THE COGNITIVE INVOLVEMENT OF CHILDREN WITH LEARNING PROBLEMS

by

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I declare that THE COGNITIVE INVOLVEMENT OF CHILDREN WITH LEARNING PROBLEMS is my own work and that all the sources that I have used or quoted have been indicated and acknowledged by means of complete references.

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M. P. DE VILLIERS

Dedicated to my wife, Kathleen
and to my son, Stanley.

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SUMMARY

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This research focuses on answering the question of whether a child with a learning problem, or more specifically, a learning disability, functions at a lower cognitive level than the non-learning disabled child. Performance on certain memory tasks and tasks that require the withholding of attention from distractors is measured and compared.

In the literature study, an overview of the neurological, the cognitive and the ecological approaches to remediation is given. The concepts of attention deficits and memory problems are investigated, as well as the theories of cognitive development as propounded by Piaget and Santostefano.

No significant difference in the cognitive functioning, as measured by the test used in this research, was found between these two groups of children. The implication of this is that where children experience learning problems, the explanation for this difficulty is possibly at an ecological level. More specifically, it may relate to a lack of stimulation during the pre-school years.

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Chapter 1

PROBLEM ORIENTATION, PURPOSE AND PLAN OF STUDY

1.1. INTRODUCTION

The child, on his way to adulthood, interacts with his environment. In this way he becomes involved, he experiences his environment and is able to give meaning to it, thus forming relationships. Through this involvement, experience and attribution of meaning, the child is able to form an identity. The continued interaction between these three concepts enables the child to evaluate himself using internal dialogue and this results in the formation of a self-concept.

According to Horrocks and Jackson (Jacobs, 1987 : 3), it is the child's cognitive abilities that enable him to give meaning to his world and thereby form a self concept. Cognitive skills therefore play an integral part in the child's becoming and two key factors in this cognition are attention, or the ability to attend, and memory.

Krupski (1987 : 62) is of the opinion that research on attention problems is in disorder and presents a muddy picture. She suggests that inconsistencies in the study of attention are not a function of the

data, but are, instead, a function of the belief system that underlies and guides the interpretation of the data. This opinion applies equally well to research on memory and to the field of remedial education in general.

This investigation focuses on attention and memory against the background of a psychoneurological appraoch, of a cognitive approach and of an ecological approach to remediation.

1.2. PROBLEM ANALYSIS

1.2.1. Awareness of problem

This research was initiated while working in the field of remedial education where it was found that over a period of four years using a psychoneurological approach to remediation, a number of pupils with problems in reading did not progress adequately. Progress during that period was most certainly made, but it was felt that for the amount of time that each child was in therapy, the progress should have been greater.

On further investigation it was found that the major complaint of the remedial teachers was that these children could not concentrate and could not

remember phonic rules, sight words or spelling from one day to the next.

In the light of this a literature study was undertaken on research conducted into attention deficits and memory problems. Alternative approaches to remediation were also investigated.

1.2.2. Exploration of the problem

1.2.2.1. General background

Learning difficulties have posed a problem for educational psychologists and teachers for many years. Not only is there controversy as to the definition of a learning disability but also as to the cause of the problem and approach to remediation.

The literature is prolific with regard to dissatisfaction with prevailing definitions of learning disabilities. The fact that practitioners and researchers continue to use a variety of descriptors, illustrates that learning disabilities have been treated as a concept by some and as a category by others. Adelman (1992 : 17) has found that viewing learning disabilities either as a concept or as a category is not satisfactory.

As a concept, Adelman says, a learning disability has been elusive, as a category, it has been polymorphous. In chapter 2 this will be discussed in greater depth.

As early as 1877 Kussmaul (Swanson, 1991 : 160) described an inability to read as word-blindness and in 1917 James Hinshelwood reported the case of an intelligent boy who failed to learn to read (Kriegler, 1988 : 3). He speculated that the cause of this was a defect in a specific area of the brain. Much research has gone into this, resulting in the idea or concept of 'dyslexia' which is used today.

According to Kriegler (1988 : 3), during the second half of the ninteenth century Paul Broca carried out research to show that an inability to speak correlates with damage to certain areas of the brain. This was further developed by Carl Wernicke who found that specific functions such as speech and the comprehension of langauage are localized in specific areas of the brain.

From the period of 1930 to 1960 a neurological approach to remedial education began to develop and held centre stage. During this period the Illinois

Test of Psycholinguistic Abilities was developed and Helmer Myklebust (1967 : 7) introduced the idea of learning disabilities being psychoneurological in nature. In addition, Strauss and Werner's (Hresko and Parmar, 1991 : 17) Perceptual-Motor approach became popular. This led to the introduction of terms such as 'Strauss syndrome', 'minimal brain dysfunction', 'psychoneurological dysfunction' and 'specific learning disability' being used to describe the child who was experiencing learning difficulties.

Later, with the development of cognitive psychology, learning problems began to be viewed from a different perspective. The works of Piaget and Feuerstein resulted in the adoption of a cognitive approach to remedial education which meant that a learning problem was no longer viewed as being caused by a brain dysfunction, but rather was viewed as a problem with thinking skills or strategies. Hence, a move towards and focussing on metacognition (Kriegler, 1988 : 10).

It would appear that a more contemporary development in remedial education is the rejection of the neurological appraoch in explaining learning prob-

lems in favour of an interactionist or ecological model (Kriegler 1988 : 11). In this approach, emphasis is placed on the child's interaction with his environment.

Adelman (1992 : 18) points out that the key to identifying learning problems caused by minor neurological dysfunctions involves, obviously, assessing such central nervous dysfunctions. Unfortunately, available methodology precludes doing this in a valid manner, as existing neurological procedures lack validity for making such a diagnosis. He advocates that rather than looking purely for a neurological deficit as the cause of a learning problem, the educational psychologist should investigate other possible aetiological factors. Examples of such factors are the following: One would usually commence by focussing on the individual. Besides looking for evidence of a neurological dysfunction, the individual's cognitive skills and strategy deficits should be investigated or assessed. The individual's environment should be taken into consideration. Factors such as parental neglect and poor instruction could most certainly

affect the ability to learn. Finally, the reciprocal interplay of the individual and his environment should be investigated.

With regard to poor attention, a tremendous amount of research has been carried out. Over the past thirty years research regarding children who suffer an attention deficit disorder has been particularly noticeable. During this period and even today, there is still controversy regarding the aetiology of this disorder and the use of medication in treating it.

It is suggested that the child who cannot concentrate has a defective "filtering mechanism" which causes him to take in a greater amount of information that is irrelevant to the situation (Wicks-Nelson and Israel, 1984 : 232). From the research carried out by Luria (Jordaan and Jordaan, 1984 : 213), using a physiological approach, the reticular formation, the limbic structures, a basal ganglion and the frontal cortex of the brain play an important role in attention.

From the above it would appear that the child with an attention deficit could be helped by attending

to the physiological aspect, taking a pharmacological approach to remediation. On the other hand, the child could be helped by addressing the development of inner language, a cognitive approach.

Douglas (Kirby, 1986 : 15) found in his research that stimulant medication provides some improvement in the child's attending behaviour, but not on tasks that make heavy demands on the problem-solving components of attention. He found that these children lack problem solving skills and that neither medication nor reinforcement, no matter how effective, can correct, unless there is a concomitant programme to develop the missing skills.

Kirby (1986 : 11) feels that the child who has a concentration problem lacks sufficient 'pulses of effort' (strings of loosely connected self statements called INTERNAL DIALOGUE). The attentive child is able to monitor and control attention through internal dialogue that relates to defining and clarifying the nature of tasks, generating the means of solution, monitoring progress and errors and anticipating success. He indicates that children who lack skills in deliberate use of internal dialogue tend to have problems on tasks and

situations requiring sustained effort, self-regulation and self control.

Memory problems, too, are pertinent in the discussion of learning problems. Memory involves maintaining information over time (Matlin, 1989 : 70). Some information can be maintained for as long as a lifetime or for a few seconds only. Memory is so central to cognitive processes that it influences all aspects of learning. For example, attention and pattern recognition are clearly affected by the strategies used to remember. Information in short term memory can be stored in terms of its sound, meaning and visual appearance. However, research on short term memory demonstrates that people easily forget material, even after a few seconds delay.

A large number of children who are regarded as learning disabled perform in the retarded range on tasks that require immediate verbatim recall of sequences of verbal information (Torgesen, 1988 : 605). Analysis of these children's performance deficit suggests that they result from inefficiency in coding or representing the phonological features of language. As a result the primary academic limitation of these children lies

in the poor acquisition of fluent word identification or word analysis skills.

It would appear then that memory and attention are mutually dependant and that problems or deficits in either would affect the ability to learn effectively. From the above discussion, it is evident that (given all other factors being equal) if a deficit in attention or memory exists, the child will not function scholastically at the same level as his peers.

1.2.3. Formulation of the problem

Against this background, and in view of the problem experienced, a literature study of the different approaches to remediation needs to be carried out with a view to selecting an approach that will possibly be more effective. This also requires that the concepts of attention and memory be investigated.

In view of the fact that attention and memory are key factors in both the psychoneurological approach and the cognitive approach, an empirical investigation, using the Cognitive Control Battery of Santostefano, which evaluates attention and memory, can be carried out.

The results of this test will help to determine which of the approaches or theories of remediation should be emphasised. If there is a great difference between the experimental and control groups with regard to performance in attention and memory, it would lend impact to or support for the psychoneurological or cognitive approach.

If there is no significant difference between the groups, the ecological approach would be the theory of choice.

1.3. STATEMENT OF THE PROBLEM

Does the child who has a learning disability function at a lower cognitive level than the non-learning disabled child?

a) Do learning disabled children perform more slowly on tasks that require the withholding of attention from external and internal distractors?

b) Do learning disabled children make more errors than non-learning disabled children when required to perform tasks while withholding attention from external and internal distractors?

c) Do learning disabled children have more difficulty in comparing images of past information with perceptions of present information than non-learning disabled children?

d) What does the literature say with regard to pre-literacy experiences:

* Do inadequate early learning experiences have an effect on cognition and metacognition?

* Are reading problems primarily teaching problems?

* Are there shortcomings concerning the instruction of reading and spelling in the South African education system?

* Have parents failed their children as far as providing "pre-literacy" experiences?

1.4 AIM OF RESEARCH

1.4.1. Specific Aim

The specific aim of this study is to investigate the cognitive functioning of the learning disabled child.

The investigation is directed essentially at:

a) Comparing the speed and accuracy with which learning disabled and non-learning disabled children complete tasks that require the withholding of attention from both internal and external distractors.

b) Establishing the degree of difficulty experienced by learning disabled and non-learning disabled children in comparing images of past information with perceptions of present information (memory).

c) Undertaking a literature study on attention and memory and various approaches to remediation in order to complement the empirical investigation.

1.4.2. General Aim

The ultimate aim of this investigation is to come

to a better understanding of the cognitive

functioning of the learning disabled child in order to:

a) help the learning disabled child to achieve a positive, realistic self concept, which is a prerequisite for self actualisation;

b) help the child towards the realisation of his true potential, not only in the school context but also in his future adult life;

c) contribute towards a frame of reference for expanded research into the life world of the learning disabled child which may further enhance an understanding of these children, particularly by those adults who have a pedagogic responsibility towards them.

1.5. METHOD OF EMPIRICAL INVESTIGATION

The investigation is aimed at determining whether learning disabled children have deficits in cognitive functioning when compared with non-learning disabled children. This investigation looks specifically at attention and memory.

For this purpose, the Cognitive Control Test Battery of Santostefano will be used as it specifically evaluates the cognitive structures of attention and memory.

In order to make a comparison, to draw conclusions and to generalize findings, a nomothetic study is adopted as opposed to an idiographic study. The mean scores of a group of learning disabled children

is compared with those of a non-learning disabled group of children. The investigation therefore takes the form of an ex post facto design for a criterion group. For the purposes of this comparison, t Tests for pairs of matched pupils are used.

1.6. PLAN OF STUDY

Subsequent chapters of this dissertation are planned as follows:

Chapter 2 -

In chapter 2 an overview of three approaches to the remediation of learning problems will be given. The three approaches are the psychoneurological approach, the cognitive approach and the ecological approach. In this chapter criticisms levelled at certain aspects of the approach are also discussed.

Chapter 3 -

In chapter 3 the concepts of cognition and metacognition are investigated, with particular reference to the cognitive developmental theory of Piaget.

Chapter 4 -

Chapter 4 contains the findings of the literature study into memory and attention and deficits in

these two areas. This is viewed from both a neurological and a cognitive perspective.

Chapter 5 -

In this chapter the method used in the empirical investigation is described.

Chapter 6 -

This chapter contains a recording of the findings of the empirical investigation.

Chapter 7 -

Chapter 7 offers the conclusions, recommendations and implications that can be made on the basis of this investigation, taking into account such defects as could be noted by the researcher.

Chapter 2

AN OVERVIEW OF APPROACHES TO REMEDIAL EDUCATION

2.1. INTRODUCTION

A great deal of research has gone into the field of remedial education and the approaches to remedial therapy for children suffering from learning disabilities have been varied and numerous. From the 1960's the most popular approach came from the perspective of the medical field and a medical model was formulated. Working from this premise it was purported that a learning disability has its aetiology in a neurological dysfunction. With this in mind, terms and definitions began to appear in the literature, to describe the child who had difficulty in learning to read and spell, such as being dyslexic, suffering from minimal brain dysfunction or psychoneurological dysfunction.

The training of remedial therapists in this country has been heavily influenced by this medical model and a multidisciplinary team (including a peadiatrician, neurologist, occupational therapist, speech therapist and psychologist) support the teacher in helping the child to cope with the underlying problems that inhibit the mastery of reading and spelling.

In more recent years the emphasis has shifted to a cognitive approach which differs in certain aspects from the psychoneurological approach. In the cognitive approach the focus is on thinking processes and knowledge about one's own thinking (metacognition).

Even more recently the following question has been raised with regard to the child who fails to learn to read or spell correctly : Does the problem which is causing reading and/or spelling failure lie within the child or within the environment in which the child is brought up? (Kriegler, 1988).

For the purposes of this research, a brief overview of these approaches will be given.

2.2. PSYCHONEUROLOGICAL APPROACH

This approach makes use of a medical model and focuses on the child with a problem rather than on the social milieu of that child with the problem.

Bryan and Bryan (1978 : 36) discuss the early models of language where an analogy was made between adult and child aphasia. Aphasia in adults represented the loss of speech - usually due to a cerebro-vascular accident or injury to the brain. Aphasia

in childen, (where there has not been a trauma) however, referred to the absence of the development of language. The dynamics of brain injury were considered analogous insofar as it was believed that specific parts of the brain were not functioning adequately and that this type of malfunction was reflected in the language behaviour of both adult and child.

This led to numerous theories of a learning disability which were neurological in origin. Fernald (1988 : 7) gives five causes of failure in learning to read:

a) Lack of normal development of certain brain functions.

b) Failure to establish unilateral cerebral dominance.

c) Lack of corresponding eye and hand dominance.

d) Handedness, which she believed caused reversal problems such as reading 'saw' for 'was'.

e) Individual differences in integrated brain functions.

Lerner (1989 : 10) states that since all learning originates in the brain it can be presumed that a disorder in learning can be caused by a central nervous dysfunction.

Possibly the most noted theorist during the 1960's was Myklebust whose theory and findings support the view of Fernald and of Lerner.

Myklebust (1967 : 8) made use of the term 'psychoneurological dysfunction' to describe the child who is regarded as learning disabled. The preference for this term being that the observable symptoms of a learning disability are psychological and the condition is neurological. It is clearly evident that his approach focuses on the central nervous system.

Children diagnosed as having a psychoneurological dysfunction are those who have "adequate motor ability, average to high intelligence, adequate hearing and vision and adequate emotional adjustment, together with a deficiency in learning" (Myklebust, 1967 : 9). Thus, in spite of his sensory capacity being intact, having adequate intellectual capacity, adequate social capacity and emotional adjustment, the child has a "deficiency in learning".

2.2.1. Definition

There are numerous formal definitions of a learning

disability. In essence they all contain certain common elements.

Each definition refers to the learning disability as a neurological dysfunction and indicates that there is an uneven growth pattern. Difficulty is experienced in academic and learning tasks, there is a discrepancy between achievement and potential and other causes are excluded. As an example, the definition, according to the National Institute of Child Health and Human Development, Interagency Committee on learning disabilities, is given here:

"'Learning disabilities' is a generic term that refers to a heterogeneous group of disorders manifested by significant difficulties in the acquisition and use of listening, speaking, reading, writing, reasoning or mathematical abilities or of social skills. These disorders are intrinsic to the individual and presumed to be due to central nervous system dysfunction. Even though a learning disability may occur concommitantly with other handicapping conditions (for example, sensory impairment, mental retardation, social and emotional disturbances), with socioenvironmental influences (for example, cultural differences, insufficient or inappropriate instruction, psychogenic factors),

and especially with attention deficit disorder, all of which may cause learning problems, a learning disability is not the direct result of those conditions or influences" (Hresko and Parmar, 1991 : 6).

The medical perspective views learning disabilities as a function of neurological, neurobiological, genetic or hormonal dysfunction related to the biological functioning of the brain (Hresko and Parmar, 1991 : 18).

Central to the psychoneurological approach is that basic psychological processes such as perception, attention and memory are affected. Hresko and Parmar, (1991 : 17) state that, because of this, a learning disability is viewed as a physiological deficit that affects the way an individual interprets or represents information.

Related to this, if the learning disabled child's hearing and vision are intact, Frostig (1973 : 1) raises the question, and in fact concludes, that problems experienced by the learning disabled child with regard to the recognition and integration of stimuli must be affected by a process that occurs

in the brain and not in the receiving organs. The process being referred to is 'perception', which is closely related to the medical model. Frostig defines perception as the ability to recognize stimuli and differentiate among them. This ability includes not only the reception of sensory impressions from the outside world and from one's own body, but the capacity to interpret and identify the sensory impressions by correlating them with previous experience.

Frostig (1973 : 10) explains that it is difficult to discover factors contributing to the child's disability in visual perception, but suggests that it may be pathological in origin or it may be a lag in perceptual development without readily discernible causes.

This maturational lag mentioned above is referred to by Bryan and Bryan (1978 : 32) as a time lag in the development of certain skills relative to others. The concept of the brain and its relationships to behaviour is again included, but rather than believing that this is the result of a shift in the way the brain works, it is suggested that parts of the brain mature at different rates.

Myklebust (1967 : 27) investigates visual and auditory perception further. He accepts that no learning can be purely intra-neurosensory, but explains that a brain dysfunction can disturb auditory-neurological processes without fundamentally disturbing other processes. Accordingly there can be problems of auditory discrimination, comprehension and memory WITHOUT equivalent problems in visual psycho-neurological processes. The same can be said for visual and tactile learning.

The inability to read is said to be caused by an inter-neurosensory learning disability. The first language system which the child acquires is the spoken word. Initially when the child learns to read, he does so by converting or translating the visual word into its auditory equivalent. In the presence of certain types of dysfunction in the brain, this cross-modal learning may be impeded. In other words, two or more systems fail to function interrelatedly.

2.2.2. A psycho-neurological approach to attention deficit and memory impairment.

Two of the important areas of concern for the remedial teacher are poor attention and poor memory skills. These two concepts form an integral part of this study and will be discussed more fully in chapter 4. However, for completeness of this overview these concepts will be mentioned briefly.

2.2.2.1. Attention deficit

According to Myklebust (1967 : 300) poor attention is the result of a child's inability to integrate sensory information successfully. When attention is disturbed, the dysfunction is thought to be in the reticular activating system (RAS) of the sub-cortex.

2.2.2.2. Memory impairment

Many types of memory impairment result from a central nervous system dysfunction, such as memory span, immediate recall and delayed recall. This can cause the child to be unable to re-visualize letters and words resulting in poor reading.

In reading or spelling, the child with a deficit in memory may be able to follow a sequence when a model is presented but cannot revisualize the

sequence from memory. Some children cannot remember either verbal or non-verbal experiences. This revisualization deficit may affect other forms of behaviour as the child cannot retain visual images (Myklebust, 1967 : 152).

2.2.3. Essence of the approach

In summarising the psychoneurological approach, emphasis is placed on the fact that a brain dysfunction has altered the way in which the child learns and that highly consequential medical problems are involved (Myklebust, 1967 : 63). Moreover, the findings of the neurologist, electro-encephalographer and ophthalmologist are paramount when deciding on a remedial programme for the child.

