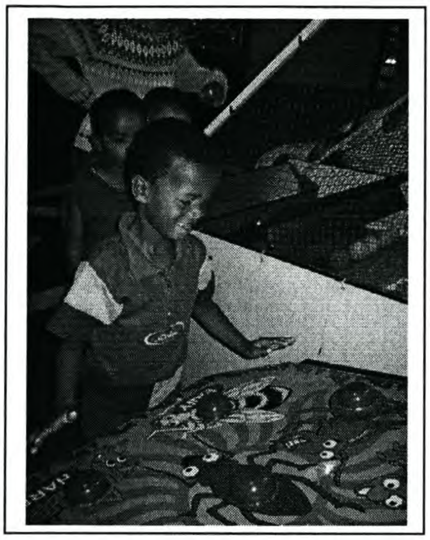
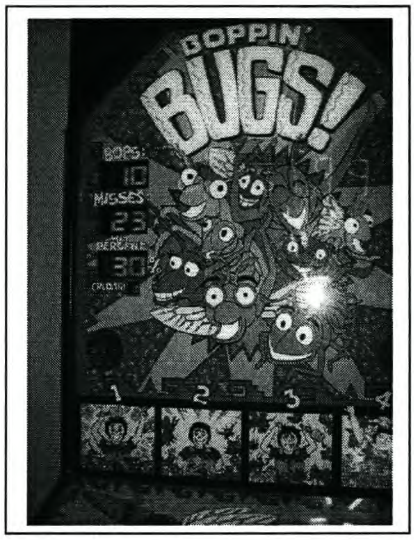
for draw-a-house were based on one point for every correctly drawn object in the sentence. All the scores were added up and the total was used to predict school readiness (maximum score 35).

Boppin' Bugs





This is an arcade game where seven buttons light up at different times. The children have to push the buttons down as they light up. The score was taken from the percentage of hits and used as an indicator for eye hand coordination. Although the children were very excited about going "on a trip" they all took it extremely serious. We also went early in the morning on a weekday so that the arcade was empty. The children were split into groups of five and each group had someone looking after them.

Data Analysis

To establish whether there were any significant improvements in the variables measured by the Movement Assessment Battery for Children, the *t*-test for small dependent samples was used to determine pre-post test differences within each group. The *t*-test for small independent samples was used to determine between group differences. The critical value of *t* was tested at the 0.05 significance level.

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Summary

The observations on crawling and hand and feet walking, the ability to draw triangles as well as counting, position and colour were used to provide an insight into the children's abilities. When added to the results of the adapted Mini Loco game it was expected to give a good impression of the children's progress on selected aspects of school readiness. It was hypothesised that the sensory motor development programme would achieve significant changes on the results of the M-ABC, which would indicate progress on some of the variables that underlie school readiness.

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Chapter Four

Results and Discussion

This chapter is divided into two parts. The first part contains the quantitative data (the results of the M-ABC) organised to answer the hypotheses. The second part contains insights that were gathered through observations and activities.

Quantitative Data

Hypothesis 1

1. There will be a significant improvement in children's manual dexterity following participation in a sensory motor development programme.

Significant improvements in manual dexterity were partially achieved.

Table 1. Manual dexterity mean results and standard deviations: girls and boys, pre- and post-test

	girls before		girls after		boys before		boys after	
	mean	*STD*	*mean*	*STD*	*mean*	*STD*	*Mean*	*STD*
Control	3.3	2.21	4.6	2.63	5.9	3.63	4.5	3.06
Experimental 1	3.31	2.29	2.23	1.59	4.77	3.14	4.46	2.76
Experimental 2	1.75	1.86	1.92	2.02	3	2.73	1.83	2.59

Table 2. Manual dexterity results for the girls: pre- to post-test comparisons (within groups)

group	t_{opps}	sig
Experimental 1, n=13, t_{crit}=1.782	2.42	✓
Experimental 2, n=12, t_{crit}=1.796	-0.31	*x*
Control, n=10, t_{crit}=1.812	-1.41	*x*

The improvement in the results of experimental group 1 was significant. None of the other improvements were significant.

Table 3. Manual dexterity results for the boys: pre- to post-test comparisons (within groups)

group	t_{opps}	sig
Experimental 1, n=13, t_{crit}=1.782	0.37	x
Experimental 2, n=12, t_{crit}=1.796	1.74	x
Control, n=10, t_{crit}=1.812	1.46	x

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It was found that all the boys improved but that none of the changes were significant.

Table 4. Differences between the manual dexterity results of girls vs boys: pre- to post-test comparisons (within groups)

	Before		after	
group	t_{opps}	sig	t_{opps}	sig
Experimental 1, n=26, t_{crit}=-1.714	-1.09	x	-2.19	✓
Experimental 2, n=24, t_{crit}=-1.717	-1.57	x	0.09	x
Control, n=20, t_{crit}=-1.745	-1.67	x	-0.09	x

When comparing the results of the girls to those of the boys, it was found that there was a significant difference between the results of the girls and those of the boys in experimental group 1.

Table 5. Manual dexterity results of each group: Pre-to post test comparison (within groups)

group	t_{opps}	sig
Experimental 1, n=26, t_{crit}=1.708	2.75	✓
Experimental 2, n=24, t_{crit}=1.714	1.13	x
Control, n=20, t_{crit}=1.729	0.07	x

As a group, only the improvement of experimental group 1 was significant.

Table 6. Manual dexterity results comparing the groups to each other

	before		after	
group	t_{opps}	sig	t_{opps}	sig
Experimental 1 vs Control, n=46, t_{crit}=1.680	-0.68	x	-1.63	x
Experimental 2 vs Control, n=44, t_{crit}=1.682	-2.86	✓	-3.51	✓
Experimental 1 vs Experimental 2, n=50, t_{crit}=±2.01	-2.25	✓	-2.03	✓

When the results of the groups were compared to each other, the results of experimental group 2 were significantly better than those of the control group and experimental group 1.

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Hypothesis 2

2. There will be a significant improvement in children's eye hand coordination following participation in a sensory motor development programme.

Significant improvements in eye hand coordination were partially achieved.

Table 7. Ball skills mean results and standard deviations (eye hand coordination): girls and boys, pre- and post-test

	girls before		girls after		boys before		boys after	
	mean	*STD*	*mean*	*STD*	*mean*	*STD*	*mean*	*STD*
Control	2.1	1.79	3.1	2.28	0.8	1.62	1.7	2.41
Experimental 1	1.77	2.28	2.46	2.67	1.92	2.84	0.77	1.92
Experimental 2	2	2.17	0.67	0.89	2.08	2.84	0.67	1.23

Table 8. Eye hand coordination results for the girls: pre- to post-test comparisons (within groups)

group	t_{opps}	sig
Experimental 1, n=13, t_{crit}=1.782	-1.14	x
Experimental 2, n=12, t_{crit}=1.796	2.19	✓
Control, n=10, t_{crit}=1.812	-1.79	x

It was found that the improvement in experimental group 2 was significant for girls.

Table 9. Eye hand coordination results for the boys: pre- to post-test comparisons (within groups)

group	t_{opps}	sig
Experimental 1, n=13, t_{crit}=1.782	1.26	x
Experimental 2, n=12, t_{crit}=1.796	1.86	✓
Control, n=10, t_{crit}=1.812	-2.21	x

The boys in experimental group 2 had a significant improvement in their results. Not only did they have the worst score to begin with, they had the best score after intervention.

Table 10. Difference between the eye hand coordination results of girls vs boys: pre- to post-test comparison (within groups)

	before		after	
group	t_{opps}	sig	t_{opps}	sig
Experimental 1, n=26, t_{crit}=-1.714	-0.25	x	1.99	✓
Experimental 2, n=24, t_{crit}=-1.717	-0.09	x	0	x
Control, n=20, t_{crit}=-1.745	1.36	x	1.24	x

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When comparing the results of the girls to that of the boys, the boys' results in experimental group 1 were significantly better than those of the girls.

Table 11. Eye hand coordination results of each group: pre- to post-test comparison (within groups)

group	t_{opps}	sig
Experimental 1, n=26, t_{crit}=1.708	0.67	x
Experimental 2, n=24, t_{crit}=1.714	2.88	✓
Control, n=20, t_{crit}=1.729	-2.8	x

As a group, only experimental group 2 had a significant improvement.

