THE UNIVERSITY OF CALGARY

"Cognitive Processes of Children With Reading Decoding Difficulties: A Comparison between Groups of Average and Gifted Intelligence Across Two Educational Divisions."

by

Lorraine Jacqueline Drummond

A THESIS

SUBMITTED TO THE FACULTY OF GRADUATE STUDIES

IN PARTIAL FULFILLMENT OF THE REQUIREMENTS FOR THE

DEGREE OF MASTER OF SCIENCE

DEPARTMENT OF EDUCATIONAL PSYCHOLOGY

CALGARY ALBERTA

JUNE, 1997

0-612-24656-6

ABSTRACT

The present study examined the patterns of cognitive processing of students with a severe decoding disability. Thirty students with a severe decoding disability from two educational Divisions were administered tasks from the Planning, Attention, Simultaneous and Successive (PASS) model of cognitive processing. These students had intelligence scores within the Average and Gifted ranges. Performance on these tasks was compared with 33 non-disabled students who were within the two intelligence levels and who were also in the two educational Divisions. Eight tasks consisting of one verbal and one non-verbal task of attention, simultaneous and successive processing plus one low level and one high level planning tasks were administered.

Results confirmed that the cognitive tasks which differentiated students with a decoding disability from non-disabled students irrespective of IQ and educational Division were the two tasks of Successive processing. No difference in performance was found on these tasks regardless of mode of presentation.

ACKNOWLEDGEMENTS

I would like to acknowledge the sincere participation of all those students who volunteered to take part in this research project. Many of these students have experienced difficulty with reading and hoped that their participation in this study would benefit other students. In addition I would like to thank the school personnel who assisted me so willingly and allowed flexibility for their students to meet with me. I would also like to thank the Calgary Board of Education for its permission in contacting schools within its jurisdiction.

I wish to thank my supervisor, Dr. Michael C. Pyryt, for his assistance, patience and support in completing the study. I would also like to thank my committee members, Dr. Ethel King-Shaw and Dr. Marilyn Samuels, for their interest in my study and for providing a thoughtful examination of this thesis.

I would like to express my deep appreciation to my husband, Ian, who developed patience as he endeavored to help me learn about statistical analysis and computer technology. Thanks also to my two sons, Andrew and Stephen, whose intellectual gifts and difficulty with reading prompted me to begin this learning path many years ago. I would also like to acknowledge Dr. Doreen Kronik who addressed a conference on learning disabilities which I attended as a parent many years ago. She urged parents of children with learning disabilities to become involved in teaching and contributing to the knowledge that we have about these complex learners.

TABLE OF CONTENTS

List of Figures and Tables

Chapter 1

Introduction

Literacy issues have become increasingly important not only as school issues but as issues in the larger society. Castell & Luke (1983) equate literacy with mastery over the process by which culturally significant information is transmitted. Edelsky (1992) suggests a just society is the end product of a literate society. Literacy is seen as a tool to employment. Personal fulfillment and pleasure (Hunsberger, 1992) are also goals. Illiteracy, on the other hand, has generally been equated with poverty, crime and immorality (Castell & Luke, 1983). Although there are differences in views of literacy, there is general agreement as to its importance and to its value and goals in an educational setting.

Teaching reading is a major focus of educational institutions. Not only is learning to read valuable for its own sake but it underlies teaching and learning across the curriculum. Students must learn to read in order to achieve academic success.

Just as there are numerous ways of viewing literacy, there are also various theories and models surrounding the process of learning to read. Some of these models are concerned primarily with decoding of print (Adams, 1990; Goodman, 1967; LaBerge & Samuels, 1974). Other theories are more involved with comprehension (Rosenblatt, 1985; Rummelhart, 1985). Decoding refers to the processes involved in giving voice to a printed representation of a particular sound. Comprehension involves the meaning surrounding the text. Researchers (Auerbach, 1989; Madigan, 1992) are also aware of the importance of the context or environment in which reading takes place.