2.2.4. Principles of remediation

In using this approach to remediation, the remedial therapist has to take cognisance of the underlying deficits which inhibit the ability to read. The approach to remediation is to teach via the child's strongest modality (visual, auditory, kinesthetic or tactile) while providing therapy to develop the weaker modalities. The child is taken back to the level of breakdown at which point remediation commences. Emphasis is placed on remediating the

underlying deficits, such as visual and/or auditory perception, in order to improve reading ability.

2.3 Cognitive approach

What is important in this approach is the way in which the child constructs a knowledge base and interacts with that knowledge and associated strategies in differing educational environments. The cognitive approach takes into account the active participation of the learner, views learning disabilities from a cognitive psychology perspective and uses information processing and other cognitive theories to answer the question of how the learning disabled child learns (Hresko and Parmar, 1991 : 21).

2.3.1. Definition

The roots of this approach are in "cognition" and "metacognition". What is meant by these two concepts?

2.3.1.1. Definition of cognition

"Cognition refers to the processes or faculties by which knowledge is acquired and manipulated" (Bjorklund, 1989 : 3). This then includes all of the processes or structures that are involved in

thinking such as perception, memory, attention, reasoning, language, organization and intelligence.

2.3.1.2. Definition of metacognition

Metacognition is cognition that transcends cognition. It is knowledge about the ordinary processes by which knowledge is acquired. It is thinking about thinking. Metacognition refers to the learner's awareness of cognitive processes and to the planning, self monitoring and evaluating of its success (Kriegler, 1988 : 93).

According to Nickerson et al, (1985 : 101) meta-cognitive skills may be thought of as cognitive skills that are necessary, or helpful to the acquisition, use and control of knowledge and other cognitive skills. They include the ability to plan and regulate the effective use of one's own cognitive resources.

To form a solid base for remediation, Engelbrecht (1989 : 191) defines metacognition as the "student's awareness of his own cognitive activity as well as the methods employed to regulate his own cognitive processes".

Reid (1988 : 4) points out that using a cognitive approach, a child would be identified as having a learning disability if:-

a) his intelligence is normal or above average;

b) he has difficulties in a few academic areas;

c) he is not suffering from a condition or disorder that can explain the learning problem.

The approach is cognitive in that it focuses on the process of learning that goes on in the learner's mind and it is developmental in that it addresses changes that occur over time.

At the mention of cognitive development, the name Jean Piaget immediately comes to mind. Labinowicz (1980 : 87) points out that in Piaget's theory of cognitive development, the order in which children pass through developmental stages does not vary and that all children must pass through the concrete operational stage in order to reach the formal operational stage. This will be discussed more fully in chapter 3. What is important to note is that the RATE at which one passes through each stage differs for each child.

2.3.2. A cognitive approach to attention deficit and memory impairment

Having looked at deficits in attention and memory from a psychoneurological perspective, it is of interest to note how these concepts are viewed from a cognitive perspective:

2.3.2.1. Attention deficit

Hresko and Parmar, (1991 : 30) raise the question whether attention is a defining characteristic of a learning disability or whether 'other' factors lead the learning disabled child to exhibit attentional characteristics that differ from those of the normal child. In answer to this they state that in the learning disabled child, frustration due to problems in basic learning processes often result in overt behaviour resembling attention problems of the hyperactive child. In support of this, Hresko states that a recurrent problem of the learning disabled child is a lack of ability to recognise words quickly and accurately. Reading is therefore frequently inhibited by slow lexical access which in turn decreases attentional capacity and comprehension.

On this issue of attention, Feuerstein (1980 : 78) emphasizes that impulsive, exploratory behaviour is not the result of an incapacity to attend, although these two phenomena frequently appear together. Instead, Feuerstein says, it is the product of inadequate training in exploratory skills. This is reflected in a poor definition of the problem to be solved, a lack of goal orientation and unsystematic exploration.

2.3.2.2. Memory impairment

According to Kail (1990 : 3) memory is viewed not as being an isolated intellectual skill. Memory is really a convenient descriptive term for a collection of cognitive processes. This view is most certainly echoed by Paiget (1968 : 4) who says that what the subject retains is not a perceptual model as such, but the way in which he assimilates it to his operational schemata, in terms of the operational level of each individual subject.

Piaget (1968 : 11) refers to different types of memory. In particular, he refers to recognition and evocation. The first type, recognition, relies on perception and sensory motor schemes alone, while evocation requires mental imagery or language. In

the case of the learning disabled child, it is this language (internal dialogue) which is usually not adequately developed, resulting in poor recall. Piaget's findings have indicated, or suggested, that developmental advances in knowledge can influence memory directly (Kail, 1990 : 78).

The cognitive approach does not regard attention disorders or memory disorders as being caused by an underlying deficit in the central nervous system. Krupski (1987 : 62) proposes that rather than regard these problems as the primary source of under-achievement or learning problems, they may be more accurately viewed as a symptom of a more fundamental cognitive limitation.

2.3.3. Essence of the approach

In the cognitive approach, the so-called learning disabled child is regarded as an immature learner - one who does not introduce strategies to aid his learning. It is felt that this type of child can be trained to introduce strategies to aid his learning. Unfortunately, according to Engelbrecht (1989 : 187), the immature learner rarely uses such strategic activities intelligently.

Finally, the profile of the learning disabled child's metacognitive skills is dependant on his cognitive skills. Learning disabled and hyperative learners lack sophisticated knowledge about their 'self', 'task' and 'strategy variables' of metacognition. They are also less able to regulate academic activity spontaneously (Engelbrecht, 1989 : 192).

2.3.4. Principles of remediation

The cognitive approach to helping the learning disabled child is to teach metacognitive skills. This is done by actively promoting a general awareness of cognitive and metacognitive processes. Children are helped to become aware of their own thinking processes. In order to do this, the teacher or therapist has to establish whether or not the learner is aware of how knowledge about the 'self', the 'task' and the 'strategies' influences performance. In addition, the therapist must find out how the child directs, plans and monitors his cognitive activities.

Techniques used include:-

a) The teacher providing a model where she "thinks aloud". By verbalising her own thought processes, the teacher demonstrates her own effective strategies for tackling difficult problems which the child can then imitate.

b) Children are asked to think aloud and are shown how to monitor their strategies. This information helps the child to develop a deliberate and systematic approach to learning.

Feuerstein (1980 : 1), in his approach to therapy, redevelops cognitive structures. His aim is to transform the learning disabled child's passive and dependant cognitive style into that which is characteristic of an autonomous and independent thinker.

Both approaches to remediation have many supporters and research studies from both the psychoneurological and the cognitive approach appear to be very convincing in their findings. However, the researcher, having worked in remedial education using the psychoneurological approach has not been completely convinced that this is the most effective approach or that the progress being made by chidren using this approach is satisfactory. There has, in fact, been strong criticism of the psychoneurological approach in favour of the cognitive approach. This criticism will now be discussed.

2.4. CRITICISM OF THE PSYCHONEUROLOGICAL APPROACH TO REMEDIATION

2.4.1. Academic problems are the domain of the educator

Firstly it has been asserted that the medical model, encorporating the psychoneurological approach, does not focus directly on the problems of learning disabled individuals; these problems being difficulties in learning. The approach has 'borrowed' from other disciplines and adapted findings to the learning disabled population. The concern is that pupils who appear to be normal in every respect sometimes fail to learn to read. The child is then seen by a host of professionals, mainly from the medical field, each giving a very convincing explanation as to the cause of the problem and advising different treatments. None of these recommendations focus on the actual learning process and the specialist in education - the teacher is regarded as ineffective. Hresko and Parmar (1991 : 21) are opposed to working from a 'borrowed' model and state that a unified theory of learning disabilities is needed. This theory should focus not only on the material to be learned, but also on the learner and the context of learning. Bonet (Hresko and Parmer 1991 : 21) says that "academic learning disabilities remain the

domain of the educator." In support of this, Gallagher (Hresko and Parmar, 1991 : 21) is also quoted as follows:

"Discovering the aetiology of mental retardation or speech pathology or emotional disturbance would provide no more help in educational planning than would discovering the causes of learning disabilities. The truth of the matter is that knowledge of the cause of the condition does not lead to specific educational treatment, nor should it be expected to".

2.4.2. The effect of perceptual processes on learning.

Proponents of the psychoneurological approach such as Strauss, Werner, Lehtinen, Cruickshank, Frostig and Kirk (Hresko and Parmar, 1991 : 17) place great emphasis on perceptual processes. The reason for this is that from their perspective, it is the brain's inability to process information adequately that results in a learning disability.

This view has come under criticism as during the last twenty years researchers have been generally unable to support the view that perceptual or perceptual-motor disabilities are the cause of most learning disabilities (Hresko and Parmar 1991 : 17). Yule and Rutter (1985 : 446) have found that

although visual-perceptual problems often appear together with reading problems, the visual-perceptual problem is not the cause of the reading problem.

Another criticism of the medical model is that it implies that the ordinary teacher cannot help a child with a learning problem unless she can diagnose and remediate the perceptual functioning of the child (Kriegler, 1988 : 21).

2.4.3. Soft neurological signs.

Although a neurological dysfunction is regarded as the cause of a learning disability, this dysfunction is not clearly evident (hard neurological signs) from a neurological examination (Kriegler, 1988 : 25). As a result of this, Bender introduced the concept of "soft neurological signs" which included: co-ordination problems, minimal tremors, gross and fine motor problems, visual-motor disturbances, language deficiencies and reading and arithmetic problems. Kriegler (1988 : 40) however, points out that these soft neurological signs are just as prevalent in children who are progressing normally in school. She is of the opinion that abnormalities in E.E.G's do not show any meaningful or significant correlation with reading problems in

children with normal intelligence. However, neurological deviations are more prevalent in weak readers who are of low intelligence, but this group of poor readers does not meet the criteria according to the definition, to be regarded as having a specific learning disability requiring remedial education. In fact, the definition of a psycho-neurological dysfunction is criticized.

2.4.4. The application of a theoretical definition.

The psychoneurological definition of a child suffering from a learning disability excludes the child who has a learning problem due to emotional, environmental, cultural or socio-economic problems or deprivation. Kriegler (1988 : 19) questions the practicality of being able to apply this criterion as it is extremely difficult to decide with any certainty which of these factors could be the underlying cause of a learning problem.

2.4.5. Attention deficit hyperactive disorder.

Closely associated with a learning disability is an attention deficit hyperactive disorder (ADHD) which is usually treated pharmacologically. In fact in certain areas of America, prescription of stimulant medication for children with attention deficit hyperactive disorders has reached epidemic

proportions (Swanson and Bray, 1991 : 89). Criticism here is that the prescription of stimulant medication should be based on an emerging body of information about the effectiveness of this treatment. At present this is not the case and the professional community is accused of remaining dependent on a knowledge base that has changed little since the late 1970's. What has been found is that stimulants have facilitated an improvement in certain aspects of behaviour, such as speed and accuracy in arithmetic. However, on short term academic achievement, the benefits of the medication are inconsistent, if beneficial at all.

It is interesting to note with regard to medication that Smart (1989 : 92), in her research at the New Hope School in Pretoria, found that when children suffering from an attention deficit were given Ritalin and a placebo during an experiment, no meaningful differences were noted in the children's behaviour. She also stated that the medication could affect the child's self concept, should he adopt the attitude: "I need the wonder tablet. On my own I cannot cope ... I am useless." In this way the child will never reach his full potential.

Other approaches to therapy which have emerged from

the medical model have also been criticized.

2.4.6. The effect of diet on learning difficulties.

The "Feingold diet" was introduced as a measure to help children with learning difficulties, more specifically those suffering from an attention deficit as it was believed that artificial colouring, preservatives and excessive ingestation of sugar adversely affected these children. There is to date no conclusive evidence to prove this and it was found that the Feingold diet worked only with a relatively small number of children (Swanson and Bray, 1991 : 95).

2.4.7. Optometric visual training programmes.

Optometric visual training programmes have been used in therapy to remediate reading disabilities. Recently in South Africa, tinted glasses have been touted as an effective therapy for reading disabilities. Proponents of this system claim that learning disabilities are associated with 'scotopic sensitivity syndrome (Swanson and Bray, 1991 : 94). This refers to vision of low illumination so that visual experience is that provided by the rods, as opposed to the cones, of the retina. With scotopic vision, hues are not seen, resulting in vision in terms of black and white. In addition, the bright-

ness threshold, compared with that of photopic vision, is low and the luminosity curve shows maximum sensitivity to a wavelength of approximately 510nm with rapidly decreasing sensitivity to longer and shorter wavelengths (Reber, 1985 : 671). Criticism levelled at tinted glasses and the optometric visual training programme is the lack of evidence that reading disabilities are in any way related to problems in the visual system.

2.4.8. Sensory integration therapy.

Neuromotor theories also form a part of the medical model. A technique frequently used in therapy, particularly by occupational therapists to improve fine-motor skill functioning, is sensory integration therapy. This therapy is based on the theory that learning disabilities are due to suboptimal organization of the midbrain and brain stem (Swanson and Bray, 1991 : 93). Therapy is therefore directed to stimulate the vestibular and somato-sensory system, rather than to improve higher cortical functions. However, Swanson and Bray (1991 : 94) point out that in a recent study it was found that there was no improvement in the academic performance of 45 children with learning disabilities after receiving sensory integration therapy.

Although one may not be able to accept all of the above criticisms, they most certainly are thought provoking. In spite of the argument in favour of a cognitive approach, this approach is also found to be lacking by some. Although cognition is emphasized in remedial work, another approach takes a wider perspective which includes the environment in which the child grows up and his interaction therein. This approach is the ecological approach.

2.5. AN ECOLOGICAL OR INTERACTIVE APPROACH

Kriegler (1988 : 53) moves away from the approach that the problems of the learning disabled child lie within the child himself. Cognitive psychology is emphasized, but she says that in helping the learning disabled child, one must not only have a good understanding of cognitive development, one must view cognitive development in relation to the child's affective and normative becoming. In the educational sense, this becoming refers to the transition towards adulthood (Vrey, 1979 : 10). Becoming is not a natural, inevitable process like biological growth under favourable conditions. It refers to the total involvement of the individual purposefully moving towards adulthood. This becoming is therefore dependant on aspects such as

the child's motivation, self concept, academic self concept, locus of control, peer relationships, method of communication and defence mechanisms.

What Kriegler (1988 : 55) is advocating is that the child, on his way to adulthood, interacts with his environment. In this way he becomes involved, he experiences his environment and is able to give meaning to it, thus forming relationships. Through this involvement, experience and attribution of meaning, the child is able to form an identity. The continued interaction between these three concepts enables the child to evaluate himself using internal dialogue and this results in the formation of a self-concept. This approach is therefore based on an ecological model where the child is viewed as interacting with his environment.

2.5.1 An interactive pedagogic - didactic environment:

Tindal and Marston (1986 : 60) support this approach as follows: "A major deficiency of traditional assessment and classification systems is to ignore the interactive nature of instruction and to place sole responsibility on the child. There is a viable alternative to this 'disordered child' model. This alternative view emphasizes the dynamic nature of the process by which school skills are acquired."

The child actually begins to acquire these so called 'school skills' from the day he is born, if not before. Research has found that during the first three years of life the development of the cerebral cortex can be enhanced and intelligence can be nurtured (Skeels and Dye, 1959:27). This is possible through stimulation and facilitating interaction with the child's environment. The preschool years of the child are therefore vital to the child's intellectual development. Beck (1969:18) summarizes this whole perspective by stating that "all later learning is likely to be influenced by the very basic learning which has taken place before the age of five or six. Ideally, the early intellectual development of the child should take place in the home."

Early childhood education is therefore of extreme importance and parents need to realise this, as they are partners in the whole education process (Topping and Wolfendale, 1985:21; Wiechers, 1991:8). In view of this, where children are left with 'surrogate parents' or nursery school teachers, these adults should be adequately qualified for the responsible task entrusted to them.

2.5.2 A model for teaching reading:

In view of the essence of the ecological approach, Young and Tyre (1982:50) suggest that in the teaching of reading, the point of departure should be from the child's own life world, as in the 'language experience approach' where the concept of 'writing for reading' is employed. This means that the child provides his own stories for reading and emphasis is placed on reading for meaning (Kriegler, 1988:97), Reid and Hresko (1991:241) refer to this approach as mind-to-eye reading rather than eye-to-mind reading.

This view is supported by Yule and Rutter (1985:444) who point out that our system of teaching reading, namely, a bottom-up approach is incorrect. Rather than teaching sounds and letters and then blending them into words and finally into sentences, these researchers suggest that a top-down approach be used where the child starts with meaning, moving down to the analysis of words. As an example, if one comes across the word 'rebel' in text, it will be pronounced in two different ways, depending on the meaning. Hall (1987:8) supports this further by stating that most children begin reading and writing long before going to school. A toddler is

able to identify the Milo tin or a particular brand of cereal in the supermarket without having been taught to sound out the letters on the container. What is important is that the product has meaning for the child and he is motivated to read the label. Kriegler (1988:97) suggests that the child should learn to read by reading!

2.5.3 The Aetiology of a Learning Problem:

The ecological approach rests on the belief that the child can change, can learn and can 'become' under the guidance of his parents and teachers. In this approach it is felt that there is no need to label the child who cannot read or regard him as having a 'sickness'.

Kriegler (1988 : 69) regards reading problems as the result of the interaction of the child with his environment. What is important then is the dynamic interaction between the child and the 'educational environment'. The implication of this, therefore, is that if the problem does not lie within the child, as intimated by the neurological approach, one has to question whether the education which the child is receiving can be regarded as optimal (Kriegler, 1988 : 100).

Where a reading problem does occur, Feuerstein (1980 : xiv) believes that it is the result of poor pedagogic input by parents during the first years of the child's life. The structure and dynamics of many families at present result in a lack of parental involvement in the child's education. This is exacerbated by certain school policies where no homework is given to children until they reach the senior primary phase of education. Homework can be used to facilitate parental involvement (Kriegler, 1988:167). Torrance (1990:12) has studied literacy in Japan and found an almost completely literate society. This weakens the argument of a neurological dysfunction causing reading problems and suggests that one look more closely at cultural and family relationships.

Two important factors emphasized in all of the literature are: parents being partners in education AND the necessity for pre-school education (Kriegler, 1988:340). These two factors make possible the 'pre-literacy experience' which enables the child to learn to read. For example, by reading to the child, language skills are developed, an appreciation for literature is

instilled and the child is helped to get ready for reading.

The ecological approach sees the role of the orthodidactician differently from that of the other approaches. The task of the orthodidactician is to expose and explain problems that occur in the interaction of the child with his environment (Kriegler, 1988:341). Finally, a knowledge of ecological theory does not only lead to a remedial approach, but also provides an answer to preventative measures to curb learning problems.

This approach assumes that individual children are different, but that these differences are gradual, moving along a continuum, and not qualitative. This implies that all children of normal intelligence can learn to read, but obviously not at the same rate or with the same ease. Rather than labelling the child as being learning disabled, Kriegler (1988 : 109) prefers more positively to refer to these children as "children who are difficult to teach."

2.6. SUMMARY

A learning disability has its aetiology in a neurological dysfunction according to the psychoneuro-

logical approach. This neurological dysfunction is usually referred to as manifesting in "soft neurological signs." The child is therefore regarded as having a brain dysfunction and as such, his problem cannot be cured. However, by gearing teaching towards the child's stronger modalities while remediating the weaker modalities (the underlying causes preventing the child from mastering reading skills) it is believed (in this approach) that the child will be helped to 'cope' with his problem and ultimately learn to read.

The cognitive approach views the learning disabled child as an immature learner rather than as a child with an incapacity due to a brain dysfunction. The child is seen as not being able to introduce strategies to assist him in learning.

From an ecological perspective, which is regarded as a more educationally dynamic - interactive approach, learning disorders are viewed as adaptations to significant environmental influences (Reid, 1991 : 122).

Because of the criticism levelled at the psychoneurological approach, in favour of the cognitive approach, the researcher wishes to under-

take a more indepth study of the concepts 'cognition' and 'metacognition'. Mention of Piaget and his theory of cognitive development has been made in this chapter and it is felt that in order to describe the learning disabled child adequately, it is necessary first to outline the cognitive development of the normal or non-learning disabled child. The following chapter will therefore take a closer look at cognition and the cognitive development of the child - particularly the child in the age range of 9 to 11 years on which this research is based.

Chapter 3

COGNITION

3.1. INTRODUCTION

Cognitive psychology and enthusiasm for a cognitive approach has grown rapidly. In fact, the period from 1960 onwards has been nicknamed the 'cognitive revolution'. Two important developments which are considered to have facilitated this are firstly, the conception of the information processing approach and secondly, Piaget's theory of cognitive development.