Table 12. Eye hand coordination results comparing the groups to each other

	before		after	
group	t_{opps}	sig	t_{opps}	sig
Experimental 1 vs Control, n=46, t_{crit}=1.680	1.43	x	-0.24	x
Experimental 2 vs Control, n=44, t_{crit}=1.682	0.89	x	-3.2	✓
Experimental 1 vs Experimental 2, n=50, t_{crit}=±2.01	0.33	x	3.26	✓

When comparing the groups to each other, the results of experimental group 2 were significantly better compared to the control group and experimental group 1 after intervention.

Hypothesis 3

3. There will be a significant improvement in children's static balance following participation in a sensory motor development programme.

Significant improvements in static balance were partially achieved.

Table 13. Static balance mean results and standard deviations: girls and boys, pre- and post-test

	girls before		girls after		boys before		boys after	
	mean	*STD*	*mean*	*STD*	*mean*	*STD*	*mean*	*STD*
Control	0.1	0.32	0.1	0.32	0.5	1.58	1.1	1.85
Experimental 1	0.31	0.63	0	0	0.85	0.99	0	0
Experimental 2	0.08	0.29	0	0	0.5	1.24	0.08	0.29

Table 14. Static balance results for the girls: pre- to post-test comparison (within groups)

group	t_{opps}	sig
Experimental 1, n=13, t_{crit}=1.782	1.75	x
Experimental 2, n=12, t_{crit}=1.796	1	x
Control, n=10, t_{crit}=1.812	0	x

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The girls showed no significant improvements.

Table 15. Static balance results for the boys:
pre- to post-test comparison (within groups)

group	t_{opps}	sig
Experimental 1, n=13, t_{crit}=1.782	3.09	✓
Experimental 2, n=12, t_{crit}=1.796	1.44	x
Control, n=10, t_{crit}=1.812	-1.15	x

The improvement of the boys in experimental group 1 was significant.

Table 16. Difference between static balance results of girls vs boys:
pre- to post-test comparison (within groups)

	before		after	
group	t_{opps}	sig	t_{opps}	sig
Experimental 1, n=26, t_{crit}=-1.714	-2.01	✓	0	x
Experimental 2, n=24, t_{crit}=-1.717	-1.10	x	-1	x
Control, n=20, t_{crit}=-1.745	-0.77	x	-1.63	x

When comparing the results of the girls to that of the boys, the boys' results in experimental group 1 were significantly better before intervention.

Table 17. Static balance results of each group:
pre- to post-test comparison (within group)

group	t_{opps}	sig
Experimental 1, n=26, t_{crit}=1.708	3.43	✓
Experimental 2, n=24, t_{crit}=1.714	1.66	x
Control, n=20, t_{crit}=1.729	-1.10	x

The improvement of experimental group 1 was significant and although experimental group 2 improved, this was not significant.

Table 18. Static balance results comparing the groups to each other

	before		after	
group	t_{opps}	sig	t_{opps}	sig
Experimental 1 vs Control, n=46, t_{crit}=1.680	1.15	x	-2.21	✓
Experimental 2 vs Control, n=44, t_{crit}=1.682	-0.03	x	-1.87	✓
Experimental 1 vs Experimental 2, n=50, t_{crit}=±2.01	-1.07	x	1.02	x

The results of experimental group 1 and 2, when compared to the control group, were not significantly different before intervention but they were after. The two

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experimental groups compared to each other did not show significant differences in their results.

Hypothesis 4

4. There will be a significant improvement in children's dynamic balance following participation in a sensory motor development programme.

Significant improvements in dynamic balance were partially achieved.

Table 19. Dynamic balance mean results and standard deviations: girls and boys, pre- and post-test

	girls	before	girls	after	boys	before	boys	after
	mean	*STD*	*mean*	*STD*	*mean*	*STD*	*mean*	*STD*
Control	0.5	0.85	0	0	1.2	2.3	0.5	1.58
Experimental 1	0.62	0.87	0	0	0.62	1.56	0	0
Experimental 2	0.83	1.6	0	0	1.83	2.7	0.25	0.87

Table 20. Dynamic balance results for the girls: pre- to post-test comparison (within groups)

group	t_{opps}	sig
Experimental 1, n=13, t_{crit}=1.782	2.61	✓
Experimental 2, n=12, t_{crit}=1.796	1.76	x
Control, n=10, t_{crit}=1.812	1.86	✓

It was found that the improvement in experimental group 1 and the control group was significant. The improvement in experimental group 2 was not significant.

Table 21. Dynamic balance results for the boys: pre- to post-test comparison (within groups)

group	t_{opps}	sig
Experimental 1, n=13, t_{crit}=1.782	1.44	x
Experimental 2, n=12, t_{crit}=1.796	2.16	✓
Control, n=10, t_{crit}=1.812	1.41	x

It was found that the improvement of the boys in experimental group 2 was significant. The improvement in experimental group 1 and the control group was not significant.

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Table 22. Difference between the dynamic balance results of girls vs boys: pre- to post-test comparison (within groups)

	before		after	
group	t_{opps}	sig	t_{opps}	sig
Experimental 1, n=26, t_{crit}=-1.714	0	x	0	x
Experimental 2, n=24, t_{crit}=-1.717	1.2	x	1	x
Control, n=20, t_{crit}=-1.745	-1.02	x	1	x

When comparing the results of the girls to that of the boys, there were no significant differences.

Table 23. Dynamic balance results of each group: pre- to post-test comparison (within groups)

group	t_{opps}	sig
Experimental 1, n=26, t_{crit}=1.708	2.75	✓
Experimental 2, n=24, t_{crit}=1.714	2.78	✓
Control, n=20, t_{crit}=1.729	2.17	✓

The individual groups' improvements were all significant.

Table 24. Dynamic balance results comparing the groups to each other

	before		after	
group	t_{opps}	sig	t_{opps}	sig
Experimental 1 vs Control, n=46, t_{crit}=1.680	0.12	x	0	x
Experimental 2 vs Control, n=44, t_{crit}=1.682	0.79	x	0.79	x
Experimental 1 vs Experimental 2, n=50, t_{crit}=±2.01	1.39	x	1.39	x

None of the results, when comparing the groups to each other showed a significant difference.

Discussion

In the control school, the girls' improvement and the group's improvement as a whole in dynamic balance was significant. This was similar to both the experimental groups and it could therefore be hypothesised that maturation plays a part in these improvements.

The significant improvements in manual dexterity, ball skills and static balance in the two experimental groups are all interesting with regards to the variables that underlie school readiness. The Controlled Drawing Observation (Krogh, 1977) is

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primarily based on the child's manual dexterity. They have to draw balls, lines, triangles, a cat, etc. Ball skills on the other hand, are a result of hand-eye co-ordination and spatial awareness and the drawing observation requires the child to draw lines from corner to corner, place a ball in the centre of the page, draw different size objects, etc. An improvement in these two areas would therefore have a positive effect on school readiness. The reason why static balance is important for a child is so that he/she is able to sit still for any given length of time. An improvement in this area would, for that reason, also have a positive effect on school readiness.

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Qualitative Data

Qualitative data was used to provide insight into the children's progress.

Running

The first running "observation" was done at the very beginning. Next to the school is a field and piles of stones marked the corners of a square that the children had to run around. Two children were randomly selected and ran at the same time. This had a range of disadvantages. Competitive children cut corners, non-competitive children stayed with the slower partner, naughty children pushed their partner in the bushes, and in group 2, children ignored the stones and started zig zagging around the field and chasing each other.

Although the children in group 1 were better behaved, it was decided that all the children had to be tested again. Two weeks later they were taken to the local sports field where they ran around the penalty box of a football field, the corners marked with hula hoops. This following table shows a summary of their results:

Table 25. Running scores

	Group 1 (n=38)	Group 2 (n=36)
Quickest time:	38 secs	29 secs
2nd quickest time:	44 secs	32 secs
Slowest time:	107 secs	103 secs
Average time general:	61.5 secs	44.7 secs
Average time girls:	67.7 secs	50.8 secs
Average time boys:	52.1 secs	38.9 secs

Overall, the boys ran faster in both groups. In group 1, a girl ran the fastest time, in group 2, a boy. Although there were many different running styles, only two really stood out. Both were girls and both ran with their arms and legs held rigid and their arms away from their bodies. One of the boys gave up. Group 2 was much faster as a group and had better results overall.

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Primitive Movement Patterns

All the children were made to crawl on hands and knees in a variety of patterns. The first pattern was just to get across the room in a straight line, in their own time. The second pattern was around an obstacle course as fast as they could and the third pattern was a race to the other side of the room and back against a classmate.

This showed 12 children in group 1 (n=36) and 4 children in group 2 (n=27) to have problems with crawling - all of them used bilateral crawling. One child in group 1 could only crawl very slowly. From the 12 children in group 1 who had problems crawling, 10 also had problems walking on hands and feet.