Rummelhart (1985) has examined reading as an interactive process which includes various components from letter-level knowledge, letter-cluster knowledge, lexical-level knowledge, syntactic knowledge, and semantic level knowledge. Decoding skills are generally thought of as mainly involving the initial components while comprehension involves the higher level components. However, all components can be involved in the decoding process. Students who have a specific decoding disability can be taught strategies which rely on the higher level components which can enable the student's decoding process.

Many models of reading have involved aspects of automaticity- that is, as a reader becomes more proficient in decoding, less attention is devoted to this skill so that more attention is freed to examine comprehension issues. Theorists have argued over top down (semantic to letter) versues bottom- up (letter to semantic) approaches to the teaching of reading. In addition there is also much public debate over the value of phonics compared with whole language instruction. Leaders in the literacy field (Allington, 1991; Stanovich, 1990) have called for an end to the paradigm wars, recognizing that theories are not mutually exclusive, and that there is much to gain from searching for convergence among research perspectives. No matter the pros and cons of each side of the debate, Allington (1991) clearly states the importance of decoding in the reading process, "All readers must aquire automatic and proficient strategies for the integrative use of the multiple cue sources available in written text" (p. 372). If a student is unable to decode, finding or creating meaning from print becomes a daunting task.

Identifying, assessing, and assisting students who have decoding difficulties are important educational tasks. With its growing focus on early literacy initiatives, the Calgary Board of Education (CBE) has recognized and demonstrated the importance it places on the development of reading.

Reading is an intelligent activity; therefore, it seems paradoxical that there are gifted students who encounter difficulty in learning to read. Just as there are a variety of theories of the reading process, there are a variety of ways of viewing giftedness. To many, the definition of giftedness has included the belief that there is a tie between innate intellectual ability, ease of learning, and achievement in school; the truly gifted student will excel academically in school (Whitmore, 1985). Current definitions offer a broader concept of giftedness. These include multiple kinds of intelligence

(Gardner,1983), triarchic theory (Sternberg, 1990), and catalysts such as task commitment (Renzulli, 1978), and environmental factors (Gagné, 1985) which can aid the development from potential to actualization. A child may not be required to excel in all areas in order to be considered as gifted:

> Children capable of high performance include those with demonstrated achievement and/or potential ability in any of the following areas: a) general intellectual ability, b) specific academic aptitude, c) creative or productive thinking, d) leadership ability, e) visual and performing arts, f) psychomotor ability. (Marland, 1971)

Many current definitions of giftedness are similar to that of the Marland report (1971) in that they include some aspect of demonstrated achievement or potential ability. The inclusion of potential in the definition has caused problems of implementation as difficulties have arisen from the measurement of potential ability.

Purpose

A two-fold problem for educators has been how to identify students who have a reading disability and how to do so in a way that the assessment results can be meaningful for remediation. The Planning-Arousal-Simultaneous-Successive (PASS) model of assessment (Das, Kirby, & Jarman, 1975, 1979) has been developed and refined over the last two decades. This model is based on the work of Luria, who was a student of Vygotsky, and is based on his work with brain functioning. It offers an alternative to traditional measures in examining and measuring the cognitive processes underlying human ability. The purpose of this study was to explore the PASS cognitive assessment tasks for possible use in the future as an alternative method of identification of students with a specific reading decoding disability.

Identification of students with a specific reading disability has been problematic. Students have generally been identified by defining a discrepancy between their potential, as measured by a traditional intelligence test, and their achievement levels in specific academic areas including reading and writing. A problem with the application of the discrepancy method of identification is that students have had to experience a significant level of academic failure before they can be identified as having specific learning needs. It has been difficult to demonstrate a significant discrepancy between potential and achievement for students in the younger grades. To be a year or two below grade level in grade two is likely to be more significant than at the junior or senior high school level.

A goal for future identification procedures is to be able to identify young students in Kindergarten and Grade One who may be at risk for reading problems so that assistance can be provided before they have to experience significant failure.