3.1.1. The information - processing approach

This approach originated in the communication sciences and in computer science but had great appeal for many psychologists. A mental process is viewed by this approach as a flow of information through various stages (Matlin, 1989 : 6). As an example, consider the flow of information that occurs when one goes into a shop to purchase an elephant skin wallet. First, a visual stimulus is received from the senses (the form of the wallet on display is registered on the retina); this visual stimulus is compared with information that is stored

in memory (the retinal image matches the information that has been stored about elephant skin wallets); additional information is obtained (by verifying with the shop assistant that the wallet is made of elephant hide); this information is compared with information stored in memory (the assistant's reply matches the wallet that has been stored in memory); a decision is made (the wallet is purchased). What is important in the information processing approach is that it concerns the flow of information within the organism and also between the organism and the environment.

3.1.2. Piaget's cognitive developmental approach

Jean Piaget constructed a new theory of developmental psychology that emphasized how children came to understand concepts such as object permanance. Piaget's theory of cognitive development soon became a classical work used extensively in the fields of psychology and education.

The cognitive approach has permeated most areas of psychology, even those areas that have not previously emphasized thought processes (Matlin, 1989 : 7). It is therefore important to have a clear understanding of cognition and how interest in

'cognition' has led to the development of the concept of 'metacognition'.

This chapter will therefore focus on cognition and metacognition. A progression from this will be to investigate Piaget's theory of cognitive development, with particular reference to the age group of pupils being studied in this research, the senior primary school child in the age group 9 years to 11 years. The reason for this is that, in order to understand the cognitive functioning of the learning disabled child, one must first be aware of what is regarded as normal cognitive development.

3.2. WHAT IS COGNITION?

Cognition, or mental activities, involves the acquisition, storage, retrieval and use of knowledge. If cognition is used every time one acquires some information, then cognition clearly includes a wide range of mental processes such as perception, memory, imagery, language, problem solving, reasoning, decision making and attention (Matlin, 1989 : 2).

Cognition is also defined as a broad term which has traditionally been used to refer to such activities

as thinking, conceiving and reasoning. It refers to an internal mental process, method or strategy which is used to get an answer (Reber, 1985 : 129). Cognition would therefore include actual knowledge, experiences and strategies that are utilized by the individual to further the acquisition of knowledge (Fry and Lupart, 1987 : 176).

Mussen et al (1984 : 219) view the major processes subsumed under the term cognition as including detecting, interpreting, classifying and remembering information; evaluating ideas; inferring principles and deducing rules; imagining possibilities; generating strategies; fantasizing and dreaming.

In considering the various definitions of cognition, it is evident that there is a certain amount of diversity depending on the perspective taken by each author. However, the central theme of each definition is constant and has ecological validity. With regard to the Psychology of Education, these definitions imply that in the absence of thought there can be no educational communication.
If the child is to be educated, he must be able to internalize the instructions he receives as well as educational actions. "From the pedagogical point of

view, thought is seen as the attribution of significance by the child to situations in which he is totally involved" (Vrey, 1979 : 150).

Possibly the most renowned expert on cognitive abilities and cognitive development is Jean Piaget. By studying his theory of congitive development, greater insight into the concept of cognition can be gained. Before doing so, however, the concept of metacognition needs to be investigated.

3.3. METACOGNITION

The Greek word 'meta' means 'going beyond' or 'transcending'. Metacognition therefore literally means cognition that goes beyond cognition. As mentioned in section 2.3.1.2., cognition means thinking about thinking.

Nickerson, Perkins and Smith (1985 : 101) explain metacognitive knowledge as being "knowledge about knowledge" including knowledge about the capabilities and limitations of human thought processes; about what human beings in general might be expected to know; and about the characteristics of specific people, especially one's self as a knowing and thinking individual. Metacognition

therefore addresses the way in which the individual directs, plans and monitors his cognitive activities.

Most of the work on metacognition has been designed to make individuals aware of their own abilities and limitations and about how to use those abilities and to work around the limitations effectively (Nickerson et al, 1985 : 102). The essence of metacognition is the ability to determine whether one is making satisfactory progress towards the objectives of a specified task and to modify one's behaviour appropriately if progress is not satisfactory.

The ability to plan, mentioned above, is also seen as central to Feuerstein's approach (1980 : 265). Planning behaviour involves being aware of both the goal, or end product, and of the strategy through which it can be obtained. Feuerstein states that a plan requires that the steps towards the goal be detailed, ordered and judged as to their desirability and efficiency. The lack of readiness to anticipate and predict the outcome of a behaviour and the lack of awareness that alternative stratergies are available will adversely affect performance.

The object of metacognition is therefore to make one a skillful user of knowledge. This is achieved by developing the individual's ability in planning, predicting, checking, reality testing, monitoring and control of one's own deliberate attempt to perform intellectually demanding tasks. In order to develop these metacognitive skills of the pupil, one has to encourage introspection on how he or she is performing a task. In this approach it is important for the pupil to realize that most problems can be approached in more than one way and self awareness is emphasized (Nickerson et al, 1985 : 203).

In taking a closer look at training in metacognition it is felt that more insight into the concept of metacognition can be obtained. For example, the Cognitive Studies Project, contained in Nickerson et al (1985 : 206), aims at:

1. assisting the pupil to become aware of and to be able to intervene in his own thinking processes;
2. assisting the pupil to become more active in his learning experience;
3. familiarizing the pupil with systematic and deliberate methods of thought which enhance problem solving and thinking abilites.

As mentioned in chapter 2, pupils being trained in metacognition are encouraged to think aloud and to work in pairs while trying to solve problems. The reason for this is two fold. By listening to other people solve problems, the pupil may learn something about the techniques that work and those that do not. Also, by exposing his own thought processes verbally both to himself and to others, the pupil makes it possible for his approach to be analysed and criticized.

To sum up, metacognition should be viewed as having the following two components (Baker, 1982 : 27) : The first component being an awareness of what skills, strategies and resources are needed to perform a task effectively. The second component is an ability to use self-regulatory mechanisms to ensure the successful completion of a task.

The achievement of equilibrium between cognitive and metacognitive skills is a formidable task for most pupils, but more particularly for the learning disabled child. Knowledge of the stages of cognitive development and to which specific stages certain age groups of pupils belong is therefore essential if one is to understand the pupil and provide an

education that is relevant to his needs. For this purpose, Piaget's theory of cognitive development has been chosen.

3.4. PIAGET'S THEORY OF COGNITIVE DEVELOPMENT

3.4.1. Introduction

From all the theories of cognition, why study Piaget? In answer, it can once again be said that the choice was influenced by the profound effect that Piaget's theory has had on psychology and education. Elkind (1975 : V) says that Piaget studied the development of intelligence, adaptive thought and action for more than half a century and it is probably fair to say that Piaget's work has been comparable to that of Freud's with regard to its impact on social science generally and upon psychology, in particular.

The discussion which follows is not intended to be a comprehensive summary of Piaget's theory, but rather a sketch of selected key concepts relevant to this research study, facilitating a comparison of the cognitive functioning of learning disabled and non-learning disabled children. A brief overview of the

theory will be given, focussing particularly on the Piagetian concepts of assimilation, accommodation and equilibration. The stages of cognitive development will then be discussed, followed by the implications of Piaget's theory with regard to the senior primary school pupil.

Although Piaget's theory is going to be discussed as the central theme, the cognitive control theory of Santostefano will also be touched on as it complements Piaget's theory so well. In addition, Santostefano's theory is included because the test which he has developed (Cognitive Control Battery) is used in this research study, as it is designed from a particular perspective that links up with the views of Piaget.

3.4.2. An overview

In Piaget's theory of cognitive development, knowledge is assumed to have a specific purpose which is to aid the child in adapting to the environment (Mussen et al, 1984 : 223). Piaget (1970 : 12) explains that "the establishment of cognitive or, more generally, epistemological relations, which consist neither of a simple copy of external objects nor of a mere unfolding of structures performed

inside the subject, involve a set of structures progressively constructed by continuous interaction between the subject and the external world". He states that the child does not receive information passively and says that thoughts are not simply the product of direct teaching or the imitation of others. In order to know objects, Piaget (1970 : 12) says that the subject must act upon them and therefore transform them. By this Piaget means that the child must mentally displace, connect, combine, take apart and reassemble objects. He points out that from the most simple sensori-motor actions to the most complicated intellectual operations, which are internalised actions carried out mentally, knowledge is constantly linked with actions and operations, that is, with transformation. According to Piaget, knowledge is acquired and thought processes become more complex and efficient as a consequence of the maturing child's interaction with the world. If the child has ideas about the world which he has not been taught and which he has not inherited, then he must have acquired these notions through his spontaneous interactions with the environment (Elkind, 1981 : 108).

In other words, the child's involvement in and experience with his own life world and how he attributes meaning to it, underlies Piaget's theory. This means that the child is seen as being active, curious and inventive. He seeks contact and interaction with his environment and, more importantly, he interprets events. The child has an innate desire to learn. The implication of this is that education need not concern itself with instilling a zest for knowledge within the child. Instead, education should ensure that it does not dull this eagerness to know, by overly rigid curricula that disrupt the child's own rhythm and pace of learning (Elkind, 1981 : 109).

Piaget's theory, supported by Vrey's (1979) whole concept of becoming, or 'self-actualization', is based on the fact that the child continually constructs and reconstructs his knowledge of the world, trying to make sense of his experiences and attempting to organize his knowledge into more efficient and coherent structures (Mussen et al, 1984 : 224).

Piaget places great importance on 'operational structures'. If one considers the concept of

conservation (which will be discussed in section 3.6), the famous example given is that of water being poured from a wide glass to a narrow glass, the shape of the water is changed both in height and in width. Before the concrete operational stage (7 years - 11 years) a child may believe that there is suddenly more water in the second glass. After the age of seven, a compensation of relations takes place and the child is usually aware that the volume of water has remained constant. This becomes possible because the child no longer relies on his perception alone. Something takes place within the child, namely, mental operations. Maier (1978 : 24) refers to these operations as mental processes which deal with the comprehension of actions symbolically rather than purely experientially. He states that operations specify mental actions such as ordering, classifying, creating, seriation, enumerating and grouping. What is most important, is that operations are thought processes which can be reversible and which are always part of a larger thought system. This then makes it possible to understand how, as the child grows older, he is able to respond correctly to the tumbler experiment described above. The acquisition of operations is therefore at the core of intellectual growth.

3.4.3. Assimilation, Accommodation and Equilibration

Intellectual growth, as mentioned in the previous section, takes place from birth and develops along a continuum as the child interacts with his environment. Piaget has described this cognitive development in terms of stages and the major mechanisms which enable children to progress from one stage of cognitive functioning to the next are called assimilation, accommodation and equilibration. These three concepts will now be discussed very briefly.

3.4.3.1. Assimilation

Piaget (1970 : 16) defines assimilation as "the integration of external elements into evolving or completed structures of an organism". Maier (1978 : 22) expands on this, explaining that the child conceives of an event in terms of his existing knowledge. This means that an experience is incorporated, without a break in continuity, into a person's ongoing way of thinking, in a way in which his present understanding permits. Assimilation therefore refers to the child's efforts to deal with the environment by making it fit into his own existing structures through incorporation.

3.4.3.2. Accommodation

Accommodation, according to Piaget (1970 : 18) is the counterpart of assimilation. He explains that if assimilation alone were involved in development, there would be no variations in the child's structures. In other words, the child would not acquire new content and would not develop further. Accommodation can therefore be viewed as the modifying of an assimilatory scheme or structure. Maier (1978 : 23) explains that to accommodate means to adjust, to change an earlier conception in order to fit it more correctly to the demands of the actual event. Most importantly, he says, to accommodate constitutes an attempt to incorporate the environmental factors as far as can be understood and managed. This means that the child has to modify his actions, ideas and pre-existing schemas to fit new situations or information.

3.4.3.3. Equilibration

Piaget's theory assumes that an individual will first attempt to understand a new experience by using the existing knowledge that he has (assimilation). When this knowledge is insufficient to explain the new experience fully, he will usually

change his previous conception so that eventually the new experience will be in harmony with his personal conception of events (accommodation) (Maier, 1978 : 23). It is therefore through a balance of assimilation and accommodation that the child adapts to his environment. What is important to note is that there can be no assimilation without accommodation and vice versa (Piaget, 1970 : 18). Accepting then that accommodation and assimilation are present in all activities, their ratio may vary and only the more or less stable equilibrium which may exist between them characterizes a complete act of intelligence.

When assimilation outweighs accommodation, thought is said to evolve in an egocentric direction. This is evident in the young child's play. When accommodation outweighs assimilation, thought evolves in the direction of imitation (Piaget, 1970 : 20).

What is understood by the foregoing information is that all organisms strive for balance in their interaction with their environment. When this equilibrium is disturbed, that is, when something new or interesting is encountered, the process of

assimilation and accommodation function to re-establish equilibrium. The process of establishing equilibrium is known as equilibration. What Piaget (1975 : 30) stresses is that "cognitive equilibration never reaches a stopping point, even on a temporary basis." He points out that any knowledge will raise new problems as it solves preceding ones. In other words, "a system never constitutes an absolute end of a process of equilibration; fresh goals always arise from an attained equilibrium ... constantly attempting to achieve a better equilibrium" (Piaget, 1975 : 31).

To sum up, Vrey (1979 : 304) states that assimilation is the way in which experiences are arranged to fit into schemas in the course of internalization and accommodation is the change that occurs in the child's schemas so that new operations can be internalized. This view regards an operation as a meaningful representation of an action and an ordering of new schemas which are based on previous schemas. Schemas of operations are therefore arranged in the cognitive structure for further use.

3.5. THE STAGES OF COGNITIVE DEVELOPMENT ACCORDING TO PIAGET.

3.5.1. Introduction

The term "stages" is used with regard to cognitive development in that it designates a particular mode of behaviour in a necessary sequence of behaviour that is related to, but not determined by, age.

The concept of developmental stages implies that the child proceeds from birth along a continuum of cognitive developmental phases. Maier (1978 : 28) points out that although Piaget's developmental phases are frequently cited as if they were entities, they are actually no more than points of reference for understanding the sequence of development. It is also important to note that where chronological ages relevant to particular stages of cognitive development are given by Piaget, these may vary from culture to culture, but the Piagetian sequential order of stages and phases never vary (Maier, 1978 : 28).

Piaget divided the cognitive development of children into four stages (Hurlock, 1978 : 355).

The sensori-motor stage (0 - 2 years)
The pre-operational stage (2 - 7 years)
The stage of concrete operations (7 - 11 years)
The stage of formal operations (11 years --->)

A full discussion of these stages is not possible, taking the limited nature of this research script into account. These stages of cognitive development are briefly summarised as follows:

3.5.2. Sensori-motor intelligence (0 - 2 years of age)

During the sensori-motor stage of cognitive development, the child begins to develop an understanding of himself as being separate and distinct from the environment. He also starts grasping the rudiments of causality and of time and space. From infancy to the age of approximately two years, his primary concern is with the construction of an object world. This is achieved by sensori-motor exploration. This whole developmental phase is achieved before the actual advent of language. This means that knowing and thinking during this stage emerges out of action. Sensori-motor knowledge is therefore the foundation for all subsequent understanding, including the knowledge of language (Hurlock, 1978 : 355; Elkind, 1975 : 2; Maier, 1978 : 30).

3.5.3. Pre-operational stage (2 - 7 years of age)

This stage is regarded as a preconceptual stage and is an intuitive stage. During this stage, the child is able to form primitive images of objects, but does not yet possess a system of rules by which ideas can be classified. In other words, his thinking is pre-logical, based on intuition rather than systematic logic. This stage extends from 2 to 7 years of age and is a time when the child is capable of using language and symbolic thinking. This is apparent in the child's imaginitive play. Thinking is usually egocentric in that the child is unable to take the view of others. He is also unable to solve problems involving number concepts or classes of objects (Hurlock, 1978 : 355; Elkind, 1975 : 4).

3.5.4. Stage of concrete operational thought

This stage relates specifically to the pupils involved in this research study.

From the age of approximately 7 years, children usually develop what Piaget calls 'concrete operations'. This means that the child is able to perform a set of actions mentally that earlier he could only have done with his hands or in a

practical situation (Elkind, 1975 : 7). In contrast to the sensori-motor stage, thought now preceeds action and the child can use thought structures rather than relying primarily on perceptual or body-motor cues (Maier, 1978 : 54).

Concrete operations make the quantification of reality possible because these operations enable the child to co-ordinate apparently contradictory properties within the same person or object. This is made possible by what was described earlier (3.4.2.) as the property of 'reversibility' of an operation. The child is therefore able to begin to form concepts of space and time and to categorize objects (Hurlock, 1978 : 355; Elkind, 1975 : 9).

Concrete operational thought also facilitates the learning of rules. For example, learning social rules such as saying "please" and "thank you" and the learning of rules for certain games such as chinese checkers or draughts. From this then develops the ability to move from the general to the specific.

A very important comment is made by Elkind (1975 : 10) with regard to this stage. Because primary school children can solve problems mentally,

by means of symbolic manipulations, it is often assumed that they no longer need concrete apparatus with which to think. It is assumed that these children, like adults, can now live comfortably in an abstract world of symbols. These are most certainly false assumptions. Elkind (1975 : 10) explains that these children can indeed solve problems mentally, but the problems themselves have to be related to 'things' and not just symbols.

Finally, concrete operations make it possible for the child to take the role of others and this leads to a greater understanding of reality (Hurlock 1978 : 355).

3.5.5. Stage of formal operational thought (11 years and older)

In this phase the child is capable of considering all possible ways of solving problems and he is able to reason on the basis of hypotheses and propositions. As a result, he can look at a problem from different points of view and can take a number of factors into consideration when solving problems. This then brings the adolescent's reality into closer alignment with that of adults (Elkind, 1975 : 11).

Formal operational thought is referred to by Elkind (1975 : 11) as second order operations. This means that metacognition forms an important part of this stage. Due to the development of a higher order symbol system, algebra, trigonometry and calculus can be included in the school curriculum. A quotation from Maier (1978 : 64) sums up this phase aptly: "Unlike the child, the youth becomes an individual who thinks beyond the present and forms theories about everything, delighting especially in considerations of that which is not".

In conclusion, Piaget's theory on cognitive development is summarized by Maier (1978 : 29) as follows:

1. Development is continuous and always follows the same sequential progression.
2. Each progression of development depends on the progression of previous learning.
3. The sequence of development creates a hierarchy of cognitive experience with each new experience entailing a more complex and effective form of cognition.
4. "Each individual is apt to achieve a different level of cognitive development though by native structures (brain) each individual has the possibility for all these developments but they are not necessarily realized by each one."

3.6. IMPLICATIONS OF PIAGET'S THEORY FOR THE SENIOR PRIMARY SCHOOL PUPIL

The focus of this research is on the senior primary school pupil. This is the child who, according to regulations promulgated by the Minister of Education under the National Education Policy Act (Act 39 of 1967), is in standards two, three or four and who usually falls within the age range of 9 to 11 years (Behr, 1984 : 42).

Kokot (1987 : 48) points out that the concept of development refers to the perceptible and imperceptible changes that occur in the child as a human being. As the child progresses towards adulthood, his physical, cognitive, affective, social, religious and moral abilities improve or develop. By studying the stages of cognitive development above, it has been possible to identify the changes in behaviour that are regarded as normal for children in different phases of development and to gain a better understanding of the primary school pupil.

In focusing on the primary school child it is felt that, in addition to the information pertaining to the stage of concrete operations given above

(3.5.4.), certain aspects should be expanded on. Firstly, logical thinking means thinking which is 'internalised cognitive activities' that enable the child to reach logical conclusions and it is normally expected of the primary school pupil that he can apply logical ways to thinking. Vrey (1979 : 107) joins Elkind (1975 : 10) in stressing the finding, however, that the primary school child's thinking is limited to solving problems of a concrete nature. At this stage of cognitive development the pupil usually cannot solve problems at an abstract level. Therefore, in teaching the child, a vast supply of concrete apparatus should be made available, particularly in the teaching of mathematics. Pupils at this stage are also often required to view films and videos which an adult may regard as educational. However, these audio-visual aids may in fact be totally beyond the thinking of the primary school pupil. The level of abstract thought should therefore be taken into account when selecting material for pupils.

Further, as logical thought develops, the primary school child attains the mental capacity to order and relate experiences within an organized whole (Maier 1978 : 54). This, which facilitates rule

making, enables the child to make sense out of quantification. He is able to arrange in a particular order. He is able to work out that if A > B and B > C then A > C. The child is also able to classify according to more than one dimension at the same time. This refers to Piaget's concept of conservation.