The children were made to repeat the three crawling patterns they did during crawling on their hands and knees, but on their hands and feet with their bottoms in the air. This showed that 13 children in group 1 and 11 children in group 2 had trouble with this exercise. They could not keep their bottoms in the air, fell over and generally reverted to crawling.

Out of all the children who had problems with primitive movement patterns, 82% in experimental group 1 and 85% in experimental group 2 had problems with hand and feet walking. However, in experimental group 1, 76% of the children had problems with crawling, with only 31% in experimental group 2.

The children who had problems with crawling, also had low balance scores.

Colours, Counting and Position

The children were given a bowl of coloured beads and asked to make patterns with them as discussed in Chapter Three. Observation provided data on whether the children knew different colours, understood the concept of numbers, and whether they understood the principle of position, i.e. above, next to, underneath. The following table shows the number of children who did not comprehend these three principles

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Table 26. Number of children who had trouble with colour, number or position

	Group 1 (n=36)	Group 2 (n=27)
colour	6%	37%
number	44%	70%
position	50%	63%

When comparing these results to crawling and hand and feet walking, 75% of the children in experimental group 2 also had problems with position compared to 50% in experimental group 1.

Mini Loco

At the end of the second term, an insight into school readiness was provided by an adaptation of this game. In group 1 (n=31) ten children and in group 2 (n=27) nine children had difficulty playing this game.

Drawing Observation (Oja et al. 2002)

The two groups performed the drawing observation in their own classes but with the tables arranged in rows rather than in groups. It was the first time that both groups experienced an "assessment" situation. The teachers read out the instructions and were allowed to repeat them as many times as they thought was necessary. They were not, however, allowed to give any further assistance. Group 1 (n=38) had an average score of 28 (maximum score 35) and group 2 (n=34) had an average score of 26. There was only one child who scored less than 20 and he was ultimately considered "not school ready" by his teacher.

Boppin' Bugs

Each group was taken to an arcade in a local shopping mall to play the game "Boppin' Bugs". Group 1 (n=38) scored an average of 32, group 2 (n=37) also scored an average of 32. One of the teachers played the game to set the "highest" score and she scored 69 which was then used as the maximum score.

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In group one, fourteen children scored less than 40% and in group 2, eleven children scored less than 40%.

Sixteen children in group 1 bopped more than 30 bugs and had an average manual dexterity score of 0.75. In group 2, twenty one children bopped 30 bugs or more and had an average manual dexterity score of 0.38.

There seemed to be three different groups of boppers; the first group saw the light and responded, the second group saw the light but did not respond appropriately (too slow), the third group did not see the light and therefore did not respond in any way. The last group often concentrated on one or two lights and waited for them to light up.

Additional Observations

1. From the workbooks of the children, information about discrimination between squares, circles and triangles was obtained. In experimental group 1, most of the children who had trouble drawing triangles in the beginning of the year, also had low manual dexterity scores (75%). Twelve children were not able to draw a triangle. Six of those children also had trouble drawing squares. Six children drew squares and triangles the same way and two drew them all as circles, five of those children had the worst manual dexterity scores. Ten of the twelve children were not considered school ready by the beginning of the third term.

   In experimental group 2, thirteen children had trouble drawing triangles. Five of those children also had trouble drawing squares with two drawing them the same way. One child had trouble with circles, squares and triangles, and one child drew a triangle the same as a circle. Of these thirteen children, only two had low manual dexterity scores. Eleven of these children were not considered school ready by the end of the third term.

2. Absenteeism information over 148 days was obtained from the teachers' books.

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Table 27. Absenteeism data

Absenteeism	Average (days)	Always at school (children)	Absent most (days)
group 1	6	10	15
group 2	13	1	46

Five of the children in experimental group 1 (n=15) were never absent, the average of the rest was 7 days with one of the children absent for 15 days. However, the average amount of days that children were absent in group 2 (n=14) was 16, with one of the children absent for 46 days and another one 33 at the beginning of the year. Ignoring those two high scores brings the average down to 11 days. Absenteeism in group 2 decreased towards the second half of the year, in group 1 it was similar across the year.

3. The teacher of experimental group 1 gave a typed report within a month of having been asked for a general report on the children that she had highlighted as "not school ready" as well as some background information on herself. She wrote:

Teaching experience: 25 years

*I am busy writing books for 3-5 year old's for helping them to read on a very early age. I have tested it on three kids with great success *there has been confirmed that Reading is a brain activity and not a subject.*

Children in my class (not yet ready but I'm working on it and I'm sure I shall succeed)

Child number 1: Family problems at home, Lives with grand parents, Mother lives on street, Violence at home, Very aggressive.

Child number 2: Do not want any help if he needs it - Stubborn, Has no interest in work, Will visit parents on 5th of May to talk to them, And how we can work together, Very aggressive.

Child number 3+4: Twins identical, Depend on each other, Wait for each other before starting with activity, Parents help them with

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everything can't dress themselves, Talked to parents and they try to help them being more independent.

Child number 5: *Very undisciplined at beginning of year. Stays with father and grandparents because of mother's alcohol problem. Parents are now divorced. Became more calm and his work shows progress.*

Child number 6: *Adopted child. At the beginning of this year she couldn't handle her crayon and scissors properly. She attended Pumpkin Patch pre-primary school for almost two years but she showed no interest in anything like puzzle building cutting papers. I let her play with dough/clay every day to strengthen her hand muscle. At the end of March she could write her full name and surname.*

Child number 7: *Very nervous child at beginning o year. Stays with grandparents while parents stays in Eerste Rivier. They are both working. Grandparents very loving and caring people. This child finds a problem handling her brush (paint) and crayons. We worked with clay and fore a lot of paper picking up rice (raw) and paste it on a sheet. This helped Danielle to have better control over her hand muscle.*

Child number 8: *Very playful child. Like to imagine things like he is spiderman "Please don't call me X, I am spiderman" he said at the beginning of the year. Likes to draw pictures. Like watching tv at home. At the beginning of this year if he turns his back at me he did not respond on any call. I try to speak a little louder so that he can respond on working. He went for a hearing test. We're still waiting on the results.*

Child number 9: *At the beginning of this year, this child was afraid of working on his own. He depend on his nephew most of the time. I had to comfort him and help him handling his crayons to colour in. I talked to his mom to buy him crayons for colouring in at home. This helped him a lot."*

The teacher of experimental group 2 unfortunately never responded, so there is no written substantiation as to why she considered the children not to be school ready.

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Chapter Five

Conclusions and Recommendations

From the pre-intervention M-ABC results it can be seen that most of the children had similar scores, and that a common problem area was manual dexterity. Yet, the second set of scores present a very different picture. The teachers of the two experimental groups were from different professional backgrounds. Experimental Group 2 achieved more improvement and the teacher of this group was an occupational therapist who was teaching for the first time. She got actively involved in the physical activities and incorporated them into her daily teaching regime.

Marcon (1999) would describe this teacher as a child-development-oriented teacher, i.e. she facilitated learning by allowing children to actively direct the focus of their learning (child-initiated classrooms). Children who participate in a child-initiated model learn concepts through self-directed actions facilitated by a teacher. In this approach a teacher facilitates learning by (a) providing children with a wide variety of experiences, (b) encouraging children to choose and plan their own learning activities, (c) engaging children in active learning by posing problems and asking questions that stimulate and extend learning, (d) guiding children through skill acquisition activities as needed, and (e) encouraging children to reflect on their learning experiences. The teacher of Experimental Group 2 also made time every day to work with the children individually.

The teacher for Experimental Group 1 had been a primary school teacher for 25 years. Marcon (1999) would describe her as an academically oriented teacher who preferred more direct instruction and teacher-directed learning experiences for her children. This direct instruction approach is highly prescriptive in that lessons are (a) scripted to assure consistency in presentation across teachers, (b) carefully sequenced with task analysis and a comprehensive system for monitoring student progress, and (c) consistently focused on academic instruction with much of the available school day allocated to practice and drill in reading, language and math.

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If one looks at the results of this study, the child-initiated model may be more productive for school readiness programmes. Some interesting contrasts were observed. The difference in teaching methods could be seen in when the children had to draw a triangle. The children in Experimental Group 1 had already learned how to draw triangles and only the children with low manual dexterity scores had difficulty completing the task. However, a number of the children in Experimental Group 2 who had difficulty drawing triangles had normal manual dexterity scores. Their coordination was sufficient, they simply had never been specifically taught how to draw a triangle.