A considerable body of literature has been developed concerning the operationalizing of the PASS theory. This theory is important to the field of learning disabilities because it offers the possibility of identification of students at an early age, prior to exposure to reading instruction, as there is little or no requirement for reading in the tasks. Evidence has been presented in the literature concerning its use in the identification of specific populations. While there has been some disagreement concerning specific aspects of the cognitive processing of students with learning disabilities, a general trend in the literature has been that the PASS assessment has been able to discriminate the learning disabled population from those who do not have the specific disability such as delinquent students, students with Attention Deficit Disorder (ADD), and the developmentally delayed (Naglieri, Prewett & Bardos, 1989). As well as being able to discriminate between different populations, differing levels of intelligence have been examined in relation to learning disabilities (Das, Mishra & Kirby, 1994; Kirby, Booth, & Das, 1996; Snart, Das, & Mensink, 1988).

A particular aim in conducting this study was to be specific about the population for whom this assessment is intended. The definitions of a learning disability are broad and include students with a broad spectrum of disabilities such as difficulties in math, spelling, fine motor, reading decoding, reading comprehension, and specific language disabilities. The label of a learning disability thus covers a wide range of handicapping conditions. A difficulty with interpretation and application of some previous research is the lack of definition of the students participating in the studies. A recent quasi-meta analysis conducted by this author (Drummond, 1995) of 106 journal articles, books, and book chapters concerned with students who are both Gifted and have a Learning Disability, found substantial variation in subject descriptors. Some gave descriptors for the "gifted" aspect of the students, while others addressed the description of the learning disability. For those studies which gave descriptions of the research population in terms of the learning disability, 29 percent were described as having a discrepancy between potential and actual performance. Twenty percent described the students with a definition specific to the study. Twelve percent noted that State criteria were used, but this was not further explained. Ten percent of the studies specified that their population was significantly below grade level and usually expressed this in a grade range which generally started from one and a half to two years below actual grade placement. Twenty-nine percent of the studies did not state how the students were selected on the basis of a presumed learning disability.

Some studies described the gifted aspect of their student population by saying they were in a gifted program. The majority of studies expressed giftedness in terms of minimum scores on an intellectual assessment. One study selected students with an intelligence quotient (IQ) of 115. Four studies used a Full Scale intellectual score of 120. Six studies used either a Full Scale score or a partial score based on either a Performance or Verbal score of a minimum of 120. A further six studies used either a Full Score, Verbal or Performance score of 124. 130 Full Scale score was the minimum requirement for a further four studies. Twenty studies gave no definition of how their population was selected on the basis of giftedness.

This current study sought to add to the literature through an examination of patterns of cognitive processing which may be used to identify students with a specific disability in reading decoding using the PASS model of assessment. The study also sought clarification of the specific pattern of cognitive processes which can be used to differentiate this population. In addition the study sought to examine the cognitive processing patterns of students within two levels of intellectual status, Gifted and Average, with and without a decoding disability. The study also sought to determine whether the same patterns of identification hold across two educational Divisions including a Division in which students have learned to read despite their decoding problems.

This study then examined the patterns of cognitive processing using the PASS assessment with students at two grade ranges, Divisions II and III, who were identified as poor decoders, and who fell within the Average, and Gifted ranges of intelligence. This pattern was compared with students within the Average and Gifted levels of intelligence who have never experienced difficulty with reading decoding.

Research Questions:

1. What are the PASS processes that discriminate poor decoders from able decoders?

2. Are these discriminatory processes the same for the two Intelligence levels, Gifted and Average?

3. Do these processes vary with Educational Division?

4. Are there interactions among Division, Reading Status and Intelligence Status?

5. Is there an interaction between Division and Reading Status?

6. Is there an interaction between Division and Intelligence Status?

7. Is there an interaction between Reading Status and Intelligence Status?

8. Is there a difference in the way students process tasks which involve verbal responses compared with non-verbal responses?

Definition of Terms

Reading Status

Poor decoders

Poor decoders are those students who have significant difficulty with word attack and/or word identification. School personnel involved in this study were given the specific example of children who could be selected due to their well below average performance (standard score <85) on the word attack and/or word recognition subtests of the Woodcock Reading Mastery Tests-Revised (Woodcock, 1987). These students do not have difficulty with comprehension of material which they can decode or material suitable for their age which is read to them. These students were identified by school personnel after in-school testing.

Average decoders

Average decoders are those students who exhibit little or no difficulty with word recognition as observed by school personnel.