Conservation, mentioned earlier, "is an acknowledgement of variability within things" (Maier, 1978 : 55). Through conservation, the child realises, for example, that the volume of a piece of plasticine remains constant irrespective of whether it is rolled into a ball or rolled out like a snake. How does this take place if perceptually there is a difference? From approximately the age of 7 years the child realises that the most general transformations of action like ordering, uniting, embedding and establishing correspondences, are reversible by inversion and reciprocity (Piaget and Inhelder, 1969 : 34). They explain that the transforming actions are internalised as real operations, which combine with each other into a coherent structure and which are stable precisely because they are reversible.

Wallach (1969 : 201) has questioned the role of reversibility in facilitating conservation. She has looked at other factors which could be responsible for conservation such as social learning, the ability to think in certain ways, differentiation, reduction of immediate stimulus dependence and conflict but, from further investigation, concludes that there is a relationship between reversibility and conservation. Wallach states that conservation refers to the continuation of something of which there is no adequate sensory evidence at the time.

In teaching the normal primary school child it is therefore anticipated that he will be able to cope with seriation, classification and the concept of number and measurement.

From the point of view of Empirical Education where the emphasis is placed on the child's orientation in his life world, the formation of meaningful relations are extremely important. Vrey (1979 : 111) therefore feels that Piaget's concept of conservation is very relevant to the child who has to orientate himself. The senior primary school pupil's ability to face the continual change with which he is confronted, is founded on the conviction

that there is stability or permanance in the appearance of things, in spite of observed variables. The ability to give meaning (significance attribution) is central to the life of the senior primary school pupil. The normal child in this phase of cognitive development is able to make representations of his perceptual experiences as 'he understands them'. What is pertinent here is that adequate significance attribution can only take place when the child is totally involved. This relates to Piaget's references to actions initially preceding thought and the essentiality of the child's interaction with the environment. When a child is able to give meaning to a situation, he experiences success which in turn affects his involvement positively.

In studying the work of Piaget, (1966 : 48) the concept of behaviour and cognitive controls led the researcher to look at the cognitive control theory of Sabastiano Santostefano. This theory was found to be particularly interesting because it seems to link up with Piaget's theory of assimilation and accommodation and the idea that a person is empowered as a 'meaning-maker'. A brief summary of Santostefano's theory will now be given.

3.7. COGNITIVE CONTROL THEORY

Santostefano (1988 : 5) defines cognition as "any process by which an individual becomes aware of, obtains knowledge of, and takes action with regard to some piece of information, be it an object, a person, a fancy, a memory, a thought or a feeling." He goes on to say that in cognition, many mental functions are involved. Attending, perceiving, recognizing, comparing, conceiving, judging, reasoning and remembering are examples of these mental functions.

Central to this theory is the idea that the individual co-ordinates information from external reality and from the internal environment of emotions, fantacies and motives so as to remain in adaptive control of information leading to the idea of 'cognitive controls'.

Cognitive controls were conceptualised as serving adaptation and as co-ordinating and mediating between the demands of internal stimuli with those of external stimuli. Santostefano defines cognitive controls as having the status of intervening variables that define principles by which motor behaviour, perceptions, memory and other aspects of

cognition are organised as an individual co-ordinates himself with environmental demands.

This model of cognitive controls and Piaget's model share a number of propositions: Both view cognitive activity as adaptation, cognitive actions as deriving from physical actions and cognitive structures as assimilating existing information while at the same time becoming more differentiated as the structures accommodate to new and different information.

3.8. CONCLUSION

The relevance of this chapter is that it provides a conceptual framework for this research study. It has been pointed out that cognition develops along a continuum and that the child has to pass through each stage in a set sequence. The age at which each level of development is achieved may vary, but is usually achieved within certain limits. Finally, this development of cognition is hierarchically structured from the performing of simple tasks to using abstract thinking in adolescence.

It therefore follows that, having this knowledge of normal cognitive development, it is possible to

compare and identify the areas of weakness or lack of cognitive development in the child who is regarded as learning disabled.

At the beginning of this chapter, included in the definition of cognition were the concepts of attention and memory. However, in the discussion of Piaget's theory, no explicit reference was made to these two concepts. This does not mean that they do not form a part of Piaget's work. In fact the whole idea of reversibility, for example, is linked with memory and none of the Piagetian tasks could ever be performed without being able to focus and concentrate attention. In the light of this, the following chapter deals specifically with 'attention' and 'memory'.

Chapter 4

ATTENTION AND MEMORY

4.1. INTRODUCTION

The concept of attention and memory were briefly discussed in chapter 2. Both attention and memory form an integral part of cognition and are regarded as fundamental to this research study. If a problem is experienced in either attention or memory, the cognitive functioning of the pupil will be adversely affected.

According to Vrey (1979 : 263) all cognitive acts have their origin in attention : He states that "attention not only initiates cognitive acts, but keeps them going until they have run their course." The ability to attend is therefore essential to cognitive functioning. Hamlett (1987 : 228) expounds on this, proposing that deficits in attentional mechanisms may interfere with cognitive performance, especially on complex problem-solving tasks that require organisation and deliberate planning or the application of 'executive processes.' By executive processes she means mechanisms that "orchestrate cognition". An example of this would be selecting the most

appropriate strategy in approaching a memory task or problem, monitoring the efficiency and effectiveness of ongoing memory processes, checking to see that the task has been completed and altering current strategies to meet any changes in task demand.

Attention and cognition are therefore interdependent. In the same way, as mentioned in 2.3.2.2., memory is not viewed as being an isolated intellectual skill. It is really a convenient descriptive term for a collection of cognitive processes (Kail, 1990 : 3).

During the last decade there has been an increasing attempt to build a bridge between cognitive processes and the neurosciences. In this regard Matlin (1989 : 10) says the following:

"The cognitive revolution is now in place. Cognition is the subject of contemporary psychology. This was achieved with little or no talk of neurons, action potentials and neurotransmitters. Similarly, neuroscience has risen to an esteemed position among biological sciences without much talk of cognitive processes. Do the fields need each other? Is there something to be gained by cross-disciplinary interchanges? Are interactions even possible? The answers are all yes because the problem of understanding the mind, unlike the 'would-be problem solvers', respects no disciplinary boundaries".

There can be no argument that cognitive functioning is dependant on neurological functioning, for this is certainly the case. For this reason, the present chapter will focus on deficits in attention and memory, investigating both cognitive and neurological aspects.

4.2. ATTENTION AND ATTENTION DEFICITS

Attention is the starting point of any cognitive activity and must be retained throughout the act of learning. In order to pay attention, one has to overcome the condition of being aware of many things without consciously paying attention. Jordaan, Jordaan and Nieuwoudt (1975 : 295) refer to attention as a condition of inner readiness in which a person directs himself towards a specific matter. In other words, the person paying attention is no longer merely vaguely aware of things, but is actively aiming at relevant matters. It is this selective nature and directedness of the perceptual and the accompanying behaviour processes which is known as 'attention' (Jordaan and Jordaan, 1984 : 212).

A concept frequently used in the literature on attention is 'selective attention'. Selective

attention referes to a person's ability to detect the relevant aspects of a pertinent matter and to destinguish them from the irrelevant aspects. Concentrated attention is therefore associated with a resistance against distraction and with the ability to ignore irrelevancies (Orpreo, 1989 : 89).

Where there is an inability to pay attention, it is referred to as distractibility. This may be as a result of internal or external factors. By external factors it is meant that the pupil is distracted by any inapposite stimulus such as a clock ticking or noises outside the classroom. Internal factors, such as anxiety or depression, can also engage the pupil's thoughts resulting in day dreaming and being quite unaware of his immediate surroundings.

Having discussed what is meant by attention, it is now necessary to look more closely at an inability to attend and what causes this inability.

An attention deficit is defined by James Coleman (1984 : 541) as "maladaptive behaviour that interferes with effective task-orientated behaviour in children - particularly impulsivity, excessive motor activity and an inability to attend."

As mentioned in chapter 2 (2.3.2.1.) Feuerstein does not regard impulsive behaviour as the result of an incapacity to attend. He regards it as a result of inadequate training in exploratory skills. He explains that impulsivity is reflected in the learning disabled pupil's probabilistic use of stimuli and his tendency to use either a salient element or the first that he encounters (Feuerstein, 1980 : 265). Correction of this deficiency involves the explicit need to gather all of the information necessary for elaboration and to impose a delay between this and the output phase of the mental act.

According to the DSM 111 - R of the American Psychiatric Association (1987 : 50), a deficit in attention is referred to as an attention deficit hyperactive disorder (ADHD). The essential feature of this disorder is the developmentally in-appropriate degree of inattention, impulsivity and hyperactivity.

4.2.1. Clinical Manifestation

In a classroom situation, the pupil suffering from ADHD usually shows inattention and impulsiveness by not remaining with a task until it is completed and by experiencing difficulty in organizing his work

correctly. It often appears as if the pupil is not listening and is day dreaming.

The pupil is impulsive in the way he responds to questions, shouting out answers before they are completed, making comments out of turn and being unable to wait his turn.

Hyperactivity is evidenced in the classroom by the pupil's inability to remain seated for long. There are also problems concerning excessive moving about, fidgeting, jumping and running around the classroom.

The DSM 111 - R (1987 : 51) and Ross and Pelham (Coleman, 1984 : 541) estimate that between three and five percent of primary school pupils manifest the symptoms of an attention deficit hyperactive disorder and that some residual effects, such as difficulties in attention, may persist into adolescence and adulthood.

Cantwell and Keogh (Wicks-Nelson and Israel, 1984 : 234) suggest that the relationship between an attention deficit and poor school performance may be due to some type of neurological impairment which causes both learning and behaviour deficits. Pupils suffering from an attention deficit do not typically

show deficits in intelligence, but because of this disorder, grossly underachieve at school. What then is the cause of an attention deficit?

4.2.2. The aetiology of an attention deficit

Besides the metacognitive explanation given by Feuerstein (as explained in section 4.2) numerous research studies have been carried out to establish the aetiology of an attention deficit. These include genetic factors, diet, psychosocial factors and neurological factors. Each of these factors will be discussed very briefly.

4.2.2.1. Genetic factors and attention deficit

Large populations are needed to study the question of genetics. However, experience indicates that attention deficit problems are over represented amongst adopted children (Bloomingdale, 1984 : 9). One of the possible reasons to explain this is as follows: ADHD is no longer regarded as a problem limited to childhood. Follow up studies of clinical samples indicate that approximately one-third of children with ADHD continue to show some signs of the disorder in adulthood (DSM lll - R, 1987 : 51). Thus, impulsive behaviour can still manifest in adulthood. A consequence of this is that in a

number of social relationships, impulsive behaviour may result in unwanted pregnancies. A large proportion of these babies are then offered for adoption. The increased likelihood of trauma to the foetus and newborn baby during unwanted pregnancies and births and possible genetic anomalies are plausible explanations (Millichap, 1975 : 10).

In adoption studies, Comings (1990 : 86) indicates that if ADHD is a genetic disorder, then the biological parents would manifest in higher frequencies of ADHD or antisocial behaviour than controls. If, on the other hand, ADHD is a learned behaviour, then there should be a high frequency of ADHD or antisocial personality in both adoptive and biological parents who do not give up their children for adoption. Cantwell (Comings 1990 : 87) found that adopted children still developed ADHD despite being raised by normal parents. This suggests that the transmission of ADHD is by genetic rather than by social-environmental factors.

If ADHD is a genetic disorder one would expect to find that many of the parents also had ADHD when they were children (Comings, 1990 : 84). In addition, if ADHD persists into adulthood, there

should also be a higher frequency of such problems among parents of ADHD children. This is substantiated by research studies of Morrison and Steward (Comings, 1990:84). In examining parents of hyperactive children and control children, alcoholism and antisocial personalities were more common in the fathers and hysteria and alcoholism more common in the mothers of ADHD children than in the controls.

4.2.2.2. Diet

In 1975 Feingold asserted that the ingestation of food containing artificial dyes, flavours and certain preservatives had a direct effect on hyperactivity (Wicks-Nelson and Israel, 1984 : 237). The traditional Feingold diet was therefore introduced. According to Millichap (1975:116) this diet eliminated artificial colouring and flavour agents, preservatives and salicylates, resulting in a calming effect. Professor van der Merwe, from the Department of Gastroenterology at Medunsa (1989:1) estimates that not more than approximately 50% of all children would respond to this form of treatment. He argues that the basic cause of hyperactivity is an Essential Fatty Acid Malabsorption. He points out that a diet such as that of Feingold

does not correct the basic cause of the problem which he states is the DEFICIENCY of essential fatty acids.

It would seem then, that the theory put forward by Feingold has not produced any positive or conclusive results.

4.2.2.3. Psychosocial Factors

In Wicks-Nelson and Israel (1984 : 238) evidence is given to indicate that children from lower income groups are at high risk for hyperactivity. The reason being that they are at high risk of biological damage and being exposed to disorganization and disruption in the home. However, although a well structured environment assists the hyperactive child, it is argued that an educationally deprived background and environmental circumstances cannot account for all cases of an attention deficit.

4.2.2.4. Neurological dysfunctioning

The hypothesized causes of an attention deficit listed above appear to be easily discounted. This is not the case when one considered the research

pertaining to the nervous system. There is strong argument that prenatal, perinatal or postnatal brain lesions or effects on the embryonic or infantile neuro-chemistry account for the predominant pathogenesis of the syndrome under discussion (Bloomingdale, 1984 : 27). This is substantiated by the DSM 111 - R (1987 : 51).

Cantwell and Satterfield (Levinthal, 1988 : 295) offer the hypothesis that hyperactive children are under-aroused, in that they show a greater amount of slow-wave activity in their electroencephalogram records and a significantly lower that normal level of skin conductance. A low arousal level in the central nervous system is posited to result in a lack of inhibitory control and the appearance of the behaviour symptoms mentioned above. This under-arousal hypothesis accounts for the paradoxical effect that the stimulant drug, Methylphenidate hydrochloride, has on controlling hyperactivity. The effect of this drug is purported to increase the child's level of arousal back into the normal range. However, this theory is disputed as studies by Rapaport (Chelune and Furguson, 1986 : 222) indicate that there is no particular response

selectivity among attention deficit disorder children as stimulants have a similar effect on normal children.

With more emphasis on attention rather than over-activity, the role of higher cortical inhibitory mechanisms have become of interest. Hynd and his co-workers (1989 : 573) state that from a neuro-psychological perspective, there is accumulating evidence that attention deficit hyperactive disorders may be related to a deficient metabolic functioning of the frontal-cortical inhibitory system.

While deficient frontal lobe functioning may not account for all forms of attention deficit hyper-active disorders, this hypothesis does offer a parsimonious model for explaining many of the findings associated with an attention deficit.

Mattes (1980 : 358) states that the prefrontal regions of the frontal lobes have a rich network of reciprocal pathways with the reticular formation and diencephalic structures, which regulate arousal and the ability to suppress responses to task-relevant stimuli. Lesions in the prefrontal regions result in a breakdown of the regulation of goal

directed activity and modulation of impulse responding. Patients with such lesions have difficulty in suppressing on-going activities despite environmental feedback that these activities are no longer appropriate (perseveration) and demonstrate increased reactivity to extraneous stimuli (distractibility and impulsivity). This results in deficient goal-directed behaviour.

The researchers, Hynd et al (1989 : 573) support the above hypothesis, as it is consistent with what is known about the frontal cortex. The frontal cortex has extensive reciprocal connections to the reticular activating system and diencephalic region - regions which are important to arousal, attention and vigilance. It is therefore their contention that lesions to the frontal cortex often produce disinhibition, attention deficits and hyperactivity.

As early as 1870 Thudichum indicated that diseases of the brain and spine are connected to specific chemical changes in the neuroplasms (Comings, 1990:313). Comings (1990:360) explains an attention deficit hyperactive disorder in terms of a chemical imbalance in the frontal lobe and that the neurotransmitters most often implicated in this

regard are dopamine and serotonin. These neurotransmitters are believed to play an important role in disorders of behaviour.

Dopamine affects movement and, in the hyperactive child, it is believed to cause stimulated and active movement. Because the frontal lobe is affected, problems of learning result. Serotonin, on the other hand, is known as the great inhibitor and ADHD children have been found to have low blood serotonin, causing poor inhibitory responses (Comings, 1990:417).

Serfontein and his co-workers (Serfontein, 1988:151) also believe that ADHD may have a neurochemical basis. According to these researchers, the most commonly implicated neurotransmitters are dopamine and norepinephrine. Urinary methoxyhydroxyphenylglycol (MHPG) is a metabolite of norepinephrine, reputed to contain a significant fraction of cerebral norepinephrine degradation and their research has shown that boys with ADHD appear to secrete significantly lower levels of MPHG than do their normal controls.

In support of this perspective, Lou, Henriksen and Bruhn (Hynd et al, 1989 : 573) reported that children with hyperactivity evidenced hypoactive metabolic activity in the region of the frontal cortex and in the diencephalic structures. Using regional cerebral blood flow, they found that when these children were administered methylphenidate, increased perfusion occurred in the prefrontal cortex, basal ganglia and mesencephalon, while perfusion decreased concurrently in the central motor and sensory areas.

The research carried out by Hynd and his co-workers (1989 : 573) led them to hypothesize that children with an attention deficit would perform significantly more slowly and with more variability than other children on tasks reflecting basic automatized processes. It was further hypothesized that the attention deficit group would manifest in longer latencies to respond and that, as speeded classification tasks become more complex (and thereby place a greater load on important automatic cognitive processes), significant differences would emerge between the children diagnosed as having attention deficits and those in a control group.

The results of the research of Hynd et al (1989 : 573) showed that there was a significant mean reaction time effect between the two groups.

In their research Sergent and Scholten (1985a : 100) also found that distractible children were slower than a control group in the speed of cognitive processing.

It would therefore appear that there is substantial evidence to support the hypothesis that the aetiology of an attention deficit disorder is, at least partially, neuropsychologically based.

However, the literature also contains contradictory research on the aspect of attention.

Richards and his co-workers (1990:129) carried out research in which sustained and selective attention of 30 fourth, fifth and sixth grade students with learning disabilities and 20 controls were compared. A continuous performance test yielded no differences for students with learning disabilities and controls, suggesting similar ability for both groups in sustaining attention and inhibiting impulsive responding. This finding is contradictory to the findings of many other researchers. One explanation

for the conflicting results might be due to diagnostically mixed samples. There is the possibility that in certain research studies there may have been an over-representation of ADHD children in the learning disabled group resulting in a biased outcome. On the other hand, it could imply that the differences in attentional performance and information processing style may be subtle.

Wong (1988:191) has found that learning disabled and normal children show qualitatively similar developmental patterns. She therefore suggests that instructional methods which promote learning in the normal child would also promote learning in the learning disabled child. Her findings relate to children older than seven years of age. Prior to this age developmental lags do occur.

Although Hynd et al (1989:573) found that lesions to the frontal cortex often produce disinhibition, attention deficits and hyperactivity, their same research (1989:578) showed that the learning disabled group and the control group did not differ significantly from each other on simple reaction time tasks. It would seem then that on this test, no group effect was evident on any

speeded classification task.

Jay Samuels (1987:60) studied attention by observing pupils in the classroom while instruction in subjects such as mathematics, reading and art were conducted by the teacher. The result of this investigation was that there were no significant differences on any measures of attention between the learning disabled and non-learning disabled children. This may suggest that an attention deficit is not necessarily the underlying problem for children with scholastic difficulties. Krupski (1987:64) found the same results as Samuels, but on further investigation she noted that as tasks became more difficult, a difference between the two groups was noticed.

4.3. MEMORY

4.3.1. Where and how does the brain store its memories?

Memory is described by Jordan and Jordaan (1984 : 521) as the flow of information through the different phases of the perceptual process. This flow is described as follows: Information is received at receptor level and coded into a format which the nervous system can accommodate. This first stop that an incoming stimulus makes, is

called sensory memory. All sensory memory, which includes visual, auditory, tactile, olfactory and kinesthetic aspects, are involved in receiving these first impressions (Khan, 1986 : 2).

In order to form meaningful percepts, this information must then be decoded. Incoming information is therefore held in sensory memory just long enough for it to be decoded and stored in short term memory. This information, if it is to be retrieved at a later stage, must then be stored in long term memory. The ability to remember therefore consists of two separate but inter-dependent abilities (Jordaan and Jordaan, 1984 : 522). These are the ability to store information during the perceptual process and the ability to retrieve or recall information already stored in long term memory.