It could be that the different teaching styles promote different motivational orientations. The teacher-directed Group 1 may have become more extrinsically motivated. When working with them, it was noticed that they usually did what they were told to do, but not always with 100% effort. The children in Group 2 seemed much more intrinsically oriented, putting more energy and dedication into their play. A comparison between the running times indicates a clear difference in their effort. The average of Experimental Group 1 was nearly 17 seconds slower than that of Experimental Group 2. There was no reason to suspect that their aerobic fitness was lower. A research project to compare the effectiveness of these two models could contribute to our understanding of successful school readiness programmes.

Thoughts About Assessment

The children who participated in this intervention were all from an economically deprived area. It is possible that some of the assessments within the M-ABC used new or unusual equipment for them. For example, “threading beads” for the first time can be confusing activity; a right-handed person should pick up the bead with his left hand and thread with his right. But a child who has never done any threading before, often picks up the bead with their preferred hand. The children in Experimental Group 1 (with the traditional classroom teaching) did not practice any threading between the pre- and post-intervention assessment. In this group, 11 children improved and 11 children either stayed the same or got lower scores. In Experimental Group 2 (with the occupational therapist teacher), the teacher practiced threading beads as part of her activities, and only one child got lower

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scores on the post-intervention assessment. The interference of the different activities provided by the classroom teachers on the children's pre- and post-intervention assessment performance cannot be documented, but the potential definitely exists.

A similar problem occurred in the rolling ball into goal item of the M-ABC. The children were instructed to kneel behind a line that was two meters away from the goal and to roll the ball between two posts. It seemed that rather than roll the ball into the goal they tried to miss the posts. In an effort to roll the ball between the two posts, children actually looked at them which resulted in hitting the posts, i.e. miss the goal. I've come across something similar in the sport of rowing when new coxswains see another boat coming their way. Although they know to steer away from the other boat, in their anxious attempt to avoid collision, they subconsciously steer right into it. It was found that when the child was told to roll the ball to a hand placed in between the posts, the ball was rolled into the goal more often.

In addition to potential problems created by the classroom teachers' presentation of somewhat different programmes throughout the year, other questions arise from looking at the results:

1. Why did some children's performance deteriorate from pre- to post-intervention assessments?
2. Why did Experimental Group 2 improve more than Experimental Group 1?
3. Did participation in the sensory motor development programme cause the improvement demonstrated by some children?
4. Did absenteeism or lack of continuity have a negative effect on the outcome of the programme?

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Why did some children "Get Worse"?

The results from the children in the control school deteriorated in three out of four scores on the M-ABC; the manual dexterity of the girls, the ball skills (eye hand coordination) of the girls and the boys, and the static balance of the boys. Bernstein's (1967) degrees of freedom were shown in all their beauty when performing the pre-intervention M-ABC: bodies swaying, arms flying and torsos trying to balance all the actions. During the post-intervention assessment, it seemed that due to the control group's eagerness to do well, as well as the fact that the children were quite excited, many children selected the wrong set of muscle contractions. Bernstein (1967) saw the basic problem of coordination as that of mastering the many degrees of freedom involved in a particular movement - of reducing the number of independent variables to be controlled. From the results of the control group, it can be suggested that mastering the many degrees of freedom is not only a matter of continued and repeated practice, but also of familiarity with the performance environment.

In Experimental Group 1, the girls' ball skills scores were lower in the post-intervention test, and in Experimental Group 2, the girls' manual dexterity deteriorated. Again, this could be due to wanting to do well on the post-intervention assessment, and the stress that caused. Stress can cause the body to become tense and performance to be affected. This will especially have an effect on the posting coins item of the M-ABC, as relaxed fingers will release coins more readily. On the other hand, the children seemed more casual on the post-intervention assessment. Perhaps they were overly confident. One of the boys, when rolling the ball into the goal, tried all kinds of different rolling techniques and examined the different effects. Playing with a ball is a special occasion for these children and this little boy was making the most of it, even though his score suffered dramatically. This was shown very clearly when a child missed the goal and the ball rolled away: every child in the area ran after it!

The Neuronal Group Selection Theory (NGST) theorises that the brain is organised into variable networks and that development starts with primary neuronal repertoires, with each repertoire consisting of multiple neuronal groups (Hadders-Algra, 2002). When most of the anatomical connections of the primary

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repertoires have been established, selection occurs on the basis of afferent information produced by behaviour and experience. Experiential selection gradually leads to the formation of secondary repertoires of neuronal groups and continuing afferent information induces modifications in the strength of the synaptic connections within and between the neuronal groups of the variable secondary repertoire. This interpretation is consistent with the maturational view that, during motor development, reflexive control changes to voluntary control. So during the first test the child may have caught the bean bag as part of a reflex (flexion being part of a re-flex) and during the second set of testing, he/she would have moved on to the developmental phase where he/she is trying to establish voluntary control. The early stage of gaining voluntary control is not only subject to the struggle to master degrees of freedom, but is also not yet supported by strong synaptic connections. This stage could bring about a lower score on the post-intervention assessment.

Why did Experimental Group 2 improve more than Experimental Group 1?

A possible reason for the greater improvements achieved by Experimental Group 2 could be, as mentioned before, the child-initiated approach of the teacher. It also could be the activities she guided the children to practice. As an occupational therapist, she had spent the beginning of the school year working on motor skills, resulting in a better initial score. Also, between the first and second M-ABC assessment, she incorporated the physical activities in the classroom. The children were exposed to more additional physical activity than the children in Experimental Group 1. When coupled with her approach that allowed the children more flexibility in their choices of activities, her classroom can be seen as a more dynamic environment. Thelen (1995) stated that developmental change "can be seen in dynamic terms as a series of states of stability, instability and phase shifts in the attractor landscape, reflecting the probability that a pattern will emerge under particular constraints". Some changing components in the system must disrupt the current stable pattern so that the system is free to explore and select new co-ordinative modes. The new views of motor development emphasise strongly the roles of exploration and selection in finding solutions to new task demands. A related issue revolves around the amount of practice that it might

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take in order for the brain to show such a change (Goleman, 2003). There is an undeniable impact on the brain, mind and body from extensive practice.

Did participation in the sensory motor development programme cause the improvement demonstrated by the children?

From the results of this study, when comparing the experimental groups to the control group, it does seem that participation in the programme had a positive effect. Through repetition and exposure to a variety of sensory motor activities, the children's brains could make new synaptic connections. Expanding connections would have provided the children with the potential to achieve greater skilfulness . The post-intervention scores indicated an improvement in the four abilities that support the physical aspect of school readiness:

1. Manual dexterity
2. Eye hand coordination
3. Static Balance
4. Dynamic balance.

Whether these same connections also contributed to the children's general school readiness can only be inferred. The dynamic systems theory views development as a complex, internal process in which the individual interacts with the learning task and the conditions of the environment in a way that results in external behavioural changes. In short, dynamic systems are systems that change over time. As we have seen before, the dynamic systems theory has gained great popularity across a wide number of fields and the essence of this theoretical model is that the emphasis is shifted away from external factors as the primary driving force in changing behaviour; instead, the focus is on the transactions that occur within the individual as the critical element of learning.

The sensory motor programme implemented in this study followed the child-initiated approach to the curriculum, and focused on play as the means for promoting learning. Making choices, assuming responsibility for one's decisions and actions, and having fun are inherent components of the play approach to

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learning. In this approach, internal cognitive transactions and intrinsic motivation are the primary forces that ultimately determine healthful choices and life habits (Rickard, Gallahue, Gruen, Tridle, Bewley & Steele, 1995). Through play, children gain a sense of competence and control over their lives. They learn to interact with others, resolve conflicts, develop their imaginations, and foster creativity. Rickard et al. (1995) encouraged this play approach to learning, which is a process in which the individual learner effectively interacts with the task and environment, as an alternative paradigm for nutrition and fitness education that focuses on *internal* rather than external transactions. In the play approach to learning paradigm, nutrition and fitness education is related to Piaget's (1985) concepts of equilibration and adaptation. Equilibration deals with the processes involved in acquiring knowledge, whereas adaptation is the means by which one uses these cognitive processes to change behaviour. The sensory motor development programme used in this study was meant to be a dynamic process by which children learn to learn.

Did absenteeism or lack of continuity have a negative effect on the outcome of the programme?