Intelligence Status

Gifted intelligence

Gifted intelligence is narrowly defined within this study as the cognitive ability of a student as measured by a standardized intellectual assessment which falls within the Very Superior range (130 plus or minus one standard error of measurement) as defined by the specific test. Full Scale or Verbal Scale scores were used.

Average intelligence

Average intelligence is defined as the cognitive ability of a student as recognized by school personnel to be within the average range within their personal experience. Teachers were asked to select students from within the average range who would most closely match the cognitive ability of students who had difficulty with decoding.

Educational Division

Division II

Division II refers to grades four, five, and six.

Division III

Division III refers to grades seven, eight, and nine.

Chapter II

Literature Review

This literature review will examine specific issues in the field of learning disabilities but as the field of learning disabilities is so broad, the literature review will largely focus on a reading disability only. The issues examined will include identification measures, the relevance of intelligence testing, and the history of the PASS theory of intelligence particularly as it relates to learning disabilities.

A personal area of fascination is the field of Gifted Learning Disabilities. The idea that a person can be both gifted and learning disabled seems to be a contradiction. Indeed, there are numerous references in the literature to gifted/learning disabilities as a "paradox" (Baum, 1984; Fall & Nolan, 1993). Part of the reason for the puzzlement relates to problems of definition. Because the definition has been imprecise and ambiguous and not defined in operational terms, all the succeeding tasks which are contingent upon the definition ie. assessment, diagnosis and remediation, have been problematic (Berk, 1983).

Both the field of gifted education and learning disabilities have suffered from definitional problems. Neither giftedness nor learning disabilities has been defined in an adequate operational manner.

Given the controversy surrounding the definitions of giftedness and learning disabilities, it is not surprising that the definition of gifted/learning disabled has been contentious. Most authors agree that these students have some aspect of giftedness combined with some aspect of learning disabilities which is often reflected as a difference between potential and achievement. Yewchuk (1984) has written a broadly based description of the gifted student with learning disabilities: "When a child is not intellectually retarded, but is functioning erratically in spite of there being nothing wrong, that child is considered to be learning disabled....One observable difference between learning disabled children of normal and high intelligence is that the discrepancy between relative areas of strength and weakness is typically much greater for the gifted" (p. 95). From this type of description it can be understood why there is little agreement as to what constitutes a gifted student with learning disabilities.

As with issues of definition and identification, there is controversy surrounding assessment practices. Many authors (Fedorak, & Yewchuck, 1986; Lupart, 1990; Senf, 1983; Silverman, 1989) have suggested that a learning disability is not the result of a school-skill problem but is an integral part of the whole child. Thus proposals have been made for the identification of gifted students with learning disabilities which suggest the use of a wide variety of measures, procedures and observations (Lupart, 1990; Tannenbaum & Baldwin, 1983; Whitmore & Maker, 1985). A quasi meta-analysis (Drummond, 1995) found that 58 different assessment measures have been used with this population.

Barton and Starnes (1989) address the importance of group heterogeneity. They found the severity of the learning disability followed a continuum from mild to severe. An interesting pattern was found in that the ratio of males to females increased directly with the severity of the disability. Only twenty percent of their sample were in the severe category and all were males. They found that while there was little difference in the Full scale scores of their population, the group with mild to moderate disabilities had higher Verbal scores. This was reversed for the group with severe disabilities in that the Performance scores were higher.

To address the issue of specificity of sample selection, this study focuses only upon students who have a specific decoding disability. Some of these students have IQ scores that are in the Very Superior range of intellectual aptitude.

Current Assessment of a Reading Disability

A commonly held definition of a reading disability is reading at a level below that which is expected in the absence of exclusionary criteria such as severe emotional problems, sensory deficits, neurological disease, or inadequate educational opportunity (Siegel, 1992). Determining what the predicted level of reading should be has traditionally been accomplished by comparing reading achievement with aptitude. Students who have a low reading score compared with their potential as measured by the IQ test are said to have a reading disability.

Siegel (1989) contended that because the key to a reading disability was a problem with phonological processing, and because phonological processing was not regulated by a central processing system, that a reading disability was independent of intelligence. She suggested that measures of reading alone were sufficient to determine a reading disability. However the source of the disability might be found in cognitive processes which are more fundamental that, while most apparent in reading, may underlie other cognitive activities. Therefore an intelligence assessment would be of value.