It is interesting to note that sensory memory has a very large capacity for storing information, but information is held here for approximately one second only. This means that a substantial amount of information is lost during this phase. Fortunately most of the information lost is usually irrelevant information. It is information that is

regarded as relevant that is allowed through into short term memory. This is the information to which a person pays active, conscious attention. This information is held in short term memory for approxiately 12 seconds. Short term memory is regarded as the active, working memory of the individual. It is this memory which influences the type and amount of information which is to be stored in long term memory. The principal function of short term memory is therefore the active control of thinking, problem solving and general memory processing (Khan, 1986 : 4).

Finally, long term memory is regarded as "the store house of all the knowledge and skills we have acquired through learning, training and our experience of life" (Jordaan and Jordaan, 1984 : 523). Long term memory requires the ability to assimilate, store and retrieve information when it is needed. This, is dependant on the learner's skill in seeing the relevance of the material to be remembered and the ability to relate it to past experience. (Lerner 1989 : 184).

The relevance of antecedent elements of cognitive structure for new learning material is therefore

an important factor in cognitive functioning. Ausubel (1978:173) says, "Concepts are more easily acquired if the specific instances from which they are abstracted are frequently rather than rarely associated with their defining attributes, and if subjects have more rather than less relevant information about the nature of this attribute." This means that past experience influences or has positive or negative effects on new meaningful learning and retention by virtue of its impact on relevant properties of cognitive structure (Ausubel, 1978:165).

Having discussed the normal process of memory, one has to consider the problems of memory or forgetting.

4.3.2. Problems of Memory

With regard to the learning disabled child and reading problems, Kussmaul in 1877 first used the term 'word blindness' referring to pupils who could not recall words. He made reference to cerebral lesions mostly involving the angular gyri of the left hemisphere as causing this problem (Swanson, 1991 : 160).

There is literature explaining memory in terms of neurological processes and also, as mentioned in chapter 2, explanations of poor memory from a cognitive point of view.

From a neurological point of view, Yanagihara and Petersen (1991 : 322) have found from their research that memory problems are caused by temporal lobe seizures. The patient with a unilateral temporal lobe lesion experiences difficulty in the realm of learning and memory. They have found that there is a link between a left temporal lobectomy and impaired tasks of verbal learning and memory, whereas a right temporal lobectomy is found to impair performance on tasks in which memoranda are difficult to verbalize.

The flow of information described above brings to realisation the fact that if there is a receptive problem, in other words, a problem of perception, memory will be adversely affected. Lerner (1989 : 182) points out that a child must obviously first receive information before he can remember. A child will usually not remember something if it is not initially perceived clearly. Also important is that Lerner regards poor reception as being related

to <u>an inability to attend</u>.

A substantial amount of research has been carried out with regard to brain lesions, but Khan (1986 : 17) cautions against this view. He explains that a lesion can affect the particular attribute being investigated but it must be borne in mind that that same lesion will disrupt other functions of the brain as well. In other words, besides memory, the same brain lesion may also impair motor functioning, motivation, emotions and sensori-perceptual capacities which themselves may produce a decrease in the performance of learned behaviour.

Thus, one has to question whether a lesion affects memory as such, resulting in impaired learning behaviour or whether the impaired learning behaviour observed, is the result of other factors or processes being affected by the lesion.

From a cognitive point of view, modern conceptions define memory as a set of CAPACITIES that enable one to interact with incoming information to make sense of the environment. Memory is regarded as encompassing both experienced and verbally trans-mitted knowledge and both the content of the memory store and procedures for behaving (Reid, 1988 : 35).

This means that if a child could not perform well on a task such as identifying a missing item, from a cognitive approach one would want to know whether the child had recognised the item and also whether he was trying to remember it. It would also be necessary to find out whether the child had developed a plan to help him retrieve the information required, what strategies he used to code the information and how he integrated the information with his current knowledge. The emphasis is on the behaviour the person uses in an effort to remember rather than looking for deficiencies in the memory store itself.

The above explanation ties up with Lerner (1989 : 184) who says that many learning disabled children do poorly on memory tests and in academic skills that require memory such as recognizing words and numbers. The problem in this regard is considered not to be one of limited memory capacity, but rather a difficulty in the management of intact memory capacity. This is possible because learning disabled children are said to manifest a general lack of reflective knowledge about memory and memory processes. This relates to metacognition which was discussed in (3.3) and addresses the way

in which the individual directs, plans and monitors his cognitive (memory) activities.

Before concluding this section, note should be taken of the research carried out by Conners, Kramer and Guerra (Reid et al, 1991:163). In contradiction to the literature thus far, these researchers found that on comparing the ability to remember information presented, no differences between learning disabled and non-learning disabled children were found. It would therefore seem that short term memory for the learning disabled child is not a problem or that short term memory was possibly not the underlying reason for the learning disabled group of children's learning problem.

4.4. CONCLUSION

The implications of the above information is that whether taken from a neurological or a cognitive processing point of view, the child with a learning disability does not and cannot function optimally with regard to memory. Results of the study carried out by Bauer and Newman (1991 : 19) support a hypothesis that the learning and memory processes of children with learning disabilities are developmentally delayed. Swanson (1991 : 163) supports

this with reports on studies carried out in 1987 which indicate that the memory performance of the learning disabled child is at the level of that of a younger non-learning disabled child.

The literature studied, most certainly shows that there is a link between attention and memory. This link lies specifically in the fact that attention is necessary for the duration of information processing (De Wet et al, 1981 : 116). Literature has also shown that the child with a learning disability does not function at the same level as the non-learning disabled child with regard to these two aspects of cognition (attention and memory). One of the most popular reasons given for this, is a "developmental lag". Where there is an attention deficit, it is also hypothesized that the child will work more slowly on cognitively demanding tasks than the non-learning disabled child.

In order to verify this empirically, the researcher questions whether there is a significant difference in the cognitive functioning, with regard to memory and attention, of the learning disabled child and the non-learning disabled child.

The research carried out to test this is therefore reported in the following chapter.

Chapter 5.

METHOD OF EMPIRICAL INVESTIGATION

5.1. INTRODUCTION

From the literature study (chapters 2, 3 and 4) it has become evident that for a child to perform adequately on reading tasks a certain level of cognitive functioning must have been achieved. The mental processes which are important in terms of cognition are: perception, memory, attention, imagery, language, problem solving, reasoning and decision making (Matlin, 1989 : 2).

The researcher has found from his own experience in working with learning disabled children that the two areas where most difficulty is experienced by these children are 'attention' and 'memory'. All too often the progress reports of these children contain remarks such as: "James daydreams". "James must try to concentrate more". "James cannot remember his sight words". "James must remember to apply the phonic rules that he has learnt, to his written work".

Taking the above into account, it would seem that the cognitive functioning of the learning disabled

child is not at the same level as that of the child who does not have a learning disability.

In this research, the empirical investigation will focus on establishing whether there is in fact a fundamental difference as far as attention and memory are concerned, in the cognitive functioning of children who are learning disabled and those who are not.

5.2. GENERAL AIM

The research is primarily aimed at determining whether the learning disabled child has a deficit in cognitive functioning when compared to the non-learning disabled child.

Due to the vast area covered by the concept of cognition, the researcher has decided to narrow this down and investigate the two cognitive structures which are regarded as being most relevant to this dissertation. The research will therefore focus on attention and memory.

5.3. FORMULATING THE PROBLEM

From the researcher's work in the field of remedial education and the information gained from the

literature study, the question which has arisen is the following:

Do non-learning disabled children have better cognitive functioning with regard to attention and memory than learning disabled children?

5.4. HYPOTHESIS

Taking an overview of the previous chapters, there is an indication that there are maturational lags and deficits in the cognitive functioning of learning disabled children. In certain instances these are neurologically based. This particular information which suggests that a reading problem lies within the child, being neurologically based, supports a psychoneurological perspective. However, it is first necessary to establish whether there is, in fact, a difference in cognitive functioning between learning disabled and non-learning disabled children.

The hypothesis put forward is therefore as follows: The cognitive functioning, with regard to attention and memory, of non-learning disabled children is better than the cognitive functioning of learning disabled children.

The NULL HYPOTHESIS with regard to the above is therefore: The cognitive functioning, with regard to attention and memory, of non-learning disabled children is no better than the cognitive functioning of learning disabled children.

5.5. SPECIFIC AIM

In order to test the validity of the hypothesis set out above, it is necessary to investigate the cognitive structures of attention and memory of both learning disabled and non-learning disabled children.

5.5.1. Attention

In comparing the ability to attend, one has to investigate the child's ability to withhold attention from irrelevant information while directing attention to information that is relevant to the task at hand. Selective attention must be taken a step further to determine whether distractors are internal or external.

Internal distractors refer to distractors within the child which will affect his ability to attend selectively. An example of such a distractor would be personal thoughts and fantacies which would

affect the child's emotions. The child may be preoccupied with the thoughts of separation after having heard his parents quarrel the night before. External distractors refer to distractions around the child which will affect his ability to attend selectively, such as noise or movement.

5.5.2. Memory

In investigating memory in this research, specific attention will be paid to the manner in which the child constructs images of information, holds these images in memory over time, and compares them to perceptions of present information, as this is particularly relevant to the task of reading.

An evaluation, by means of a test will therefore be carried out for each of the aspects mentioned above, using both learning disabled and non-learning disabled children. For each test or subtest a null hypothesis will be formulated which can then be accepted or rejected, leading to a final conclusion.

5.6. METHOD OF RESEARCH

5.6.1. Type of study:

As opposed to investigating the individual or unique attributes of the individual, two groups of

children will be studied. The object of this is to be able to make comparisons, to draw conclusions and to generalize these findings. For this reason, the type of study to be adopted will be nomothetic in nature as opposed to an idiographic study.

5.6.2. Ex Post Facto Design

The nature of this research calls for a comparison of the mean standard scores of the cognitive functioning of learning disabled and non-learning disabled children.

No experimental treatment is to be given to either group and from previous diagnoses, the children to be used already belong to one of the two groups: learning disabled or non-learning disabled. For this reason an ex post facto design for a criterion-group is to be used. The classification factor (independent variable) will be: ability to learn (learning disabled / non-learning disabled). The dependant variable will be: performance on the tests administered.

In order to prevent confounding of data, the following nuisance variables should be taken into account: sex, intelligence quotient, standard of education and age.

5.6.3. Selection of Subjects

This investigation is limited to subjects between the ages of 9 and 11 who are in the senior primary phase of their schooling. The selection of the two groups will now be discussed briefly.

5.6.3.1. Learning disabled children

The researcher has access to twenty learning disabled children who fall within the age group 9 years to 11 years and who are in standards two, three or four. By learning disabled it is implied that each child attends a full time remedial school; is functioning in reading at a level at least two years below his/her choronological age, has normal intelligence (an IQ score of at least 90 on the Senior South African Intelligence Scale) and is proficient in speaking English.

5.6.3.2. Non-learning disabled children

By non-learning disabled it is implied, for the purposes of this investigation, that the child is in a main-stream school; is functioning at an age-appropriate level in reading; is of normal intelligence (an IQ score of at least 90 on the

Senior South African Intelligence Scale) and is proficient in speaking English.

Matching:

The learning disabled group of twenty children is given. It was therefore necessary to approach a local primary school to find subjects who could be matched with the learning disabled children. From the senior primary school pupils, twenty children were found to match with the learning disabled group on age, standard, IQ score and sex. The intelligence quotient used was also obtained on the Senior South African Intelligence Scale.

Finally, from the children selected, reading ages were verified to establish that they were age appropriate. For this purpose the Neale Analysis of Reading test was used.

A number of the subjects from the learning disabled group take medication (Methylpenidate) due to hyperactivity. For the purposes of this research and with the permission of parents and attending medical practitioners, no medication was taken on the day that the test was administered.

The researcher is aware that the size of the sample

group is small and, as such, the results cannot be generalised and projected onto a large population.

5.6.4. Measures

The hypothesis to be tested relates to cognitive functioning that is regarded as appropriate at certain stages of a child's development. In particular, the hypothesis focuses on attention and memory. For these reasons, a test based on a developmental hierarchy which measures attention and memory was selected as the instrument for measurement.

The Cognitive Control Battery of Tests developed by Sabastiano Santostefano (1988) meets these requirements and was therefore selected for use by the researcher.

The Cognitive Control Battery test was designed and developed for children and adolescents. It measures three discrete, nonverbal cognitive functions that play a fundamental role in learning and adaptation: scanning, attending selectively and comparing images of past information with present perceptions. These cognitive functions have been conceptualized in terms of developmental principles, which operate within personality functioning.

The framework of the Cognitive Control Battery views cognition as a developmental hierarchy of unique patterns of mental process. Focal attention is the first subtest and is defined as the manner in which an individual scans a field of information. Field articulation refers to the manner in which an individual attends selectively to a particular stimulus while ignoring others. The third subtest, Level-sharpening evaluates the manner in which an individual compares images of past information with perceptions of present information.

The above processes are referred to as cognitive controls by Santostefano who states that "each of these cognitive controls involves a particular discrete process that is stable when the person functions in average and expectable situations" (Santostefano, 1988 : 2). Each of these controls grows and changes throughout normal development and becomes compromised in pathological functioning and development (such as neurotic or psychotic behaviour, brain-damaged or learning disabled children).

For the purposes of this research the sub tests for Field Articulation and Level-sharpening were administered to each subject individually. The

test for Focal Attention, although relevant, was not used as no age norms are available for the age group being researched. Inferences made from the results of the Focal Attention test would therefore not be valid.

5.6.4.1. Fruit Distraction Test (Field Articulation)

1. General description of the test

This test consists of four cards. Before each card is administered, the child is coached with practice cards to ensure that he understands the task and that he knows and can identify primary colours, the names of certain common fruit (apple, banana, grapes) and one vegetable (lettuce) and the colour typical of each.

Card 1 consists of 50 rectangles randomly arranged in rows and coloured red, yellow, green and blue. The child is asked to name the colours as rapidly as he can. The time taken to complete the card is recorded and errors are noted.

Card 2 contains 50 drawings of apples, grapes, lettuce and bananas coloured red, blue, green and yellow respectively. The child is asked to name the colours only, (and not to give the names of the fruit) as rapidly as possible. The time and

errors are recorded.

Card 3 contains the same coloured fruit arranged as in Card 2. However, in addition, immediately surrounding each of the fruit are achromatic line drawings of various common objects. These drawings are considered intrusive information that is irrelevant to the child's central task. The child is asked to try to ignore these line drawings. He is told that he must pay attention only to the colours and to name them as rapidly as possible. The time taken is recorded and errors are noted.

Card 4 presents the same fruit but coloured incorrectly. The child will be asked to name, as rapidly as possible, the colour that each fruit should be and not the colour that he is observing. The time taken will be recorded and errors noted.

2. Rationale

The first two cards function as baseline measures whereas the remaining two cards present increasing degrees of distraction, or compelling irrelevant information, that must be managed. Children who handle cards 3 and 4 as quickly as card 2 and with few errors demonstrate the ability selectively to withhold attention from irrelevant information, and

to direct attention at information relevant to the task at hand. The child who takes longer to name colours on cards 3 and 4 than on cards 1 and 2 and who recalls more peripheral figures after card 3 is removed, tends not to withhold attention selectively from irrelevant information and is likely to be distracted from the central task. In addition to this broad interpretation, a distinction is made between the kind of distraction represented by card 3 versus card 4. Card 3 with its peripheral, irrelevant pictures, provides a measure of the degree to which a child is vulnerable to the pull of external distractions such as irrelevant information in the immediate environment. For example, pictures on a wall, footsteps in the room. Card 4 with its contradictory colours provides a measure of the degree to which a child is vulnerable to the pull of internal distractions such as information in private thoughts and fantacies including associated emotions (Santostefano, 1988 : 58).

5.6.4.2. Leveling - Sharpening House Test

1. General description of the test

This test consists of 60 line drawings of a house,

each printed on a card. The cards are shown to the child, one at a time, 5 seconds per display. Gradually, from card to card, elements of the drawing are omitted cumulatively, each picture representing some combination of omissions. The child is asked to examine each card as carefully as possible and to tell the examiner to stop wherever "the picture changes or looks different". The child has to explain to the examiner what is different when he indicates that there is a change. This response will be recorded. The child has to look at all 60 cards.

2. Rationale

A child who detects many changes and who detects the first correct change earlier, is able to maintain stable, differentiated images in his memory and to keep present information separate from past information. Conversely, late detections of the first correct change and fewer numbers of correct changes perceived, indicate cognitive functioning that is characterized by the construction of global, undifferentiated images of on-going information fused with present perceptions (Santostefano, 1988 : 75)

5.6.4.3. Clinical and Research Application

The main purpose of each test is to assess the developmental status of one aspect of a child's cognitive control functioning, such as selective attention or comparing memory images of information with present perceptions.

From these two tests a cognitive control profile for the child can be established, defining the child's cognitive style.

A hierarchy of cognitive controls serves the individual in managing the requirements of information presented by an individual environment. Santostefano's (1988 : 81) view is that, throughout childhood, if there is a reasonable match between a child's cognitive functions and the complexity and pace of information presented by the environment, cognitive controls assimilate and accommodate to this complexity and develop along particular lines associated with normality. When there is a mismatch, a re-structuring of controls takes place to fit the pace or complexity of that unusual stimulation. From this point on, the cognitive control lags in development.

5.6.4.4. Evaluation

The developmental status of each cognitive control is determined by converting raw scores into standard scores using the appropriate age norms. The standard scores are interpreted as reflecting six levels of developmental maturity in cognitive control functioning:

Standard score			Percentile
66+	-	functioning that is elevated	Top 5% of age group
56 - 65	-	moderately elevated functioning	73 - 93
46 - 55	-	age-adequate functioning	34 - 69
41 - 45	-	border line dysfunction	18 - 31
36 - 40	-	moderately severe dysfunction	8 - 16
35 and below	-	severe dysfunction	lowest 7%

5.6.4.5. Reliability of the test

The test manual (Santostefano, 1988 : 130) indicates that studies carried out, lend support to the consistancy and stability of the Cognitive Control Battery scores. Although indirect, the moderate-to-high levels of correlation observed between

alternate forms of the subtests suggest that the forms measure common underlying dimensions. Correlations between performance with Card 3 and Card 4 are viewed as relating to the consistency of this test (Santostefano 1988 : 127) as each requires that the same sequence of colours be named as rapidly as possible in the face of distracting information. In a number of studies, both distraction cards were administered to various groups of children such as learning disabled, attention deficit hyperactive disorder and typical learners. These studies provide a certain amount of indirect information about consistency in performance with different types of distractions. The findings of these studies, while not expected to be perfectly correlated, lend indirect support to the consistency of a child's performance on the Fruit Distraction Test across two somewhat similar tasks of the test.

A similar indirect measure of alternate forms reliability is available for the Leveling-Sharpening House Test. A test-retest was employed to establish stability over a five year period. For the purposes of this study children showing learning difficulties and typical learners were used. The results of this

study indicate a fair degree of stability over the five year period. In a further study over a four week period, pupils were evaluated on three occasions. The Leveling-Sharpening House Test scores obtained in each administration were correlated with the respective scores obtained in the other administrations, resulting in eighteen correlation coefficients. Sixteen of the eighteen correlations reached statistical significance, (r's ranged from 0,02 to 0,82) supporting the proposition that the LSHT scores are relatively stable over a four week period even when administered in very different environments (Santostefano, 1988 : 130).

5.6.4.6. Content Validity

From the studies cited in the manual (Santostefano, 1988 : 141) there is strong evidence that the cognitive functioning of children observed in a wide variety of tasks can be reduced to several basic principles and that these principles satisfy the operational definitions of cognitive controls. Seven independent factor analytic studies involving normal and clinical child samples yielded essentially similar factors that could be inter-

pretted in terms of the cognitive control constructs. In each of these studies, the Cognitive Control Battery measures were instrumental in defining the principal dimensions common among various tests, and each factor was clearly interpretable in terms of one or another cognitive control principle (Santostefano, 1988 : 140).

With regard to construct validity, these studies demonstrate that cognitive control principles, as measured by the Fruit Distraction Test and Leveling-Sharpening House Test, maintain their stability across different populations and age groups.

5.6.5. Hypothesis Testing

In order to make inferences about population parameters, hypotheses will have to be tested. In formulating the hypotheses to be tested it will be assumed that this investigation will find no difference between the two groups being investigated - the null hypothesis (Ho). Should the null hypothesis which is being tested, be rejected, then the alternative hypothesis (H_1) will be tenable.

From the test which is to be administered to each subject, enough data is available to obtain nine means from the standard scores of the Fruit

Distraction test and Leveling Sharpening House test.