The average rate of absence for Experimental Group 1 was seven days, with one of the children being absent for 15 days. In Experimental Group 2, the average number of days that children were absent was 16, with one of the children absent for 46 days and another one 33 days. Ignoring those two high scores brings the average down to 11 days. The rate of absenteeism in Experimental Group 2 decreased in the second half of the year, whereas in Experimental Group 1 it was similar across the year. Cronan, Brooks, Kilpatrick, Bigattie and Tally's (1999) study documented that continuity plays a major part in the motor development of a child. Absenteeism disrupts continuity and although absenteeism in this group of children was not always because of disease, the literature provides evidence that if a child is absent regularly because of sickness, there will be a deficit in academic achievement (O'Brien Caughy, 1996).

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A Summary of the Results

- Manual dexterity

  The improvement of the girls in Experimental Group 1 was significant, as well as significantly better than the improvements achieved by the boys in their group. The improved results of Experimental Group 2 were significant compared to the results of the Control Group and Experimental Group 1.

- Ball skills (eye hand coordination)

  The improvement of the girls in Experimental Group 2 was significant. The boys' improvement in Experimental Group 2 was also significant. The boys' improvement in Experimental group 1 was significantly better that the achievement of the girls in their group. Experimental group 2 achieved a significantly better result than the control group and Experimental Group 1. As a group, Experimental Group 2 achieved a significant improvement.

- Static balance

  The improvement of the boys in Experimental Group 1 was significant. There was a significant improvement in the results of Experimental Groups 1 and 2, when compared to the control group. The improvement of Experimental Group 1 was significant.

- Dynamic balance

  The improvement in Experimental Group 1 and the Control Group was significant. The improvement of the boys in Experimental Group 2 was significant.

A Personal Note

In a dialogue with the Dalai Lama about destructive emotions, Goleman (2003) talks about the "plastic brain" and the fact that neuroscience's assumptions about human possibility are being stretched due to a revolution in the field's supposition about the malleability of the brain. The new watchword is "neuroplasticity"; the notion that the brain continually changes as a result of our experiences - whether through fresh connections between neurons or through the generation of utterly

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new neurons. "Musical training, where a musician practices an instrument every day for years, offers an apt model for neuroplasticity. MRI studies find that in a violinist, for example, the areas of the brain that control finger movements in the hand that does the fingering grow in size. Those who start their training earlier in life and practice longer show bigger changes in the brain." (Goleman, 2003: p.21)

Cronan, Brooks, Kilpatrick, Bigattie and Tally (1999) suggested that "low-income children get further behind as they get older." High rates of absenteeism could be part of this trend. Creating permanent cognitive and behavioural change requires continuous intervention. Expecting change to be permanent when intervention is sporadic is like trying to "operate a railroad over separated sections of track. The behavioural train, like a physical train, requires continuity." Cronan et al. (1999) found that in order to improve the performance of low-income children on standardised tests, intervention programmes need to be implemented early and there needs to be some sort of continuity if their performance is to be maintained or improved.

Most of the children in the intervention groups in this intervention employed dynamic systems: the all or nothing system, action and reaction system, the "activate-every-muscle-fibre-and-see-what-happens" system; spot a ball and run, preferably whilst screaming - until a wall or a tree gets in the way. Running especially was an occasion to free degrees of freedom, in more ways than one. Gravity was explored when little legs, not able to keep up with the demand, introduced many little knees to unforgiving concrete. Body schema was refined as tears resulted in a "drukkie". Cause and effect discovered as the child received lots of attention after falling and sometimes even a bandage. Trying to calm the children down was difficult and ultimately the madness had to be incorporated into the programme. As was found in the literature, there was also increased synaptic connectivity, pre-frontal cortex stimulation, simultaneous organisation of afferentation and efferentation and multiregional retroactivation - working closely with the children I could actually see and hear the crackling of electricity!

The reason for this intervention was to study the effects of a sensory motor programme on four of the physical/perceptual variables that are proposed to support school readiness. It was found that the sensory motor development

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programme did produce improvement on these variables (as measured by the M-ABC assessment battery). Taking the results from this intervention into consideration, it is strongly recommended that children at pre-primary level should be exposed to a sensory motor development programme and that this programme is continuous and sustainable.

Finally, this intervention was about, and for, the children. Together we set the pace, teaching each other valuable lessons and ultimately making this study a success - regardless of the outcome.

My heart is so small
it's almost invisible.
How can You place
such big sorrows in it?
"Look", He answered,
"your eyes are even smaller,
yet they behold the world."

- Rumi (Barks, 2001)

Working with the children had as much an effect on me as it had on the children. Now that I've come to the conclusion of this study, I realise how big a part these children have played in my life. The idea was always that physical activity was going to improve the children's readiness for school and very early on I had to come to terms with the fact that it was not only my skills as a sport scientist that mattered. One day I arrived at school and found the number one "problem" child playing outside. He was an undisciplined and extremely naughty child and I thought there was absolutely no point in telling him off as he never listened. To my surprise he caught up with me and walked next to me, looking up with his deep dark eyes, waiting (wanting?) to be punished. For some unknown reason I stopped and hugged him... and that is when the intended "boot camp" style intervention turned into a "drukkie delight". The child turned to mush and, although he remained very naughty, he became far less troublesome and highly affectionate.

Although I would like to think that the success of the intervention was a deliberate one, some of the breakthroughs were totally unintentional. In one of the sessions, the children had been playing with bean bags. During the break I was absent-

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mindedly tossing the bean bag from one hand to the other whilst talking to the teacher, when I noticed a little girl staring at me with keen eyes. I knew she had trouble catching so carefully threw the beanbag at her; it fell on the floor. She picked it up and gave it back to me, barely able to throw. To cut a long story short, by the end of the break this child could catch and throw and I was planning her future for the SA cricket squad.

Two things resulted from this, the first was a realisation that it was more than likely that nobody had ever thrown a beanbag or a ball at this child and that she had probably had little or no exposure to any kind of physical activity. The second was totally unexpected; from a shy girl, unable - and often unwilling - to do anything, sickly and absent most of the time, she became a real little champion. She oozed confidence and, with the support of her teacher, all her skills improved dramatically.

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Raw Data M-ABC before and after intervention

CONTROL SCHOOL

BEFORE

	NO	PC	TB	BT	CBB	RB	OLB	JOC	WHR
F	302	4	3	0	5	0	0	0	0
F	304	2	0	0	3	0	0	0	0
F	306	3	0	0	0	3	0	0	0
F	310	4	0	0	0	0	0	0	0
F	313	1	4	1	1	0	0	0	2
F	314	3	0	0	1	1	0	0	2
F	317	0	0	0	0	0	0	0	1
F	318	0	2	0	0	0	0	0	0
F	319	1	0	0	3	1	0	0	0
F	320	0	2	3	3	0	1	0	0
M	301	1	1	2	0	0	0	0	0
M	303	5	5	0	0	0	0	5	0
M	305	1	1	0	0	0	0	0	0
M	307	4	1	2	0	0	0	0	0
M	308	0	0	0	0	0	0	0	0
M	309	5	2	5	1	0	0	5	1
M	311	1	4	3	2	3	5	0	0
M	312	4	0	1	2	0	0	0	0
M	315	2	2	0	0	0	0	0	0
M	316	2	4	1	0	0	0	0	1

AFTER

	NO	PC	TB	BT	CBB	RB	OLB	JOC	WHR
F	1302	1	2	1	3	1	0	0	0
F	1304	3	0	5	2	2	1	0	0
F	1306	1	0	0	1	0	0	0	0
F	1310	1	1	4	0	0	0	0	0
F	1313	1	4	0	2	1	0	0	0
F	1314	3	0	0	1	5	0	0	0
F	1317	0	0	1	0	0	0	0	0
F	1318	3	4	0	2	0	0	0	0
F	1319	2	0	1	1	5	0	0	0
F	1320	1	4	3	4	1	0	0	0
M	1301	0	0	5	1	0	1	0	0
M	1303	2	1	4	1	0	0	0	0
M	1305	2	1	0	0	0	0	0	0
M	1307	3	0	3	0	0	1	0	0
M	1308	4	0	0	1	0	0	0	0
M	1309	4	2	5	3	2	5	5	0
M	1311	1	0	0	3	4	4	0	0
M	1312	0	1	0	2	0	0	0	0
M	1315	1	0	1	0	0	0	0	0
M	1316	1	3	1	0	0	0	0	0

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Raw Data M-ABC before and after intervention