Stanovich (1991) argues that if an IQ score must be used, we should consider the Verbal IQ as an aptitude measure. Verbally loaded measures are likely to provide the best estimate of what a dyslexic reader could get from text following remediation of the dysfunction. In addition the Verbal measure, rather than the Performance measure, is the better predictor of academic performance. This measure also helps to discriminate dyslexic readers from what Stanovich refers to as "garden-variety poor readers" (p.11). Stanovich contends that if a Performance IQ alone is used as the basis for a learning disability, it becomes harder to distinguish the two groups. If the latter group is allowed to have depressed verbal components, these Performance-discrepancy students with a reading disability will have a variety of verbal deficits and are less likely to reach a level of success with reading achievement. Stanovich also sees merit in using the Verbal measure alone as "it would be more likely to isolate a circumscribed deficit shared by a group of students who could be differentiated cognitively and neurologically from other poor readers, unlike the sample of students that have been defined by other methods" (p. 19).

A reason for the concern regarding the value of an intelligence assessment may be found in the limited scope of assessment tools which have been commonly used to diagnose a reading disability. Boodoo, Bradley, Frontera, Pitts, & Wright, (1989) found the intelligence test preferred by most psychologists has been the Wechsler Intelligence Scale for Children- Revised (WISC- R) (Wechsler, 1974). Using this test, researchers have looked for patterns such as possible Verbal-Performance discrepancies or patterns of subscale scatter. Results have been mixed such as the finding of Schiff, Kaufman and Kaufman (1981) of a substantial Verbal > Performance discrepancy. They examined the WISC-R profiles of 31 Gifted students who had a learning disability. These students exhibited a Verbal > Performance discrepancy of 18 points . Kaufman (1979) found that Verbal > Performance discrepancies were as common as Performance > Verbal discrepancies for most of the subgroups he studied. The manual for the WISC-R suggests that low scores on the subtests of Arithmetic, Coding, Information, and Digit Span (the ACID profile) may indicate a learning disability. Some research has found three of the four subtests to have low scores for students with learning disabilities but there is little agreement as to which of the three subtests were the low scoring ones and which one was not low scoring (Mather & Udall, 1985; Schiff et al., 1981).

Kavale and Forness (1984) conducted a meta-analysis on the validity of the WISC-R scale profiles and categorizations. They found the profile for students with learning disabilities failed to demonstrate either significant or distinctive groupings for reliably separating students with a learning disability from non-disabled students. When compared to average levels, the students with learning disabilities did not exhibit any significant deviations and generally revealed less variability than the normal population.

Concerns have been raised regarding using the discrepancy between Verbal and Performance scores of the WISC-R for identification of gifted students with learning disabilities. Silver and Clampit (1990) suggest that the tables provided with the manual are misleading since they assume a statistically typical child. "When applied to children with a high IQ, the tables exaggerate the rarity of Verbal-Performance discrepancies causing clinicians undue alarm or concern" (p.77). They suggest that statistical theory finds more than one half of all children with a Verbal or Performance score above 125, also have a discrepancy of 15 points or more. Kaufman (1979) suggests that "Verbal - Performance differences as large as 17 points cannot be considered abnormal by any reasonable statistical standard" (p. 25). In addition Kaufman (1979) also stated that about 25 percent of normal children had Verbal-Performance discrepancies which the WISC-R manual suggested was important enough to require further investigation.

Concerns have also been raised regarding the standardization sample of the WISC-R in that few minority groups, including the gifted and the learning disabled, were represented. In addition researchers (Gonzales & Hayes 1988; Vaughn 1989) have concerns that the discrepancy between the aptitude scores and the achievement scores may be a statistical artifact of the testing process as the standardization sample was not the same for both tests.