COGNITIVE PROFILE

Standard scores obtained for each of the following form the cognitive profile of the pupil:

Fruit Distraction Test

a) Card 2 : Time

b) Card 2 : Errors

c) Card 3 - Card 2 : Time

d) Card 3 - Card 2 : Errors

e) Card 4 - Card 2 : Time

f) Card 4 - Card 2 : Errors

Leveling - Sharpening House Test

g) First Stop Score

h) Number of correct changes

i) Ratio Score

Refer to Appendix A for an example of the Cognitive Control Battery profile.

The results obtained by the two groups on each of the above subtests are to be compared. A null hypothesis and alternative hypothesis for each has therefore been formulated.

In each case the numerical value for the null hypothesis will be Ho : $\mu - \mu = 0$

Because it is expected that the mean of the non-

learning disabled children will be higher than that of the learning disabled children for each subtest, a directional alternative hypothesis is involved:

$H_1 = \mu - \mu > 0$

The hypotheses to be tested for each subtest follow:-

Fruit Distraction Test

a) Card 2 : Time

Ho : There is no significant difference in the average time taken to name colour bars by learning disabled children and non-learning disabled children.

Hi : There is a significant difference in the average time taken to name colour bars by learning disabled children and non-learning disabled children.

b) Card 2 : Errors

Ho : There is no significant difference in the number of errors made by children who are learning disabled and children who are non-learning disabled when required to name colour bars.

Hi : There is a significant difference in the number of errors made by children who are learning disabled and children who are non-learning disabled when required to name colour bars.

c) Card 3 - Card 2 : Time

Ho : There is no significant difference in the average time taken by learning disabled and non-learning disabled children in naming colour bars when required to withhold attention from external distractions defined as irrelevant and to direct attention at information relevant to the task at hand.

H_1 : There is a significant difference in the average time taken by learning disabled and non-learning disabled children in naming colour bars when required to withhold attention from external distractions defined as irrelevant and to direct attention at information relevant to the task at hand.

d) Card 3 - Card 2 : Errors

Ho : There is no significant difference in the number of errors made by children who are learning disabled and children who are non-learning disabled when required to withhold attention from distractions defined as irrelevant and to direct attention at information relevant to the task at hand.

H_1 : There is a significant difference in the number of errors made by children who are learning disabled and children who are non-learning disabled when required to withhold attention from distractions defined as irrelevant and to direct attention at information relevant to the task at hand.

e) Card 4 - Card 2 : Time

H_0 : There is no significant difference in the average time taken by learning disabled and non-learning disabled children in naming colour bars when required to withhold attention from internal distractions defined as irrelevant and to direct attention at information relevant to the task at hand.

H_1 : There is a significant difference in the average time taken by learning disabled and non-learning disabled children in naming colour bars when required to withhold attention from internal distractions defined as irrelevant and to direct attention at information relevant to the task at hand.

f) Card 4 - Card 2 : Errors:

Ho : There is no significant difference in the number of errors made by children who are learning disabled and children who are non-learning disabled when required to withhold attention from internal distractions defined as irrelevant and to direct attention at information relevant to the task at hand.

Hi : There is a significant difference in the number of errors made by children who are learning disabled and children who are non-learning disabled when required to withhold attention from internal distractions defined as irrelevant and to direct attention at information relevant to the task at hand.

Leveling - Sharpening House Test

g) First Stop Score

Ho : There is no significant difference between the learning disabled and non-learning disabled child's ability to perceive the first correct change on the cards presented.

Hi : There is a significant difference between the learning disabled and non-learning disabled child's ability to perceive the first correct change on the cards presented.

h) Number of correct changes

Ho : There is no significant difference between the learning disabled and non-learning disabled child's score of the total number of correct changes perceived on the cards presented.

Hi : There is a significant difference between the learning disabled and non-learning disabled child's score of the total number of correct changes perceived on the cards presented.

i) Ratio Score

Ho : There is no significant difference between the learning disabled and non-learning disabled child's ability to construct stable, differentiated images of ongoing information that are differentiated from present perceptions.

Hi : There is a significant difference between the learning disabled and non-learning disabled child's ability to construct stable, differentiated images of ongoing information that are differentiated from present perceptions.

5.6.6. Analysis of Data

5.6.6.1. t Test for pairs of matched pupils

Due to the fact that a standardized test is to be used, the two groups can be compared by making use of the means of standard scores. For this purpose t tests may be applied.

For each subtest, scores will be available for the two groups of children (matched) with respect to one variable. The learning disabled children will be designated as Group A and the non-learning disabled children as Group B. The data for each pair of children with respect to the relevant variable will be placed side by side and the following calculations performed:

The summation of D (Σ D) where D = A - B
The summation of D^2 (ΣD^2)

The formula to be used is so adjusted that it will not be necessary to calculate arithmetic means or standard deviations (Mulder, 1982 : 144). The t - value will be calculated for each subtest directly using the following formula:

$$t = \frac{\sqrt{N - 1}\,\Sigma D}{\sqrt{N\Sigma D^2 - (\Sigma D)^2}}$$

where N denotes the number of pairs of children. In this research N = 20.

5.6.6.2. Level of Significance

The null hypothesis will be rejected in favour of the alternative hypothesis if the sample result has a very small probability under the null hypothesis (Huysamen, 1976 : 37). The researcher is aware that in rejecting the null hypothesis there is, however, the possibility that Ho might be rejected while this hypothesis is actually true. Taking the small sample size of this research into account, it has been decided that the level of significance should be $\alpha = 0{,}01$ as this bestows a greater degree of confidence. If the null hypothesis can be rejected with 99% confidence it means that not more that 1% of the observed differences will occur by chance.

One-tailed test

From the literature it is expected that the mean of the non-learning disabled children (group B) for each subtest will be higher than that of the learning disabled children (group A). For this reason a one-tailed test must be used to decide whether to reject the null hypothesis or not

(Mulder, 1982 : 139).

Degrees of freedom

The degrees of freedom indicate the number of values which are free to vary, subject to certain set limitations (Mulder, 1982 : 139).

For the purposes of this research the number of degrees of freedom will be:

$$df = N - 1$$
$$= 20 - 1$$
$$= 19$$

The critical t value for a one-tailed test with 19 degrees of freedom at the 1% level of significance will be 2,539. The 5% level of significance will be 1,729. These values are read from Table C (t Distribution) (Mulder, 1982 : 236).

If the calculated t-value for each subtest is greater than the critical t-value (2,539) then the null hypothesis must be rejected at the 1% level of significance. It can then be accepted that there is a significant difference between the arithmetic means of the two groups of children with 99% confidence (Mulder, 1982 : 147).

The decision rule for a one-tailed test relevant to this research is:

If the absolute value of the obtained test statistic exceeds the value of the theoretical probability of $1 - \alpha$, reject Ho

If $/z\bar{x}/ > z, -\alpha$, reject Ho.

It must be noted that failing to reject the null hypothesis does not imply that the null hypothesis should be accepted. Failing to reject the null hypothesis simply means that the observed sample data does not provide sufficient evidence for the rejection of the null hypothesis (Huysamen, 1976 : 42).

5.7 CONCLUSION

From the literature study, it would appear that a cognitive approach to remediation may be more successful. In adopting this approach one has to assume that the cognitive functioning of the learning disabled child is not at the same level as that of the non-learning disabled child. It is hoped that the above research design will verify this hypothesis.

The researcher feels that if the majority of the

null hypotheses listed above can be rejected, then the hypothesis initially stated : The cognitive functioning, with regard to attention and memory, of non-learning disabled children is better than the cognitive functioning of learning disabled children - will most certainly be tenable.

If, however, the null hupotheses cannot be rejected, there may be grounds to support an ecological approach instead, where interaction with the environment may be a causal factor in learning disabilities rather that a problem within the child himself.

Chapter 6

RESULTS OF THE EMPIRICAL INVESTIGATION

6.1. INTRODUCTION

This chapter records the findings of the empirical investigation. The results obtained for both Group A (Learning disabled children) and Group B (Non-learning disabled children) will be given for the purposes of a comparison.

The subjects used for the purpose of this investigation are given in Table 1 - Compilation and matching of test group. For ethical reasons, the names of the research subjects have been changed.

Data analysis was directed at determining whether there is a significant difference in the cognitive functioning with regard to attention and memory between learning disabled and non-learning disable children.

6.2. COGNITIVE CONTROL TESTS

The tests used for determing the above were:-

6.2.1. Field Articulation (Fruit distraction test)

The investigation looked at the manner in which each subject dealt with information that is regarded as relevant or irrelevant to the task at hand.

Table 1

COMPILATION AND MATCHING OF TEST GROUP

	Group A Learning Disabled					Group B Non-Learning Disabled				
Pair	Subject	Sex	CA	IQ	Std	Subject	Sex	CA	IQ	Std
A	Stephen	M	11	105	4	Peter	M	11	107	4
B	Bruce	M	11	96	4	Matthew	M	11	96	4
C	Wesley	M	11	112	3	John	M	11	116	4
D	Robert	M	11	116	4	Regan	M	11	118	4
E	Simone	F	11	104	4	Joan	F	10	107	4
F	Dyllan	M	11	113	3	James	M	11	115	4
G	George	M	11	106	4	Damien	M	11	107	4
H	Chad	M	10	101	2	Jerome	M	10	100	3
I	Clyde	M	10	111	3	Luke	M	10	113	3
J	Robin	M	10	101	2	Mark	M	9	105	2
K	Andrew	M	9	111	2	Ted	M	9	116	2
L	William	M	11	93	4	Jayson	M	11	99	4
M	Jane	F	9	96	2	Mary	F	9	92	2
N	Wayne	M	10	108	2	Simon	M	10	109	2
O	Darryl	M	11	102	3	Tom	M	11	104	3
P	Greg	M	11	110	4	Ryan	M	11	109	4
Q	Philip	M	11	102	4	Kenneth	M	11	104	4
R	Alan	M	11	90	4	Sean	M	11	95	4
S	Lawrence	M	11	106	3	Michael	M	11	104	3
T	Robert	M	10	96	2	Wilfred	M	10	98	2

6.2.2. Leveling-Sharpening House Test

The investigation looked at the manner in which each subject managed information over time - how the subject constructed memory images and compared these with currently presented perceptions.

6.3. METHOD OF INTERPRETING RESULTS

Raw scores were converted into standard scores using norm tables provided for the test. The mean for each of the tests was calculated and recorded for Group A and Group B separately.

In order to test hypotheses, t-tests were carried out for each of the subtest scores.
The standard scores obtained by each subject in the learning disabled group and the non-learning disabled group are given in Appendix B for the Fruit Distraction Test and the Leveling-Sharpening House Test.

The mean standard score, t values and level of significance for each group are summarised in Table 2.

The t tests for all results obtained are given in Appendix C.

TABLE 2

SUMMARY OF CALCULATIONS

TESTING THE HYPOTHESES.

[t Test for two sets of matched data (t test)]

	Card 2		Card 3/ Card 2		Card 4/ Card 2		First Stop	Number Correct	Ratio Score
	Time	Error	Time	Error	Time	Error			
$\bar{x}$ Learning Disabled[1]	39,4	46,8	50,1	53,0	41,1	48,8	58,0	56,2	57,3
$\bar{x}$ Non-Learning Disabled[1]	46,2	50,4	49,7	49,1	41,2	43,4	51,7	54,3	54,2
Calculated t value[2]	1,698	1,282	0,158	1,582	0,019	1,225	1,933	0,609	0,976
Level of significance[3]	*	*	*	*	*	*	**	*	*

Significance : $p > 0,05$ * df = 19
$p < 0,05$ **
$p < 0,01$ ***

1. See Appendix B.

2. See 5.6.6.1. and Appendix C.

3. See 5.6.6.2.

6.4. ANALYSIS OF RESULTS

6.4.1. FRUIT DISTRACTION TEST

6.4.1.1. Card 2

The cognitive functioning on this sub-test relates to an ability to attend selectively.

Card 2 was administered individually to subjects and the time taken to complete the test was recorded. The number of errors made was noted. Raw scores were converted to standard scores and the mean for each group was calculated (5.6.4.1).

The mean scores for time taken and errors made were used to test the following two null hypotheses, A and B:

Fruit Distraction Test Card 2 : Time

A There is no significant difference in the average time taken to name colour bars by learning disabled children and non-learning disabled children (5.6.5.a).

Group A: $\bar{x}$ = 39,4 Group B: $\bar{x}$ = 46,2

t = 1,698; df = 19; $p > 0,05$ (refer to Table 2)

From these results it can be inferred with 95% confidence that the null hypothesis cannot be rejected. Thus, no significant difference exists between the average time taken to name colour bars by learning disabled children and non-learning disabled children.

Fruit Distraction Test Card 2 : Errors

B There is no significant difference in the number of errors made by children who are learning disabled and children who are non-learning disabled when required to name colour bars (5.6.5.b).

Group A: $\bar{x}$ = 46,8 Group B: $\bar{x}$ = 50,4

t = 1,282; df = 19; $p > 0,05$ (refer to Table 2).

The above null hypothesis can therefore not be rejected. Thus, no significant difference exists between the average number of errors made by children who are learning disabled and children who are non-learning disabled when required to name colour bars.

6.4.1.2. Card 3 - Card 2

Card 3 with its peripheral, irrelevant pictures provides a measure of the degree to which a subject is vulnerable to EXTERNAL distractors (irrelevant

information in the immediate environment).

Card 3 was administered individually to subjects and the time taken to complete the test was recorded. The number of errors was also noted. Raw scores were converted to standard scores and the mean for each group was calculated (5.6.4.1).

The mean scores for time taken and errors made were used to test the following two null hypotheses, C and D:

Card 3 - Card 2 : Time

C There is no significant difference in the average time taken by learning disabled and non-learning disabled children (in naming colour bars) when required to withhold attention from external distractions defined as irrelevant, and to direct attention at information relevant to the task at hand (5.6.5.c).

Group A: $\bar{x}$ = 50,1 Group B: $\bar{x}$ = 49,7

t = 0,158; df = 19; $p > 0,05$

The null hypothesis cannot be rejected. Thus, no significant difference exists between the average time taken by learning disabled and non-learning disabled children (in naming colour bars) when required to withhold attention from external

distractions defined as irrelevant, and to direct attention to information relevant to the task at hand.

Card 3 - Card 2: Errors

D There is no significant difference in the number of errors made by children who are learning disabled and children who are not learning disabled when required to withhold attention from external distractions defined as irrelevant and to direct attention at information relevant to the task at hand (5.6.5.d).

Group A: $\bar{x}$ = 53,0 Group B: $\bar{x}$ = 49,1

t = 1,582; df = 19; $p > 0,05$

Table 2 shows that both the learning disabled and non-learning disabled groups performed at an age appropriate level on this test.

The null hypothesis cannot be rejected. Thus, no significant difference exists between the average number of errors made by children who are learning disabled and children who are non-learning disabled when required to withhold attention from external distractions defined as irrelevant and to direct attention to information relevant to the task at hand.

6.4.1.3. Card 4 - Card 2

Card 4 has contradictory colours and provides a measure of the degree to which a subject is vulnerable to INTERNAL distractors (information in private thoughts and fantasies).

Card 4 was administered individually to subjects from both groups and the time taken to complete the test was recorded. The number of errors was also noted. Raw scores were converted to standard scores and the mean for each group was calculated (5.6.4.1).

The mean scores for time taken and errors made were used to test the following two null hypotheses, E and F:

Card 4 - Card 2 : Time

E There is no significant difference in the average time taken by learning disabled and non-learning disabled children (in naming colour bars) when required to withhold attention from internal distractions defined as irrelevant and to direct attention at information relevant to the task at hand (5.6.5.e).

Group A: $\bar{x}$ = 41,1 Group B: $\bar{x}$ = 41,2

t = 0,019; df = 19; p > 0,05

The null hypothesis cannot be rejected. Thus, no significant difference exists between the average time taken by learning disabled and non-learning disabled children (in naming colour bars) when required to withhold attention from internal distractions defined as irrelevant and to direct attention to information relevant to the task at hand.

Card 4 - Card 2 : Errors

F There is no significant difference in the number of errors made by children who are learning disabled and non-learning disabled when required to withhold attention from internal distractions defined as irrelevant and to direct attention at information relevant to the task at hand (5.6.5.f).

Group A: $\bar{x}$ = 48,8 Group B: $\bar{x}$ = 43,4

t = 1,225; df = 19; p > 0,05

The null hypothesis cannot be rejected. Thus, no significant difference exists between the average number of errors made by children who are learning disabled and non-learning disabled when required to

withhold attention from internal distractions defined as irrelevant and to direct attention at information relevant to the task at hand.

6.4.1.4. Interpretation

The Fruit Distraction Test evaluates certain aspects of the subject's cognitive structure - attention.

From the above results using this particular group of subjects, the null hypotheses could not be rejected. One can infer from this that there is no significant difference in the cognitive functioning with regard to selective attention of children who are learning disabled and those who are not learning disabled according to this particular test.

There was no significant difference in the time taken to complete each of the cards in the test. There was also no significant difference between learning disabled and non-learning disabled children in the way they were able to withhold attention from both internal and external distractions defined as irrelevant and direct attention to information relevant to the task at hand.

6.4.2. Leveling-Sharpening House Test

6.4.2.1. All three standard scores are associated with the construction of stable, differentiated images of on-going information and the differentiation of these images from present perceptions. These characteristics are, according to Santostefano (1988 : 75), indicative of cognitive functioning. The three standard scores for each subject were obtained by administering the Leveling-Sharpening House Test (5.6.4.2). The first correct change and the number of correct changes were noted. The ratio score was calculated according to the formula given by Santostefano (1988 : 74):

> Total number of cards on which a change remained undetected divided by 19.

Raw scores were then converted to standard scores and the mean for each group was calculated. The mean scores for first correct change, number of correct changes and ratio score were used to test the following three null hypotheses, G, H and I:

1. First Correct Change

G There is no significant difference between the learning disabled and non-learning disabled child's ability to perceive the first correct change on the cards presented (5.6.5.g).

Group A: $\bar{x}$ = 58,0 Group B: $\bar{x}$ = 51,7

t = 1,933; df = 19; $p < 0,05$;

(refer to Table 2)

The null hypotheses can be rejected with 95% confidence. Thus, a significant difference exists between the learning disabled and non-learning disabled child's average ability to perceive the first correct change on the cards presented.

2. Number of correct changes

H There is no significant difference between the learning disabled and non-learning disabled child's score of the total number of correct changes perceived on the cards presented (5.6.5.h).

Group A: $\bar{x}$ = 56,2 Group B: $\bar{x}$ = 54,3

t = 0,609; df = 19; $p > 0,05$ (refer to Table 2)

The null hypothesis cannot be rejected. Thus, no significant difference exists between the learning disabled and non-learning disabled child's average score of the total number of correct changes perceived on the cards presented.

3. Ratio Score

I There is no significant difference between the learning disabled and non-learning disabled child's ability to construct stable, differentiated images of ongoing information that are differentiated from present perceptions (5.6.5.i).

Group A: $\bar{x}$ = 57,3 Group B: $\bar{x}$ = 54,2

t = 0,976; df = 19; $p > 0,05$

The null hypothesis cannot be rejected. Thus, no significant difference exists between the learning disabled and non-learning disabled child's average ability to construct stable, differentiated images of ongoing information that are differentiated from present perceptions.

6.4.2.2. Interpretation

The Leveling-Sharpening House Test evaluates certain aspects of the subject's cognitive structure of memory.

From the above results using this particular group of subjects, only the null hypothesis with regard to perceiving the first correct change could be rejected. It could only be rejected at the 0,05 level of significance, but not at the 0,01 level. It is interesting to note that the difference in the mean is significant, but that it is the learning disabled group which performed better. The means for all three standard scores were slightly higher for Group A (learning disabled) than for Group B (non-learning disabled) (See Table 2). This is opposite to what one would expect. It is the researcher's view that this slightly better performance is due to the fact that the children in the remedial school are regularly given visual perceptual exercises as part of therapy. These test subjects were therefore, a little more familiar with the type of task required in the test.

The null hypotheses with regard to the 'Number of correct changes' and 'Ratio score' could not be rejected.

One can infer from these results that children who are learning disabled do not function at a lower cognitive level with regard to memory than non-learning disabled children as measured by this test.

6.5. SUMMARY OF THE RESULTS OF THE EMPIRICAL INVESTIGATION

Taken from the point of view of Santostefano's Cognitive Controls, it can be said that the cognitive functioning, with regard to attention and memory, of the learning disabled child is not significantly different from that of the non-learning disabled child. This implies that there is no significant cognitive impairment in the learning disabled children who were tested.

It must however be borne in mind that the group used in this investigation is small and the findings of the research cannot therefore be projected onto a large population.