INTERVENTION GROUP 1

BEFORE

M/F	NO	PC	TB	BT	CBB	RB	OLB	JOC	WHR
F	114	1	0	1	0	0	0	0	2
F	115	3	1	1	0	0	1	0	0
F	117	1	0	2	1	0	0	0	0
F	118	0	0	0	2	2	0	2	0
F	119	1	1	1	1	0	0	0	1
F	120	2	0	0	0	0	0	0	0
F	121	2	4	0	0	0	0	0	1
F	124	0	0	0	0	0	0	0	0
F	125	3	1	1	2	5	0	0	0
F	128	2	4	1	0	2	0	2	0
F	129	2	2	2	0	0	0	0	0
F	130	2	0	0	4	0	1	0	0
F	132	1	1	0	3	1	2	0	0
M	101	3	2	3	0	0	3	0	0
M	102	2	4	0	0	0	1	0	0
M	103	5	3	1	0	0	0	5	0
M	106	3	3	5	5	1	1	0	0
M	108	2	1	1	5	1	1	0	0
M	109	4	0	0	0	2	2	0	3
M	111	2	0	3	1	0	0	0	0
M	116	0	4	1	0	0	0	0	0
M	122	0	0	0	4	4	0	0	0
M	123	1	0	0	0	0	0	0	0
M	126	1	0	1	0	0	0	0	0
M	127	2	1	0	0	2	1	0	0
M	131	3	1	0	0	0	2	0	0

AFTER

M/F	NO	PC	TB	BT	CBB	RB	OLB	JOC	WHR
F	1114	1	0	0	0	0	0	0	0
F	1115	1	0	0	0	2	0	0	0
F	1117	2	1	1	1	2	0	0	0
F	1118	0	0	0	0	1	0	0	0
F	1119	1	0	0	0	3	0	0	0
F	1120	1	0	0	1	1	0	0	0
F	1121	0	1	3	0	1	0	0	0
F	1124	1	0	0	1	0	0	0	0
F	1125	1	0	1	5	5	0	0	0
F	1128	2	2	1	0	1	0	0	0
F	1129	3	1	0	1	2	0	0	0
F	1130	2	0	0	4	1	0	0	0
F	1132	0	3	0	0	0	0	0	0
M	1101	3	1	1	0	0	0	0	0
M	1102	2	4	3	0	0	0	0	0
M	1103	4	4	0	0	0	0	0	0
M	1106	2	3	1	0	0	0	0	0
M	1108	0	3	3	0	0	0	0	0
M	1109	2	0	0	0	0	0	0	0
M	1111	1	0	3	0	1	0	0	0
M	1116	1	4	0	1	0	0	0	0
M	1122	2	2	3	1	0	0	0	0
M	1123	0	0	0	0	0	0	0	0
M	1126	0	0	3	3	4	0	0	0
M	1127	0	1	0	0	0	0	0	0
M	1131	0	0	0	0	0	0	0	0

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Raw Data M-ABC before and after intervention

RAW DATA INTERVENTION GROUP 2

BEFORE

M/F	NO	PC	TB	BT	CBB	RB	OLB	JOC	WHR
F	219	0	0	0	4	0	0	0	5
F	220	0	0	0	3	0	0	0	0
F	221	0	0	0	0	0	0	0	0
F	222	1	0	0	4	1	0	0	0
F	224	0	3	3	1	2	0	0	0
F	225	2	0	0	0	0	0	0	0
F	226	1	0	1	1	0	0	0	3
F	227	1	0	1	2	4	0	0	0
F	228	1	3	0	2	0	0	2	0
F	232	1	0	0	0	0	1	0	0
F	233	0	0	0	0	0	0	0	0
F	234	3	0	0	0	0	0	0	0
M	201	2	4	0	5	0	0	0	0
M	203	1	2	0	1	0	0	5	0
M	206	0	0	1	0	1	0	0	0
M	210	2	0	0	0	0	0	0	0
M	211	4	4	1	5	4	4	0	5
M	214	0	0	3	0	0	0	0	2
M	215	2	0	1	5	0	0	5	3
M	217	0	4	0	0	0	0	0	0
M	223	0	0	0	2	0	2	0	2
M	229	4	1	0	0	0	0	0	0
M	230	0	0	0	0	0	0	0	0
M	231	0	0	0	2	0	0	0	0

AFTER

M/F	NO	PC	TB	BT	CBB	RB	OLB	JOC	WHR
F	1219	0	0	1	1	2	0	0	0
F	1220	0	1	0	0	0	0	0	0
F	1221	1	1	1	0	0	0	0	0
F	1222	2	0	1	0	0	0	0	0
F	1224	4	0	0	1	0	0	0	0
F	1225	1	0	0	1	0	0	0	0
F	1226	0	0	0	1	0	0	0	0
F	1227	0	0	0	1	0	0	0	0
F	1228	3	0	1	0	0	0	0	0
F	1232	0	0	0	0	0	0	0	0
F	1233	0	0	0	0	0	0	0	0
F	1234	3	3	0	1	0	0	0	0
M	1201	0	0	0	0	0	0	0	0
M	1203	1	0	0	0	0	0	0	0
M	1206	1	0	0	0	0	0	0	0
M	1210	0	0	0	2	1	0	0	0
M	1211	4	2	3	2	1	1	0	3
M	1214	0	0	0	0	0	0	0	0
M	1215	4	0	0	0	0	0	0	0
M	1217	2	1	0	0	0	0	0	0
M	1223	1	0	1	2	0	0	0	0
M	1229	1	0	0	0	0	0	0	0
M	1230	1	0	0	0	0	0	0	0
M	1231	0	0	0	0	0	0	0	0

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Profiles

The following are the profiles of the children who were not considered school ready by the beginning of the third term. They are divided by their post-intervention M-ABC results; those that stayed the same, those that got worse and those that improved. Instead of 'juffrou', the children called the investigator 'tannie Ann'.

Results that stayed the same (3)

Child no 112: Running time: 58, had no concept of numbers, had trouble with position, crawling and drew squares and triangles as circles. Absent: 0 days. Not school ready according to Mini Loco and teacher.
M-ABC before: 12 - M-ABC after: 12. Major problem areas: manual dexterity and ball skills.
She did not concentrate on threading beads, looked like she was in slow motion, when catching her fingers closed too late and she did not adjust to direction of throw. When jumping she landed on flat feet, did not look ahead when walking on toes and individual movements lacked smoothness and fluency.
Final assessment - drawing observation score: 30. Boppin' Bugs: 25.
Drawing: draws herself same as 'tannie Ann', legs coming out of head with only eyes, arms coming out of legs. Can write name.

Child no 125: Running time: 57, had no concept of numbers, had trouble with position, and colour. Absent: 5 days.
M-ABC before: 12 - M-ABC after: 12. Major problem areas: manual dexterity and ball skills.
She changed hands whilst posting coins, went too fast for accuracy and did not use pendular swing of the arm.
Final assessment - drawing observation score: 31. Boppin' Bugs: 23.
Drawing: draws herself different to 'tannie Ann', anatomically correct bodies. Can write name.

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Child no 225: Running time: 41. She had trouble with position, concept of numbers and colour. Absent: 9 days . Not school ready according to Mini Loco and teacher. When writing, she arranges letters randomly.
M-ABC before: 2 - M-ABC after: 2. Major problem area: posting coins.
She did not use pincer grip to pick up coins (left hand only) and did not use the supporting hand to keep the box steady. She was chewing gum when threading beads and the faster she thread, the faster she chewed. She did not look at the bicycle trial, held her face too near paper, held her head at an odd angle, held pen with an immature grip, progressed in short jerky movements and used excessive force.
Final assessment - drawing observation score: 25. Boppin' Bugs: 38.
Drawing: draws herself the same as 'tannie Ann' but smaller and draws anatomically correct bodies. Can write name.

Results that got worse (5)

Child no 126: Running time: 52, had trouble with position of coloured beads. Absent: 3 days. Not school ready according to teacher.
M-ABC before: 2 - M-ABC after: 10. Major problem areas after: ball skills.
He did extremely poorly with one hand and when trying to thread beads faster his hands became less controlled.
Final assessment - drawing observation score: 32. Boppin' Bugs: 40.
Drawing: draws himself different to 'tannie Ann', anatomically correct bodies. Can write name.

Child no 102: Running time: 58, had no concept of numbers, had trouble with position, crawling, hands and feet walking and could not draw squares or triangles. Found it physically difficult to write. Absent: 0 days. Not school ready according to teacher.
M-ABC before: 7 - M-ABC after: 9. Major problem area: threading beads.
He did not use a pincer grip to pick up coins, misaligned coins with respect to slot, changed threading hand during trial, sometimes missed hole with tip of lace, picked up beads the wrong way around, progressed in short jerky movements on the bicycle trial and was exceptionally slow.

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Final assessment - drawing observation score: 31. Boppin' Bugs: 21.
Drawing: draws himself different to 'tannie Ann', anatomically correct bodies.
Can write name.