In addition to the inconsistencies in research results, the use of the WISC-R has been questioned for its view of intelligence, as it represents a snapshot at a particular time of an inferred ability. Intelligence, from this perspective, can be seen as fixed and thus not likely to benefit from intervention (Naglieri & Das, 1990). In addition, this particular assessment tool is unrelated to the perceived functioning of the brain and to the underlying cognitive processes of intelligent behavior and so there is a lack of direction for intervention (Naglieri & Das, 1990). In suggestions for future research in the field of intelligence, Detterman (1989) suggested that the best research would require a theory to be consistent with what is known about how the brain works.

Other tests commonly used in the diagnosis of a learning disability are the Stanford-Binet (Thorndike, 1985) and the Kaufman Assessment Battery for Children

(K-ABC) (Kaufman & Kaufman, 1983). Bracken (1985) is concerned regarding the floor and ceiling inadequacies of the K-ABC which he suggests makes questionable test interpretation for gifted and low functioning students.

While the requirement for a diagnosis of a learning disability is a discrepancy between aptitude and achievement, many researchers have additionally sought to find a distinctive test pattern for various populations, including the learning disabled. Both Clarizio and Bennett (1987) and Naglieri (1985a) compare the WISC-R and the K-ABC in an examination of a severe discrepancy and a distinctive profile for special needs populations. Naglieri found that students with learning disabilities did not show distinctive profiles on either test, which thus limits their value as diagnostic indicators. In addition Naglieri suggests that the WISC-R may produce lower IQ scores than the K-ABC when the level of intelligence declines due in part to the inclusion of more verbal tasks in the WISC-R and because of the influence of acquired knowledge on the Verbal Scale. Naglieri also found a strong relationship between the WISC-R Verbal IQ scores and achievement scores. This link between achievement and the WISC-R Verbal Scale concerns Naglieri when the diagnosis of a learning disability is involved. Naglieri suggests that it may be more difficult to find an aptitude/achievement discrepancy with the WISC-R when the two measures share some of the same content.

Clarizio and Bennett (1987) built on Naglieri's work and additionally found that the K-ABC identified significantly more students with learning disabilities than the WISC-R. In addition there was lack of agreement in identifying students with a severe discrepancy between ability and achievement in their study using these two tests. Less than half of the same students were identified as having a learning disability by each test.

Although many researchers have queried the use of the aforementioned intelligence tests in diagnosing a specific learning disability, there is general agreement that these tests serve a useful purpose in determining intelligence levels.

The issues already outlined, concerning the definition of a learning disability, have concerned many. A recent paper on the definition and treatment of dyslexia (Gersons-Wolfensberger & Ruijssenaars, 1997) has abandoned the connection between intelligence and dyslexia entirely. They instead propose the following working definition: "Dyslexia is present when the automatization of word identification (reading) and/or word spelling does not develop or does so very incompletely or with great difficulty."(p. 209).

Rather than disregarding the connection of a learning disability with intelligence, we may need to view intelligence in a different manner. The view that intelligence is unrelated to reading is seen from the narrow perspective of a specific view of intelligence as seen from the aforementioned mentioned intelligence tests. These tests have limitations on the view of intelligence compared with models of intelligence proposed by Das (1972), Gardner (1983), Naglieri & Das (1990), and Sternberg (1990). Gardner's theory (1983) involves seven components; linguistic, logical/mathematical, musical, spatial, bodily kinesthetic, interpersonal and intrapersonal. Sternberg's triarchic theory (1990) balances three components; analytical, synthetic, and practical. While the models proposed by Gardner and Sternberg are a fuller view of intelligence, they have difficulty with quantifiability and convergent and discriminant validity respectively. The theory proposed by Naglieri & Das called the Planning, Attention, Simultaneous, and Successive (PASS) cognitive processing model, has significant literature outlining validity evidence (Das, Naglieri, & Kirby, 1994; Kirby & Das, 1990; Kirby & Williams, 1991; Naglieri, 1989a; Naglieri & Das, 1990; Naglieri, Das, & Jarman, 1990).

The PASS model offers significant scope as it examines processes rather than abilities. Typically, intelligence tests have measured abilities which are limited and have been found and organized hierarchically. However, a cognitive approach to intelligence suggests that the nature of the processing can alter performance, which is valuable in the assessment and remediation of a reading disability.