However, for this particular research, with this particular group of subjects, none of the null hypotheses could be rejected at the 0,01 level of

significance. The original hypothesis that the cognitive functioning of non-learning disabled children is at a higher level than the cognitive functioning of learning disabled children, as far as memory and attention are concerned and as measured by this test is therefore rejected.

Chapter 7

INTEGRATION OF FINDINGS, CONCLUSION AND RECOMMENDATION.

7.1. INTRODUCTION

The aim of this chapter is to:

a) relate the information gained from the empirical investigation to the literature study;

b) record the implications which can be made on the basis of the research findings;

c) note defects in the investigation which may have influenced the research and subsequent results;

d) offer recommendations and a conclusion on the basis of the research findings.

7.2. RELATION BETWEEN FINDINGS FROM THE LITERATURE STUDY AND THE EMPIRICAL INVESTIGATION:

In this section the findings of the literature study and the findings of the empirical investigation will be discussed. Investigating the relationships between the findings of the literature study and the empirical investigation will facilitate further discussion of the findings (7.3) and the implications thereof (7.4).

7.2.1. Findings of the literature study:

The following findings from the literature are relevant to the hypotheses formulated and will be related to the results of the empirical investigation.

(1) The literature study has indicated that children with learning disabilities do not function at the same level as non-learning disabled children with regard to cognition. The general view given is that learning disabled children function at a lower level of cognition when compared with non-learning disabled children.

(2) The view that the learning disabled child functions at a lower level of cognition than the non-learning disabled child implies that the internal mental processes involving the acquisition, storage and use of knowledge in the learning disabled child are deficient. It also implies that the learning disabled child cannot effectively direct, plan and monitor his internal mental processes which means that he is not a skillful user of knowledge.

(3) By studying the works of Piaget it became evident that knowledge is used to aid the child in adapting to his environment and that, as he interacts with his environment, further knowledge is acquired and thought processes become more complex and efficient. It would therefore seem that, underlying the whole concept of cognition is the child's involvement in

and experience with his own life-world and how he attributes meaning to it.

(4) Piaget's stages of cognitive development show that from the moment of birth, the child begins a journey along a continuum of cognitive developmental phases. What is understood from this is that, within a given culture, the majority of children will move along the continuum at a similar rate. One can therefore compare a particular child with the norm and decide whether his cognitive development is average, relatively delayed or advanced.

(5) The literature has also indicated that the ability to remember and the ability to attend are essential for effective cognitive functioning. In fact, memory and attention are interdependent (De Wet, 1989 : 116) and attention is necessary for the duration of information processing.

(6) With regard to attention, a deficit has been explained as possibly being caused by inadequate training in exploratory skills (metacognition) or, from a neurological point of view, as a lesion in the frontal cortex which is connected to the reticular activating system (RAS).

(7) In chapter 4 (4.2.2.4.) Hynd and his co-workers hypothesized that children with problems in attention would perform significantly more slowly and with more variability than other children on tasks reflecting basic automatized processes. It was further hypothesized that children with an attention deficit would manifest in longer latencies to respond and that, as speeded classification tasks became more complex, thereby placing a greater load on important automatic cognitive pocesses, significant differences would emerge between the learning disabled and non-learning disabled groups of children.

(8) Also in chapter 4, findings of the research of Sergent and Scholten indicated that distractible children were slower than control groups in speed of cognitive processing.

(9) The aetiology of memory problems are also explained from neurological and cognitive points of view. Neurologically, a memory problem is regarded as the result of a temporal lobe seizure. Metacognitively, a memory problem is viewed as a lack of capacities that enable one to interact with incoming information to make sense of the environment.

(10) In chapter 4 (4.4.) Bauer and Newman pointed out that the memory processes of children with learning disabilities are developmentally delayed. This was confirmed by Swanson who found that the memory performance of learning disabled children can be equated with that of younger non-learning disabled children.

The above findings led the researcher to formulate the following hypothesis and then carry out an empirical investigation to varify its validity:-

The cognitive functioning, with regard to attention and memory, of non-learning disabled children is better than the cognitive functioning of learning disabled children.

7.2.2. Findings from the empirical investigation.

With regard to the hypotheses, as outlined in chapter 5, the findings of the empirical investigation suggest the following:

(1) Using the particular sample of children described in chapter 5 and the Cognitive Control Test Battery of Santostefano, the results of this investigation indicate that there is no significant difference

between learning disabled children and non-learning disabled children with regard to:

a) the speed with which tasks are completed

b) the way each child is able to withhold attention from both internal and external distractions and direct attention to information that is relevant to the task at hand.

c) the ability to construct images of past information and compare these to perceptions of present information.

These three conclusions are based on the following:

a) Three different tasks were performed and timed and the average scores of the two groups for each task were compared. The average of Group A (Learning disabled) was lower than that of Group B (non-learning disabled) on the first test, but approximately the same on the second and third tests, which were slightly more complex. However, in using a t Test for matched data in order to make a valid comparison, no significant difference was noted between the two groups.

b) On each of the three subtests, the children from both groups firstly had to call the colours observed on a card as quickly as possible. On the second card the same task was required but it had to be performed while being subjected to external distractors. On the final subtest, again the same task was re-

quired, but while being subjected to internal distractors. It is interesting to note that both groups made more errors when subjected to internal distractors as opposed to external distractors. Both groups also slowed down in their rate of calling answers to accommodate the complexity of the tasks. However, although the averages of the two groups differed, the t Tests indicated that there was no significant difference between the Group A (learning disabled) and Group B (non-learning disabled) in their ability to withhold attention from both internal and external distractors while directing attention to information that was regarded as relevant to the task at hand.

c) When looking at a series of pictures on cards both Group A and Group B were able to respond correctly and obtain similar scores in identifying changes which took place randomly on cards in the series. According to the t Tests for matched data, no significant differences were noted in their scores. However, on the task of identifying the first error correctly, Group A (learning disabled) performed better than Group B (non-learning disabled). This was confirmed by the t Test carried out. A possible

explanation for this could be that the learning disabled group was possibly "test-wise" to this particular task as it is similar to exercises for visual discrimination which these children do on a regular basis in the remedial school. From this it is therefore safe to conclude that the learning disabled children performed at least as well as the non-learning disabled children with regard to constructing images of past information and comparing these images to perceptions of present information.

(2) Therefore, from the point of view of Santostefano's Cognitive Controls, it can be said that, with regard to memory and attention, the cognitive functioning of the learning disabled child is not significantly different from that of the non-learning disabled child.

(3) The finding that the cognitive functioning of the learning disabled child is not significantly different from that of the non-learning disabled child implies that there is no significant cognitive impairment (as far as attention and memory are concerned) in the learning disabled children who were tested.

7.3. DISCUSSION OF FINDINGS

The initial reaction to the above findings was one of surprise. Contrary to the majority of the literature studied, the results of the empirical investigation suggest that there is no significant difference in the level of cognitive functioning (concerning attention and memory) between the two groups studied. By implication, both groups are neurologically intact in terms of the functions evaluated by the Cognitive Control Test Battery of Santostefano.

These findings are supported by the following researchers:

7.3.1. Conners, Kramer and Guerra (Reid et al, 1991 : 163) compared learning disabled and non-learning disabled children on their ability to remember information presented to them (see 4.3.2.). The result of their findings was that there was no difference between the groups on short term recall. The same results are reported by Reid and Hresko (1991 : 164). Which means that in terms of this research the underlying reason for the learning disabled group's learning problem was probably not at a short term memory level.

7.3.2. Richards and his co-workers (1990 : 133) carried out research in sustained and selective attention (see 4.2.2.4.). Their findings, too, indicated that there was no difference between the performance of the learning disabled group and non-learning disabled group on tasks requiring sustained and selective attention when observed in their classroom. This suggests that the differences in attentional performance and information processing style may be subtle.

7.3.3. The developmental lag referred to so frequently in the literature has been found by Wong (1988 : 191) to relate only to younger children (see 4.2.2.4.). She has found that after the age of approximately 7 years, a lag is no longer noticable. This implies that after this age, performance should become age appropriate.

7.3.4. Hynd et al (1989 : 578) found in their research that the learning disabled groups with hyperactivity or without hyperactivity and the control group did not differ significantly from each other on simple reaction time tasks (see 4.2.2.4.) which means that at a low level of responsivity, the children in these groups cannot be distinguished.

7.3.5. Jay Samuels (1987 : 61) found, from research carried out, that there were no significant differences between learning disabled and non-learning disabled children on any measures of attention which he used (see 4.2.2.4.). Since there is always the possibility of experimental error, a replication and extention of the test was carried out on another group of children, using different research assistants. Once again no overall difference in attention between the two groups was found. What this research implies is that, if attention is regarded as a hypothetical construct with a variety of aspects, no differences showed up on any of these aspects. This related for example to attention during reading, art and on tasks requiring selective attention.

7.3.6. Krupski's (1987 : 64) findings support the above researchers (see 4.2.2.4.). However, she did note that there were some differences between the two groups of children when tasks became far more cognitively demanding. This suggests that attention may be affected by the level of difficutly and duration of the task.

7.4. IMPLICATIONS OF FINDINGS

The initial problem encountered by the researcher which prompted this investigation was: In spite of receiving remedial education on a full time basis, a number of children with reading problems do not make adequate progess. This raised the question as to whether the approach to remediation being used is appropriate. The literature study therefore focussed on the psychoneurological approach, the cognitive approach and the ecological approach. In deciding on which approach should be emphasized, the empirical research made use of the Cognitive Control Test Battery of Santostefano which specifically evaluates attention and memory. This test was selected because attention and memory are regarded as being at the basis of the psychoneurological approach, an approach which the researcher has used in remediation.
It was felt that if there was a significant difference in these two areas between the learning disabled and non-learning disabled groups, it would lend impact to or strengthen the psychoneurological theory.

Further, if one regards memory as being a descriptive term for a collection of cognitive processes and that all cognitive acts have their origin in attention, then poor performance on the Cognitive Control Test Battery would indicate a lower level of cognitive functioning.

If the test used is accepted as being valid and one considers the research findings of other researchers in support of this empirical investigation, the implications are most interesting.

Firstly the results of this empirical investigation indicate that there is no significant difference in the cognitive ability concerning attention and memory, between the two groups investigated.

Further, by implication, there is no neurological dysfunction as far as memory and attention deficit is concerned, to account for the problems being experienced in learning. One can therefore assume from this that neither a psychoneurological approach nor a purely cognitive approach to remediation will be effective in helping the child who does not cope with learning. This also brings into question whether perceptual training or occupational therapy

should have a central place in remediation. Where then does the problem lie?

It would appear that the problem does not predominantly lie within the child. If this is the case, then one has to look for a possible aetiology of the problem in the child's environment or life world.

The literature study pertaining to the psychoneurological approach and the cognitive approach is not substantiated by the results of this empirical investigation, with this particular group of children. However, the researcher is of the opinion that the results do correlate with the ecological approach referred to in chapter 2. This approach emphasizes the dynamic interaction between the child and his educational environment.

Kriegler (1988 : 271) is of the view that where a problem of learning exists, the problem does not necessarily lie within the child, but with the environment and teaching methods that have been provided as far back as the birth of the child, all of which result in poor language skills. Adelman (1992 : 18) too, looks to the environment for answers as to the cause of a learning problem. He investigates the primary environment such as poor

instruction programmes and parental neglect, as well as a secondary environment, such as racially isolated schools and neighbourhoods and then finally at tertiary environments such as broad social, cultural, economic and policical influences.

This view is supported by Hall (1987 : 8) who says

"- Most children begin to read and write long before they arrive at school. They do not wait until they are 'taught'.

- Literacy emerges not in a systematic, sequential manner, but as a response to the printed language and social environment experienced by the child.

- Literacy is a social phenomenon and as such is influenced by cultural factors. Therefore the cultural group in which children grow up will be a significant influence on the emergence of literacy."

This ecological approach appears to be so logical when one considers Piaget's theory of cognitive development, discussed in chapter 3. According to Kriegler (1988 : 340) a learning problem is seen as the result of a dysfunctional pedagogic - didactic guidance towards the self-actualization of the child's literacy potential. She points out that it is not the brain or brain processing that learns, it is the <u>whole</u> person who learns. She therefore advocates that in studying learning problems this studying should come from a perspective based in an

holistic, personalistic anthropology. Developmental psychology is therefore very important in dealing with learning problems. Not only is it important to have a sound knowledge of cognitive development, one also has to have a good understanding of affective and normative becoming (Kriegler, 1988 : 54).

The question still to be answered is why all children do not learn with the same ease and at the same tempo? In order to answer this, one has to take many educational factors into consideration. Learning is believed to take place through the interaction between unique attributes of the child and the teaching and education that he encounters (Kriegler, 1988 : 100). In other words, a child's becoming cannot be regarded as pre-programmed from birth. Becoming is dependant on the active interaction which the child has with his environment or life-world.

From the above information, is it then fair to say that reading problems are primarily teaching problems? Have parents failed their children? Are there shortcomings in our education system?

Kriegler (1988 : 340) explains reading problems in terms of a dysfunctional education system. She emphasizes that parents should be recognized as uniquely qualified partners in the teaching of reading. Reading should begin on the mothers lap. From here, in an environment of warmth and nurturing, a love for language and reading can be developed. Before the child can learn to read a certain level of language development must have been attained. Before one can learn to read, one must have a good idea of what reading is and what it involves. One must also be convinced that reading is a meaningful, valuable and enjoyable experience. By reading stories to a child from an early age, one helps to develop, for example, an awareness that spoken language and the language used in books differ. The above refers to the pre-literacy experience and should happen in the home. Kriegler (1988 : 164) believes that the child who can already read and write on entering school and who has a well developed expressive language, starts his school career at a tremendous advantage. She regards it as a tragedy that parents do not teach their children to read before they commence formal schooling.

Parental involvement in the child's learning is also reduced by our education system, in that pupils are not given formal homework until after standard one (Kriegler 1988 : 167).

With regard to faults in our education system referred to above, Kriegler criticizes the present system of teaching reading. At present, the approach used in most schools in South Africa is what Yule and Rutler (1985 : 444) refer to as a 'bottom-up' model. In other words, sounds are taught, these are blended to form words, words are then read in sentences, finally arriving at meaning. For the child who experiences difficulty, working step by step through a passage, places a tremendous burden on memory and attention, often resulting in poor comprehension. This approach is not acceptable because semantics, structural and syntactical aspects of language are ignored as well as cognition, attention and memory (Kriegler, 1988 : 71). For Kriegler (1988 : 97) reading for <u>meaning</u> is the only valid objective for teaching reading and the only way to learn to read is to read. She therefore advocates a 'top-down' model such as the language experience approach. This

approach can be summarised as : thought --> spoken language --> written language --> read.

This approach is aptly described by Young and Tyre (1982 : 50) where the point of departure for teaching reading is the child's life world: "I know what I mean when I read what I write, because I know what I meant when I wrote it." In addition, it is obvious that the object of writing is the symbolising of 'meaning'. Reid and Hresko (1991 : 241) regard reading as being mind-to-eye and not eye-to-mind.

The approach advocated in helping the child who does not cope in the mainstream therefore implies a shift in emphasis in the traditional role of the orthodidactician. The help given to the child with a learning problem must form a part of the total strategy which is aimed at harmonizing the pedagogic - didactic guidance towards the self-actualization of the child's learning and personal potential (Kriegler, 1988 : 341). The role of the orthodidactician should also encompass a preventative task, such as preparing parents for the very important function they have in preparing their children for reading. The task of the orthodidactician is there-

fore to expose and explain a disharmonic education dynamic. This means that in order to identify problems and thereby help the child, the orthodidactician must have a complete understanding of how the 'accompaniment' to literacy should develop. Accompaniment refers to the way in which the adult 'holds the child's hand' on his way to adulthood.

The positive aspect of the ecological approach, encorporating Kriegler's educational dynamics perspective, is that it is based on the optimistic assumption that the child can change, become and learn under the guidance of his parents and teachers.

This ecological approach, as opposed to a neurological or purely cognitive approach, appears to have validity. It would be interesting, for example, to compare the differences in culture and language development of western countries with that of Japan where a one hundred percent literacy is reported (Torrance, 1980 : 12).

Finally, the following quotation by Singer (Kriegler 1988 : 170) is appropriate to conclude this section.

> "... when reading specialists try to determine why students are having difficulties in learning to read, they should not only examine students to determine whether they have 'learning disabilities' but also teachers to discover whether they have 'teaching disabilities', and schools to find out whether administration and organization of the reading programme facilitates or interferes with conditions for a consistent, cumulative and coherent instructional programme."

7.5. DEFECTS IN THIS STUDY

The sample size used for this empirical investigation was twenty learning disabled pupils and twenty non-learning disabled pupils, as defined in chapter 5. This sample size is regarded as being relatively small. As such, the results, although obtained on a standardized test, cannot be projected onto a large population. However, the results are accepted as valid for this experimental group and, as such, can be seen as a pilot study for further investigation and research with larger groups which will then allow generalisations to be made.

7.6. CONCLUSION AND RECOMMENDATIONS

On the basis of the research findings the researcher is left with a feeling of optimism. The results imply that the child who is not coping at school does not necessarily have a disability and can be helped in a pedagogic - didactic milieu. It also implies that preventative measures, in addition to remedial measures, can be taken in schools by changing the approach to reading instruction. This bodes well in South Africa today where the rationalization of education and multicultural education are presently issues of concern.

In the past, most remedial therapy was provided on a one-to-one basis. If this is not necessary, moving away from a psychoneurological approach, where individual underlying deficits had to be remediated, more pupils who have learning problems can now be accommodated and assisted. The task that lies ahead for educators may therefore not be as daunting as initially anticipated.

The importance of the pre-literacy experience cannot be over emphasized. If this is the case, the researcher sees the function of a primary care giver (be it a mother or a mother substitute) taking on a

whole new perspective. Because pre-school children spend a large portion of their day with this caregiver, she has a tremendous responsibility with reregard to the child's future career and life success.

It also makes sense that where an educational environment has been deprived, bridging classes should be provided. In this way, pupils coming from a background where they have been deprived of the experiences which facilitate school readiness can be helped "to create some order in their cognitive structures and to give them a slightly better cognitive grasp of the reality around them" (Wiechers, 1991 : 6).

The literature study has also indicated that the child begins to read long before commencing formal schooling. Surely then, the preprimary schools should be allowed to offer a programme that is more orientated towards reading and mathematics.

In support of the above, Topping and Wolfendale (1985 : 21) state that the influence of the parents (or other pre-school educators) is stronger than that of the school. "All later learning is likely

to be influenced by the very basic learning which has taken place before the age of five or six. Ideally, the early intellectual development of the child should take place in the home" (Beck, 1969 : 18).

The message in this is that early childhood education cannot be left to chance or to the ignorant (Wiechers, 1991 : 8). Parents, day mothers, and nursery school teachers should therefore be suitably trained and adequately qualified for the important task of educating the young child.

In Feuerstein's conceptual framework, Begab (Feuerstein, 1980 : xiv) says that parents, as the primary educators of their children, need to be aware that a major inhibiting factor for children with learning problems is poor pedagogical input by parents during the child's first years of life.

On the basis of this research study, the ecological approach is therefore the theory or approach to remediation that should be emphasized. The ecological approach is based on a theory which can be used to build a preventative or a therapeutic strategy.

The researcher feels that in view of the information obtained from this research study, it may be worthwhile to carry out further investigations on a much larger scale.

Finally, there is an idiom, 'Sticks and stones may break my bones, but words will never harm me.' What a wonderful day it will be when this becomes a truth for our pupils with reading problems.

A P P E N D I X A

COGNITIVE CONTROL BATTERY
Record Booklet

Sebastiano Santostefano, Ph.D.