Child no 117: Running time: 103, had no concept of numbers, had trouble with position, crawling, hands and feet walking and could not draw triangles.
Absent: 7 days. Not school ready according to teacher.
M-ABC before: 4 - M-ABC after: 7. Major problem areas: manual dexterity and ball skills.
She changed hands whilst threading beads, went too fast for accuracy, arms and hands did not 'give' on impact of bean bag, made no compensatory arm movements to help maintain balance. When jumping she landed on flat feet.
Final assessment - drawing observation score: 27. Boppin' Bugs: 14.
Drawing: draws herself different to 'tannie Ann', anatomically correct bodies.
Can write name.

Child no 234: Running time: 40. Absent: 20 days. Not school ready according to Mini Loco.
M-ABC before: 3 - M-ABC after: 7. Major problem area before: posting coins and after: posting coins and threading beads.
She did not use pincer grip to pick up coins, did extremely poorly with one hand and misaligned coins with respect to slot when using her left hand. On threading beads she sometimes missed hole with tip of lace and picked up beads the wrong way around. On the bicycle trail she held her head at an odd angle, held pen too close to point and was exceptionally slow. Although she caught the bean bag seven times, she did not follow trajectory of bean bag with eyes, her arms and legs did not 'give' to meet impact of bean bag and she did not adjust to the height or direction of the throw.
Final assessment - drawing observation score: 34. Boppin' Bugs: 41.
Drawing: draws herself exactly the same as 'tannie Ann' but anatomically correct bodies. Can write name.

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Child no 116: Running time: 47, had no concept of numbers and could not draw squares or triangles. Absent: 7 days. Not school ready according to Mini Loco.
M-ABC before: 5 - M-ABC after: 6. Major problem area: threading beads.
Final assessment - drawing observation score: 31. Boppin' Bugs: 18.
Drawing: draws himself different to 'tannie Ann', legs coming out of head, arms coming out of legs. Can write name.

Results that improved (21)

Child no 211: Running time: absent. He had trouble with position, the concept of numbers, crawling and walking on hands and feet. Drew triangles and squares the same. Absent: 11 days. Not school ready according to teacher.
M-ABC before: 27 - M-ABC after: 16. Problems in all areas bar jumping over cord.
Everything this child did was accompanied by associated movements. He held his face too near paper, held his head at an odd angle, held pen with an immature grip, moved constantly, was exceptionally slow, did not follow trajectory of bean bag with eyes, held hands out flat with fingers stiff as the bean bag approached, arms and hands did not 'give' to meet impact of bean bag, did not move until bag struck body, did not adjust to height, direction or force of throw, did not use pendular swing or follow through with rolling arm, could not stand on one leg at all, did not compensate with arms to maintain balance and went to fast for accuracy when walking on his toes.
Final assessment - drawing observation score: 21. Boppin' Bugs: 21.
Drawing: when just drawing himself, he draws himself anatomically correct, but when drawing himself and 'tannie Ann', the arms go missing and they are identical. Can nearly write his name.

Child no 107: Running time: 101, had no concept of numbers, had trouble with position, crawling and drew triangles the same as squares. Problem with cross balance. Absent: 4 days. Not school ready according to Mini Loco and teacher.

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M-ABC before: 17 - M-ABC after: 11. Major problem area: ball skills and balance.

She changed threading hand during trial, got distracted, held head at an odd angle, progressed in short jerky movements on the bicycle trial, did not catch one bean bag, did not use pendular swing of arm, did not follow through with the rolling arm, could not maintain balance while rolling ball, judged force of roll poorly, did not hold head and eyes steady, had exaggerated movement of arms and trunk which disrupted balance, swayed wildly to maintain balance, did extremely poorly on one leg and failed all jumping over cord trials.

Final assessment - drawing observation score: 34. Boppin' Bugs: 15.

Drawing: draws herself different to 'tannie Ann', anatomically correct bodies. Can write name.

Child no 133: Running time: 47, had no concept of numbers, had trouble with position. Absent: 2 days. Not school ready according to Mini Loco and teacher. Child can not sit still or concentrate.

M-ABC before: 10 - M-ABC after: 9. Major problem area: manual dexterity and ball skills.

He held his face too close to the paper, had a poor sitting posture, moved constantly, progressed in short jerky movements.

Final assessment - drawing observation score: 18. Boppin' Bugs: 38.

Drawing: draws himself different to 'tannie Ann', anatomically correct bodies. Can not write name.

Child no 103: Running time: 51, had trouble crawling and could not draw squares or triangles, they all looked like circles. Wrote back to front. Absent: 0 days. Not school ready according to teacher.

M-ABC before: 14 - M-ABC after: 8. Major problem area: manual dexterity and jumping over cord.

He did not use the supporting hand to hold box steady, turned his left hand around the wrong way to put coin in slot, moved constantly, picked up beads the wrong way around, failed all jumping over cord trials.

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Final assessment - drawing observation score: 27. Boppin' Bugs: 27.
Drawing: draws himself different to 'tannie Ann', anatomically correct bodies. Can write name.

Child no 108: Running time: 51, had no concept of numbers, had trouble with position and could not draw squares or triangles. He had poor listening skills, no discipline and was not motivated. Absent: 15 days. Not school ready according to Mini Loco and teacher.
M-ABC before: 11 - M-ABC after: 6. Major problem area: manual dexterity and ball skills.
He held lace too far from tip, changed threading hand during trial, his control of direction was variable and did not use his arms to assist jump.
Final assessment - drawing observation score: absent. Boppin' Bugs: absent.
Drawing: absent.

Child no 128: Running time: 107, had no concept of numbers, had trouble with position, hand and feet walking and could not draw squares or triangles. Absent: 0 days. Not school ready according to Mini Loco.
M-ABC before: 11 - M-ABC after: 6. Major problem areas: manual dexterity rolling the ball and jumping over cord.
She put the lace down when picking up beads and had her tongue out of her mouth, she held her face too near to the paper and moved her tongue as she moved her pen, her control of force was variable.
Final assessment - drawing observation score: 22. Boppin' Bugs: 9.
Drawing: draws herself same as 'tannie Ann', anatomically correct bodies. Can write name.

Child no 134: Running time: 47, had no concept of numbers. Absent: 8 days. Not school ready according to Mini Loco and teacher. Suspected hearing problem.
M-ABC before: 15 - M-ABC after: 5. Major problem area: manual dexterity and ball skills.
He moved constantly and when he wrote he put his head on his shoulder.

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Final assessment - drawing observation score: 32. Boppin' Bugs: 24. Drawing: draws himself different to 'tannie Ann', anatomically correct bodies. Gives himself big ears. Can write name.

Child no 228: Running time: 54. She had trouble with position and concept of numbers. Could not draw circles, squares or triangles. Absent: 11 days (also during primitive movement observation). Not school ready according to Mini Loco and teacher.

M-ABC before: 8 - M-ABC after: 5. Major problem area: manual dexterity, catching bean bag and jumping over cord.

She held her face too near paper, held her head at an odd angle, held pen with an immature grip, progressed in short jerky movements and was exceptionally slow. She also turned the paper to go around the corners. When catching the bean bag, she held hands out flat with fingers stiff as the bean bag approached and her arms and legs did not 'give' to meet impact of bean bag. In the ball skills, she did not keep eyes on target, did not use pendular swing of arm and did not follow through with the rolling arm.

Final assessment - drawing observation score: 25. Boppin' Bugs: 24. Drawing: draws herself the same as 'tannie Ann' but smaller and draws arms coming out of head and no bodies, just legs. Writes her name from right to left.

Child no 215: Running time: 33. He had trouble with position, concept of numbers, colour and could not walk on his hands and feet. Drew triangles and circles the same. Absent: 6 days. Not school ready according to Mini Loco and teacher.

M-ABC before: 16 - M-ABC after: 4. Major problem area: all areas especially catching bean bag and jumping over cord. After intervention only posting coins was still a problem.

In catching bean bag he did not move until the bag struck his body. He was incapable of jumping over cord and did not know how to walk on his toes.

Final assessment - drawing observation score: 32. Boppin' Bugs: 21. Drawing: draws himself the same as 'tannie Ann' with huge ears, and arms coming out of legs. Can almost write his name, he forgets one letter.