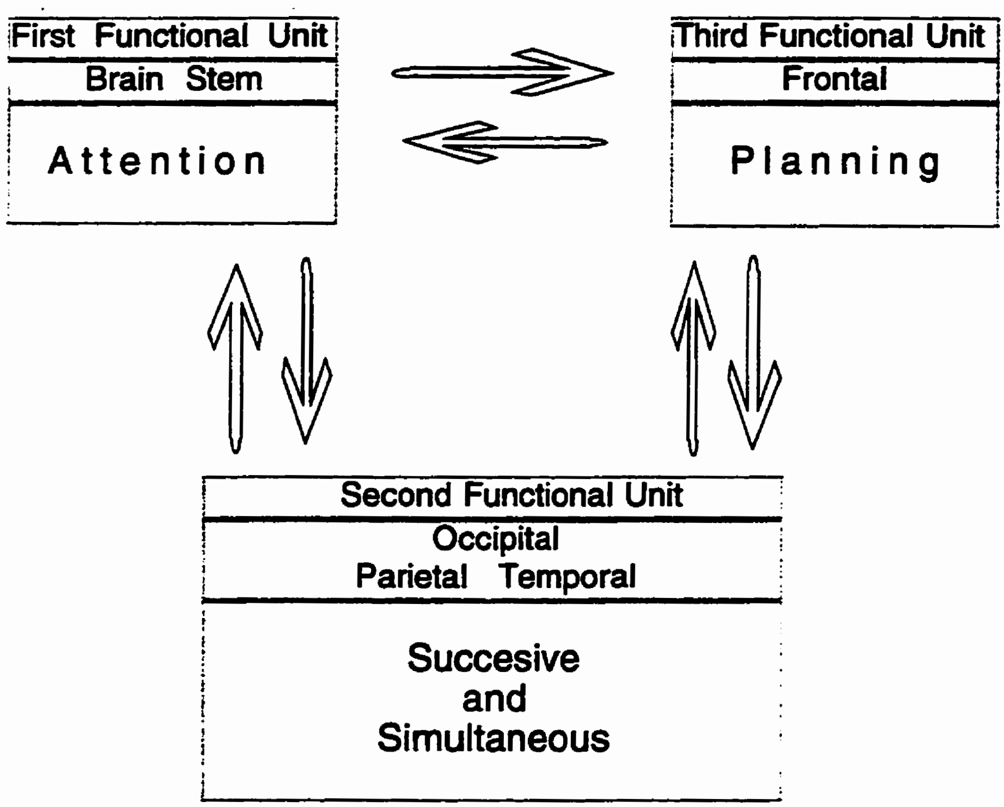
The PASS cognitive theory of intelligence has a strong theoretical foundation, has been operationalized, has made significant contributions to understanding exceptionality, predicting academic and job performance and intervention design (Das, Naglieri, & Kirby,1994). Prior to an examination of the model itself, it is valuable to examine the historical roots of the PASS model of cognitive functioning.

Historical Roots of PASS

PASS was initially described as an information processing model based on the neuropsychological work of Luria (1966, 1973, 1974, 1980), a Russian psychologist, who was a student of Vygotsky. See Figure 1 for a model of PASS as it is structured on Luria's work. Information processing theory views intelligence, not as fixed, but as fluid. It provides a process based approach which allows for an understanding of the underlying cognitive processes and so gives direction for possible remediation. The information processing approach used by the PASS model is an attempt to understand human functioning (including reading) based on how information is processed in the brain. Luria worked with people who had suffered damage to a specific part of their brain and his research led him to hypothesize three neurological functional units which work together during cognitive activity. The first unit or system is located in the brain stem, diencephalon, and regions of the hemispheres. The second unit is located in the occipetal, parietal, and temporal lobes while the third unit is located in the frontal lobes.

Luria proposed three functions of the brain which are engaged in any type of mental activity. The first unit is responsible for arousal, the second for receiving, processing and storing of information and the third unit programs, regulates, and verifies mental activity. The first unit, arousal, corresponds to the Attention component of the PASS model. It involves not only the subcortical function of wakefulness, but also allocation of effort and resources which is a frontal cortex function. An appropriate level of arousal is necessary for mental activity. Too much or too little interferes with proper processing of information and with making effective plans of action (Das &

Figure 1 *PASS Model of Ability Based on the Work of Luria*



Naglieri, 1992). Sustained attention is required in order to concentrate for long periods of time while selective attention is necessary to be able to attend to relevant stimuli and to ignore potentially distracting stimuli. Das, Naglieri, & Kirby (1994) have found measures of selective attention to be the most useful in distinguishing different groups of students with special needs.