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Child's Name GEORGE Date Tested 92 03 (Year, Month, Day)

School _____ Grade Sr 4 Sex M Date of Birth 8 01 27 (Year, Month, Day)

Parent's Name _____ Age 11 - 2 (Years, Months, Days)

Referred by _____ Examiner _____

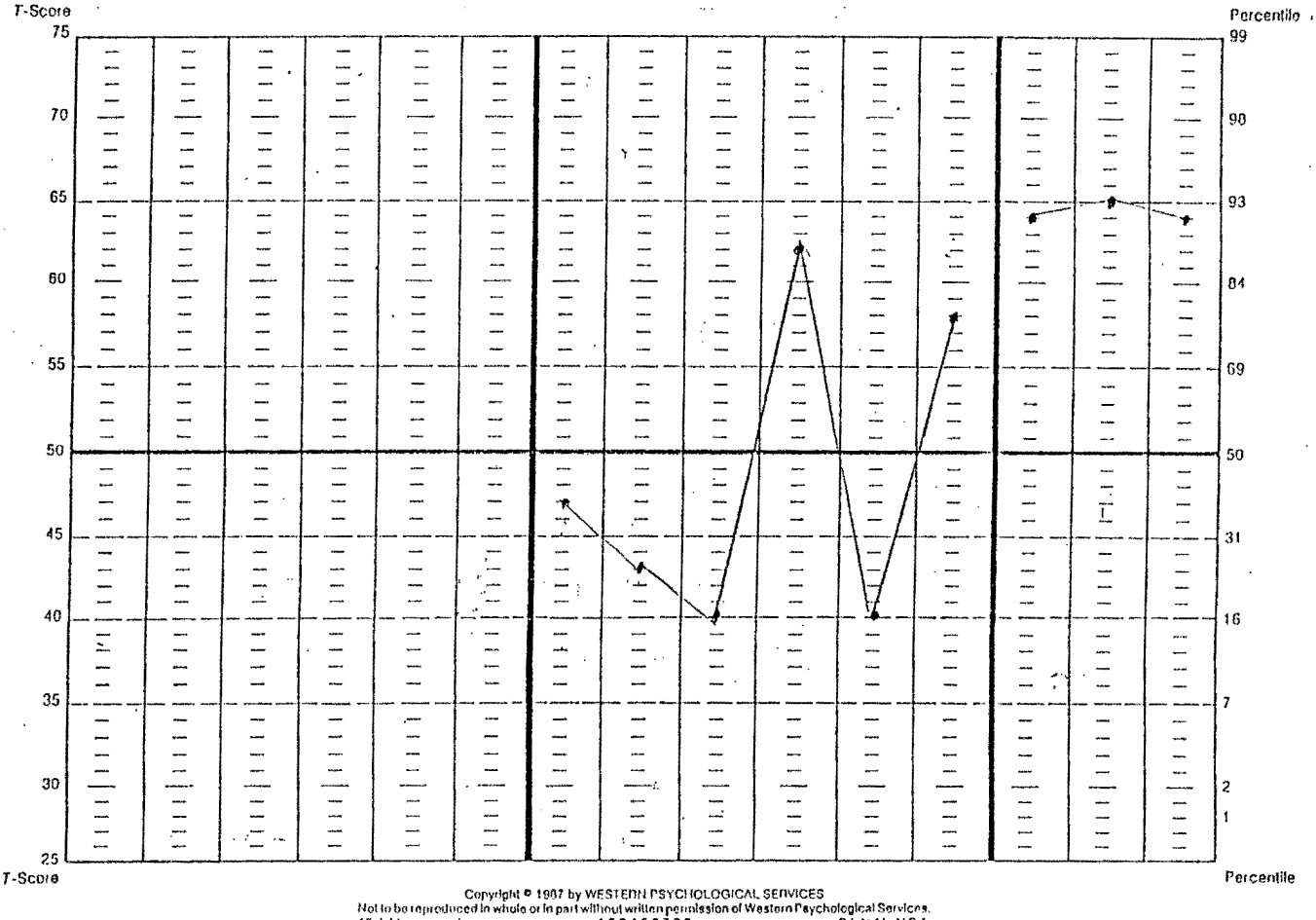
Reason for Referral _____

Language spoken at home (if other than standard English) _____

Rapport ☐ Good ☐ Variable ☐ Poor General Observations _____

CCB PROFILE

	Scattered Scanning Test						Fruit Distraction Test						Leveling-Sharpening House Test		
	Motor Tempo	Number Correct Shapes Marked	Ratio I	Total Distance	Ratio II	Mean Distance	Card 2 Time	Card 2 Errors	Card 3-Card 2 Time	Card 3-Card 2 Errors	Card 4-Card 2 Time	Card 4-Card 2 Errors	First Step Score	Number Correct Changes	Ratio Score
Raw Score							42	3	6	-2	27	-2	5	16	7.8
T-Score							47	43	40	62	40	58	64	65	64
Percentile							38	34	16	88	16	79	92	93	92



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A P P E N D I X B

TABLE 1

FRUIT DISTRACTION TEST RESULTS FOR LEARNING DISABLED GROUP (GROUP A)

(All figures indicate Standard scores.)

Subject	Card 2		Card 3 - Card 2		Card 4 - Card 2	
	Time	Errors	Time	Errors	Time	Errors
Stephen	59	59	30	40	42	32
Bruce	34	43	72	57	56	50
Wesley	25	36	40	40	30	55
Robert	47	39	40	40	48	50
Simone	34	37	47	57	54	62
Dyllan	55	59	42	40	40	45
George	47	43	40	62	40	58
Chad	29	35	57	67	50	62
Clyde	43	43	50	62	39	58
Robin	25	43	61	62	30	58
Andrew	41	44	55	53	39	40
William	43	59	45	40	44	50
Jane	25	49	60	53	34	56
Wayne	37	53	56	57	28	23
Darryl	37	43	52	62	40	58
Greg	26	37	40	57	50	58
Philip	51	59	61	52	40	39
Alan	37	43	72	67	56	58
Lawrence	59	59	52	40	39	32
Robert	34	53	30	52	31	32
N = 20	788	936	1002	1060	822	976
$\bar{x}$	39,4	46,8	50,1	53,0	41,1	48,8

TABLE 2

FRUIT DISTRACTION TEST RESULTS FOR NON-LEARNING DISABLED GROUP (GROUP B)

(All figures indicate Standard scores.)

Subject	Card 2		Card 3 - Card 2		Card 4 - Card 2	
	Time	Errors	Time	Errors	Time	Errors
Peter	25	39	50	52	44	58
Matthew	25	43	61	62	47	55
John	37	53	52	52	56	55
Regan	47	59	42	26	42	45
Joan	64	53	54	52	39	55
James	40	47	56	40	50	45
Damien	55	59	34	46	39	39
Jerome	55	47	45	52	33	32
Luke	43	37	54	57	30	23
Mark	72	55	58	48	47	31
Ted	56	61	46	48	41	36
Jayson	55	59	50	33	39	23
Mary	41	55	40	48	45	56
Simon	37	39	45	62	35	55
Tom	40	47	54	46	40	50
Ryan	51	47	47	52	39	32
Kenneth	43	43	64	62	40	45
Sean	40	59	40	40	41	39
Michael	51	53	56	52	31	39
Wilfred	47	53	45	52	45	55
N = 20	924	1008	993	982	823	868
$\bar{x}$	46,2	50,4	49,7	49,1	41,2	43,4

TABLE 3

LEVELING-SHARPENING HOUSE TEST RESULTS FOR LEARNING DISABLED GROUP (GROUP A)

(All figures indicate Standard scores.)

Subject	First Correct Stop	Number of Correct Changes	Ratio Score
Stephen	50	61	54
Bruce	68	61	62
Wesley	50	57	52
Robert	54	47	52
Simone	50	47	46
Dyllan	64	69	68
George	64	65	64
Chad	68	61	66
Clyde	57	65	69
Robin	46	47	52
Andrew	69	55	60
William	50	39	49
Jane	69	64	64
Wayne	64	57	52
Darryl	48	39	44
Greg	50	57	52
Philip	50	47	46
Alan	57	61	60
Lawrence	68	73	73
Robert	64	52	60
N = 20	1160	1124	1145
$\bar{x}$	58,0	56,2	57,3

TABLE 4

LEVELING-SHARPENING HOUSE TEST RESULTS FOR NON-LEARNING DISABLED GROUP (GROUP B)

(All figures indicate Standard scores.)

Subject	First Correct Stop	Number of Correct Changes	Ratio Score
Peter	50	61	54
Matthew	50	47	46
John	33	39	35
Regan	50	52	49
Joan	68	65	64
James	46	52	49
Damien	50	43	57
Jerome	54	61	60
Luke	50	47	39
Mark	65	55	60
Ted	47	43	43
Jayson	68	52	60
Mary	50	55	60
Simon	48	65	62
Tom	50	61	62
Ryan	50	61	52
Kenneth	68	65	64
Sean	33	43	41
Michael	50	57	60
Wilfred	54	61	66
N = 20	1034	1085	1083
$\bar{x}$	51,7	54,3	54,2

A P P E N D I X C

FRUIT DISTRACTION TEST

Card 2 : Time

Pair	Gr A	Gr B	D = A-B	D^2
A	59	25	34	1156
B	34	25	9	81
C	25	37	-12	144
D	47	47	0	0
E	34	64	-30	900
F	55	40	15	225
G	47	55	- 8	64
H	29	55	-26	676
I	43	43	0	0
J	25	72	-47	2209
K	41	56	-15	225
L	43	55	-12	144
M	25	41	-16	256
N	37	37	0	0
O	37	40	- 3	9
P	26	51	-25	625
Q	51	43	8	64
R	37	40	- 3	9
S	59	51	8	64
T	34	47	-13	169
20 (N)			-136 (ΣD)	7020 (ΣD^2)

$$t = \frac{\sqrt{N-1} \times \Sigma D}{\sqrt{N \Sigma D^2 - (\Sigma D)^2}}$$

$$= \frac{\sqrt{19} \times 136}{\sqrt{20 \times 7020 - 18496}}$$

$$= \frac{592,8102564}{349,1475333}$$

$$= 1,697878976 \quad \text{or} \quad 1,698$$

One tailed test * : 5% = 1,729
1% = 2,539

1,698 < 1,729

The t value is less than the theoretical probability distribution at the 0,05 level of significance. The null hypothesis can therefore not be rejected at the 5% level of significance.

* For derivation of figures refer to Method of Empirical Investigation (5.6.6.2.)

FRUIT DISTRACTION TEST

Card 2 : Errors

Pair	Gr A	Gr B	D = A-B	D^2
A	59	39	20	400
B	43	43	0	0
C	36	53	-17	289
D	39	59	-20	400
E	37	53	-16	256
F	59	47	12	144
G	43	59	-16	256
H	35	47	-12	144
I	43	37	6	36
J	43	55	-12	144
K	44	61	-17	289
L	59	59	0	0
M	49	55	- 6	36
N	53	39	14	196
O	43	47	- 4	16
P	37	47	-10	100
Q	59	43	16	256
R	43	59	-16	256
S	59	53	6	36
T	53	53	0	0
20 (N)			-72 (ΣD)	3254 (ΣD^2)

$$t = \frac{\sqrt{N-1} \times \Sigma D}{\sqrt{N \Sigma D^2 - (\Sigma D)^2}}$$

$$= \frac{\sqrt{19} \times 72}{\sqrt{20 \times 3254 - 5184}}$$

$$= \frac{313,840724}{244,7365931}$$

$$= 1,282361252 \quad \text{or} \quad 1,282$$

One tailed test * : 5% = 1,729
1% = 2,539

1,282 < 1,729

The t value is less than the theoretical probability distribution at the 0,05 level of significance. The null hypothesis can therefore not be rejected at the 5% level of significance.

* For derivation of figures refer to Method of Empirical Investigation (5.6.6.2.)

FRUIT DISTRACTION TEST

Card 3 - Card 2 : Time

Pair	Gr A	Gr B	D = A-B	D^2
A	30	50	-20	400
B	72	61	11	121
C	40	52	-12	144
D	40	42	- 2	4
E	47	54	- 7	49
F	42	56	-14	196
G	40	34	6	36
H	57	45	12	144
I	50	54	- 4	16
J	61	58	3	9
K	55	46	9	81
L	45	50	- 5	25
M	60	40	20	400
N	56	45	11	121
O	52	54	- 2	4
P	40	47	- 7	49
Q	61	64	- 3	9
R	72	40	32	1024
S	52	56	- 4	16
T	30	45	-15	225
20 (N)			9 (ΣD)	3073 (ΣD^2)

$$t = \frac{\sqrt{N-1} \times \Sigma D}{\sqrt{N \Sigma D^2 - (\Sigma D)^2}}$$

$$= \frac{\sqrt{19} \times 9}{\sqrt{20 \times 3073 - 81}}$$

$$= \frac{39,2300905}{247,7478557}$$

$$= 0,158346842 \quad \text{or} \quad 0,158$$

One tailed test * : 5% = 1,729
1% = 2,539

$0,158 < 1,729$

The t value is less than the theoretical probability distribution at the 0,05 level of significance. The null hypothesis can therefore not be rejected at the 5% level of significance.

* For derivation of figures refer to Method of Empirical Investigation (5.6.6.2.)

FRUIT DISTRACTION TEST

Card 3 - Card 2 : Errors

Pair	Gr A	Gr B	D = A-B	D^2
A	40	52	-12	144
B	57	62	- 5	25
C	40	52	-12	144
D	40	26	14	196
E	57	52	5	25
F	40	40	0	0
G	62	46	16	256
H	67	52	15	225
I	62	57	5	25
J	62	48	14	196
K	53	48	5	25
L	40	33	7	49
M	53	48	5	25
N	57	62	- 5	25
O	62	46	16	256
P	57	52	5	25
Q	52	62	-10	100
R	67	40	27	729
S	40	52	-12	144
T	52	52	0	0
20 (N)			78 (ΣD)	2614 (ΣD^2)

$$t = \frac{\sqrt{N-1} \times \Sigma D}{\sqrt{N \Sigma D^2 - (\Sigma D)^2}}$$

$$= \frac{\sqrt{19} \times 78}{\sqrt{20 \times 2614 - 6084}}$$

$$= \frac{339,9941176}{214,9325476}$$

$$= 1,58186427 \quad \text{or} \quad 1,582$$

One tailed test * : 5% = 1,729
1% = 2,539

1,582 < 1,729

The t value is less than the theoretical probability distribution at the 0,05 level of significance. The null hypothesis can therefore not be rejected at the 5% level of significance.

* For derivation of figures refer to Method of Empirical Investigation (5.6.6.2.)

FRUIT DISTRACTION TEST

Card 4 - Card 2 : Time

Pair	Gr A	Gr B	D = A-B	D^2
A	42	44	- 2	4
B	56	47	9	81
C	30	56	-26	676
D	48	42	6	36
E	54	39	15	225
F	40	50	-10	100
G	40	39	1	1
H	50	33	17	289
I	39	30	9	81
J	30	47	-17	289
K	31	41	-10	100
L	44	39	5	25
M	34	45	-11	121
N	28	35	- 7	49
O	40	40	0	0
P	50	39	11	121
Q	40	40	0	0
R	56	41	15	225
S	39	31	8	64
T	31	45	-14	196
20 (N)			- 1 (ΣD)	2683 (ΣD^2)

$$t = \frac{\sqrt{N - 1} \times \Sigma D}{\sqrt{N \Sigma D^2 - (\Sigma D)^2}}$$

$$= \frac{\sqrt{19} \times 1}{\sqrt{20 \times 2683 - 1}}$$

$$= \frac{4,358898944}{231,6441236}$$

$$= 0,018817222 \quad \text{or} \quad 0,019$$

One tailed test * : 5% = 1,729
1% = 2,539

0,019 < 1,729

The t value is less than the theoretical probability distribution at the 0,05 level of significance. The null hypothesis can therefore not be rejected at the 5% level of significance.

* For derivation of figures refer to Method of Empirical Investigation (5.6.6.2.)

FRUIT DISTRACTION TEST

Card 4 - Card 2 : Error

Pair	Gr A	Gr B	D = A-B	D^2
A	32	58	-26	676
B	50	55	- 5	25
C	55	55	0	0
D	50	45	5	25
E	62	55	7	49
F	45	45	0	0
G	58	39	19	361
H	62	32	30	900
I	58	23	35	1225
J	58	31	27	729
K	40	36	4	16
L	50	23	27	1225
M	56	56	0	0
N	23	55	-32	1024
O	58	50	8	64
P	58	32	26	676
Q	39	45	- 6	36
R	58	39	19	361
S	32	39	- 7	49
T	32	55	-23	529
20 (N)			108 (ΣD)	7970 (ΣD^2)

$$t = \frac{\sqrt{N - 1} \times \Sigma D}{\sqrt{N \Sigma D^2 - (\Sigma D)^2}}$$

$$= \frac{\sqrt{19} \times 108}{\sqrt{20 \times 7970 - 11664}}$$

$$= \frac{470,761086}{384,3644104}$$

$$= 1,224778032 \quad \text{or} \quad 1,225$$

One tailed test * : 5% = 1,729
1% = 2,539

$1,225 < 1,729$

The t value is less than the theoretical probability distribution at the 0,05 level of significance. The null hypothesis can therefore not be rejected at the 5% level of significance.

* For derivation of figures refer to Method of Empirical Investigation (5.6.6.2.)

LEVELING-SHARPENING HOUSE TEST

First Stop Correct

Pair	Gr A	Gr B	D = A-B	D^2
A	50	50	0	0
B	68	50	18	324
C	50	33	17	289
D	54	50	4	16
E	50	68	-18	324
F	64	46	18	324
G	64	50	14	196
H	68	54	14	196
I	57	50	7	49
J	46	65	-19	361
K	69	47	22	484
L	50	68	-18	324
M	69	50	19	361
N	64	48	16	256
O	48	50	- 2	4
P	50	50	0	0
Q	50	68	-18	324
R	57	33	24	576
S	68	50	18	324
T	64	54	10	100
20 (N)			126 (ΣD)	4832 (ΣD^2)

$$t = \frac{\sqrt{N - 1} \times \Sigma D}{\sqrt{N \Sigma D^2 - (\Sigma D)^2}}$$

$$= \frac{\sqrt{19} \times 126}{\sqrt{20 \times 4832 - 15876}}$$

$$= \frac{549,2212669}{284,1900772}$$

$$= 1,932584249 \quad \text{or} \quad 1,933$$

One tailed test * : 5% = 1,729
1% = 2,539

$1,933 > 1,729$

$1,933 < 2,539$

The t value is greater than the theoretical probability distribution at the 0,05 level of significance. The null hypothesis can therefore be rejected at the 5% level of significance. It cannot however be rejected at the 1% level of significance.

LEVELING-SHARPENING HOUSE TEST

Number of correct changes.

Pair	Gr A	Gr B	D = B-A	D^2
A	61	61	0	0
B	61	47	14	196
C	57	39	18	324
D	47	52	- 5	25
E	47	65	-18	324
F	69	52	17	289
G	65	43	22	484
H	61	61	0	0
I	65	47	18	324
J	47	55	- 8	64
K	55	43	12	144
L	39	52	-13	169
M	64	55	9	81
N	57	65	- 8	64
O	39	61	-22	484
P	57	61	- 4	16
Q	47	65	-18	324
R	61	43	18	324
S	73	57	16	256
T	52	61	- 9	81
20 (N)			39 (ΣD)	3973 (ΣD^2)

$$t = \frac{\sqrt{N - 1} \times \Sigma D}{\sqrt{N \Sigma D^2 - (\Sigma D)^2}}$$

$$= \frac{\sqrt{19} \times 39}{\sqrt{20 \times 3973 - 1521}}$$

$$= \frac{169,9970588}{279,175572}$$

$$= 0,608925264 \quad \text{or} \quad 0,609$$

One tailed test * : 5% = 1,729
1% = 2,539

0,609 < 1,729

The t value is less than the theoretical probability distribution at the 0,05 level of significance. The null hypothesis can therefore not be rejected at the 5% level of significance.

* For derivation of figures refer to Method of Empirical Investigation (5.6.6.2.)

LEVELING-SHARPENING HOUSE TEST

Ratio Score

Pair	Gr A	Gr B	D = A-B	D^2
A	54	54	0	0
B	62	46	16	256
C	52	35	17	289
D	52	49	3	9
E	46	64	-18	324
F	68	49	19	361
G	64	57	7	49
H	66	60	6	36
I	69	39	30	900
J	52	60	- 8	64
K	60	43	17	289
L	49	60	-11	121
M	64	60	4	16
N	52	62	-10	100
O	44	62	-18	324
P	52	52	0	0
Q	46	64	-18	324
R	60	43	19	361
S	73	60	13	169
T	60	66	- 6	36
20 (N)			62 (ΣD)	4028 (ΣD^2)

$$t = \frac{\sqrt{N - 1} \times \Sigma D}{\sqrt{N \Sigma D^2 - (\Sigma D)^2}}$$

$$= \frac{\sqrt{19} \times 62}{\sqrt{20 \times 4028 - 3844}}$$

$$= \frac{270,2517345}{276,9765333}$$

$$= 0,975720691 \quad \text{or} \quad 0,976$$

One tailed test * : 5% = 1,729
1% = 2,539

$0,976 < 1,729$

The t value is less than the theoretical probability distribution at the 0,05 level of significance. The null hypothesis can therefore not be rejected at the 5% level of significance.

* For derivation of figures refer to Method of Empirical Investigation (5.6.6.2.)

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