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<u>Child no 219</u>: Running time: 45. Absent: 5 days (during position, counting and colour observation). Not school ready according to Mini Loco.
M-ABC before: 9 - M-ABC after: 4. Major problem area: catching bean bag and walking heels raised.
When catching the bean bag, her arms were not raised symmetrically for catching, arms and legs did not 'give' to meet impact of bean bag and she did not adjust to the force of the throw. When walking on her toes, she did not look ahead, did not compensate with arms to maintain balance, individual movements lacked smoothness and only one foot had its heel raised.
Final assessment - drawing observation score: 32. Boppin' Bugs: 41.
Drawing: draws herself the same as 'tannie Ann' but smaller. Anatomically correct bodies. Can write name.

<u>Child no 223</u>: Running time: 35. He had trouble with concept of numbers, colour and could not walk on his hands and feet. Could not draw squares or triangles. Absent: 17 days. Not school ready according to teacher. Holds his head in his hand and sticks his tongue out when writing.
M-ABC before: 6 - M-ABC after: 4. Major problem area: catching bean bag and balance.
He changed threading hands during trial. On the bicycle trail he held his head at an odd angle, did not hold the paper still and progressed in short jerky movements. In ball skills, he did not follow trajectory of bean bag with eyes, his arms did not 'give' to meet impact of bean bag approached, did not use a pendular swing of the arm and did not follow through with the rolling arm.
During balance, exaggerated movements of arms and trunk disrupted his balance, he swayed wildly to tray to maintain balance, body appeared rigid, was very wobbly when placing feet on line, swayed wildly to maintain balance and the sequencing of steps is not smooth.
Final assessment - drawing observation score: absent. Boppin' Bugs: 42.
Drawing: draws himself the same as 'tannie Ann' but smaller and draws anatomically correct bodies. Can write his name. Had his hand bandaged when re-testing M-ABC.

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Child no 115: Running time: 58, had no concept of numbers or colour and could not draw triangles. Absent: 0 days. Not school ready according to Mini Loco.
M-ABC before: 6 - M-ABC after: 3. Major problem area: posting coins.
She held lace too far from tip, did not keep eyes on target, could not stand still in one leg balance, when jumping she landed on flat feet and she did not look ahead when walking on toes.
Final assessment - drawing observation score: 20. Boppin' Bugs: absent.
Drawing: draws herself smaller but the same as 'tannie Ann', anatomically correct bodies. Can write name.

Child no 210: Running time: 40. He had trouble with position, the concept of numbers, colour and crawling. Could not draw triangles. Absent: 12 days. Not school ready according to teacher.
M-ABC before: 6 - M-ABC after: 3. Major problem area: posting coins and catching bean bag, general ball skills after intervention.
He held his head at an odd angle and progressed in short jerky movements. When trying to catch the bean bag he seemed to not be able to interpret distance and always missed by half a meter or so.
Final assessment - drawing observation score: 23. Boppin' Bugs: 25.
Drawing: draws himself exactly the same as 'tannie Ann'. Can write his name.

Child no 109: Running time: 44, had trouble with crawling, hands and feet walking and could not draw triangles. Did mirror writing. Absent: 8 days. Not school ready according to Mini Loco and teacher.
M-ABC before: 11 - M-ABC after: 2. Major problem areas: posting coins, rolling the ball and balance.
He held his head at an odd angle, his sitting posture was poor, moved constantly, did not hold head and eyes steady in one leg balance, his body was held rigid and he swayed wildly to maintain balance.
Final assessment - drawing observation score: 34. Boppin' Bugs: 27.
Drawing: draws himself different to 'tannie Ann', anatomically correct bodies. Can write name.

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Child no 218: Running time: 103. She had trouble with position, concept of numbers, colour and was absent during primitive movement observation. Could not draw triangles or squares. Absent: 33 days. Not school ready according to Mini Loco and teacher.

M-ABC before: 10 - M-ABC after: 2. Problems in all areas apart from balance, after intervention problem area only posting coins.

She did not use supporting hand to hold box steady, moved constantly, held hands out flat with fingers stiff as the bean bag approached, did not adjust to height or direction of throw. She kicked her legs and put everything in her mouth. She also could not release the beads onto the board. After intervention she was one of the few children who picked up beads with her left hand!

Final assessment - drawing observation score: 27. Boppin' Bugs: 9 (too small). Drawing: draws herself different to 'tannie Ann'. Anatomically correct bodies. Can write her name.

Child no 222: Running time: 35. She had trouble with position, concept of numbers, colour and crawling. Could not draw triangles. Absent: 5 days. Not school ready according to Mini Loco and teacher.

M-ABC before: 6 - M-ABC after: 2. Major problem area: catching bean bag.

In the bicycle trial before, she held face too near paper, held head at an odd angle, held pen too close to point, progressed in short jerky movements and used excessive force, she also lifted her hand up all the time, however, she did not cross the line. During re-testing she only held face too near paper and held head at an odd angle but did cross the line. When catching the bean bag, she did not follow trajectory of bean bag with eyes, arms were not raised symmetrically for catching, held hands out flat with fingers stiff as the bean bag approached, her arms and legs did not 'give' to meet impact of bean bag and her body appeared tense.

Final assessment - drawing observation score: 29. Boppin' Bugs: 21.

Drawing: draws herself different to 'tannie Ann'. Anatomically correct bodies. Can write name but mixes two letters up.

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Child no 205: Running time: 100. She could not draw triangles. Absent: 15 days. When writing she looks away with her head on her shoulder.
M-ABC before: 5 - M-ABC after: 1. Major problem area: posting coins.
She did not use supporting hand to hold box steady, leant back when putting the coins in the box, changed hands during threading, held head at an odd angle, held pen too close to point, progressed in short jerky movements, her fingers closed too late when trying to catch. She did not use pendular swing of arms nor did she follow through with the rolling arm.
Final assessment - drawing observation score: 35. Boppin' Bugs: 27.
Drawing: draws herself different to 'tannie Ann'. Anatomically correct bodies. Can write name.

Child no 229: Running time: 54. He had trouble with position, concept of numbers, colour and could not walk on his hands and feet. Could not draw triangles. Absent: 46 days. Not school ready according to teacher.
M-ABC before: 4 - M-ABC after: 1. Major problem area: manual dexterity.
He did not use the supporting hand to hold the box steady, changed hands from trial to trial. On the bicycle trail he held his head at an odd angle, held pen too close to point and progressed in short jerky movements. When the bean bag approached, he closed his eyes.
Final assessment - drawing observation score: 25. Boppin' Bugs: 9.
Drawing: draws himself the same to 'tannie Ann', bar an appendage, but draws anatomically correct bodies. Can not write name. Mirror writing.

Child no 131: Running time: 46, had trouble with the concept of numbers. Absent: 11 days. Not school ready according to Mini Loco.
M-ABC before: 7 - M-ABC after: 0. Major problem areas: posting coins and one leg balance.
He changed his hand during threading, progressed in short jerky movements and was exceptionally slow in the bicycle trail, did not hold head and eyes steady, had exaggerated movements of arms and trunk and swayed wildly to maintain balance.

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Final assessment - drawing observation score: 34. Boppin' Bugs: 26.
Drawing: draws himself different to 'tannie Ann', anatomically correct bodies.
Can write name.

Child no 214: Running time: 43. He had trouble with position and the concept of numbers. Absent: 16 days. Not school ready according to Mini Loco and teacher.
M-ABC before: 5 - M-ABC after: 0. Major problem area: bicycle trail and walking heels raised.
During the bicycle trail he held his head at an odd angle, held pen too close to point, progressed in short jerky movements and went too fast for accuracy.
He did not compensate with arms to maintain balance when walking on his toes and did not look ahead.
Final assessment - drawing observation score: 29. Boppin' Bugs: 50.
Drawing: draws himself almost exactly the same as 'tannie Ann' with no arms, he has one circle on his body and 'tannie Ann' has three. Can write name.

Child no 232: Running time: 43. She had trouble with position, concept of numbers and when picking up beads she would use her entire arm. Could not draw triangles. Absent: 15 days. Not school ready according to teacher.
Writes standing up.
M-ABC before: 2 - M-ABC after: 0. Major problem area: posting coins and one leg balance.
She held lace too near tip in threading beads, changed threading hand during trial, sometimes missed hole with tip of lace and picked up beads the wrong way around. On the bicycle trail she held her head at an odd angle, held pen too close to point, progressed in short jerky movements and was exceptionally slow. Although she caught the bean bag seven times, she held hands out flat with fingers stiff as the bean bag approached, her arms and legs did not 'give' to meet impact of bean bag, she did not move until the bean bag struck the body and she caught with one hand.
Final assessment - drawing observation score: 27. Boppin' Bugs: 9.
Drawing: draws herself different to 'tannie Ann' and draws anatomically correct bodies. Can write half her name

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