Luria's second unit involves the coding, or receiving, analyzing and storing of information. Coding is what occurs when incoming information is interpreted in terms of what we already know as the stimulus, by itself, has no meaning. How the information is to be coded may be limited by prior knowledge. Coding can take place automatically or may be the result of conscious effort. If it is not automatic, then attention or effort will have to be accessed, which will limit the attention given to other aspects of the task. Coding is also involved in both long and short term memory. Luria proposed two forms of information processing; simultaneous, a function of the occipital-parietal lobes, and successive, located in the temporal lobe. Simultaneous coding involves the ability to see a number of elements as a whole. Every element involved in this type of processing is related to every other element so that it is possible to survey the content holistically. Das, Naglieri, and Kirby (1994) have outlined several important features regarding simultaneous processing. Most importantly, all of the pieces of information have to have a relationship with each other such as sharing a group characteristic. The key to understanding the relationship or solving the code, exists in long term memory. Once the simultaneous processing has occurred, the pieces of the information do not have to be retained in the same order as presented. Finally, some of the initial information may be lost but the principal will remain. This type of coding may involve such activities as design copying, solving matrices, comprehending numerical and grammatical concepts and understanding abstract thinking.

Successive processing concerns the coding of elements in sequential order. This type of information processing cannot be viewed holistically, but each element activates the next consecutive one. There are several key features which are pertinent to successive processing. These include the fact that the order or sequence is essential such as dialing a telephone number. In addition, no relationship other than the sequential one is perceived, otherwise it involves simultaneous coding. As an action becomes automatic it can automatically activate the next in a series of successive actions, thereby taking up less active working memory space. The critical aspect of successive coding is that the information must be ordered without surveyability (Naglieri, Das, & Jarman, 1990). Information is related in a linear fashion such as in learning to write, a series of skilled movements is involved. In the initial stages, each successive link may be viewed as separate and may be taught as a single unit. Finally, when each step becomes automatic, the initial step will be able to initiate the automatic reaction of the successive steps. The decoding of print or repetition of words or numbers are activities which involve primarily successive processing.

Auditory information is presented successively, while visual information is presented simultaneously. However, after the information is in working memory, the coding or processing that is done with it may be either simultaneous or successive. While simultaneous processing is usually thought of as primarily visual and spatial, and successive processing as temporal and language based, either type of coding may be involved (Das, Naglieri, & Kirby, 1994).

Snart and Das (1994) suggest that "both simultaneous and successive processing interact in any cognitive processing task with dominance of one over the other depending upon both task demands and individual preference."(p. 100). Evidence for this statement is found in an earlier paper (Das, Kirby, & Jarman, 1975). They state that the selection of processing modes "depends upon the individual's habitual mode of processing information as determined by socio-cultural and genetic factors, and by the demands of the task" (pp 91). Several researchers (Kirby & Robinson, 1987; Naglieri & Das, 1988) have suggested that students with a reading disability may be selecting the less advantageous mode for decoding, that is they may be using simultaneous processing when successive processing is called for. In addition, Das, Kirby, & Jarman (1975) reported factor analytic studies for the two processes across a variety of IQ groups, cultural groups, age groups, and socioeconomic status. In one study, several tasks were used with normal and developmentally delayed groups of students. Using principal component analysis, two factors, simultaneous and successive emerged. A second study included white Canadian children and high-caste children from India. Three factors, simultaneous, successive and speed were evidenced. A third study involved six and ten year old boys and again the same three factors emerged. They were also evidenced in another study involving fourth grade students from low, middle, and high socio-economic backgrounds.

Luria (1966) and Jarman (1980) suggest that simultaneous and successive processes as well as attention and planning are involved in language use. Successive processing is implicated in understanding the syntax of a sentence or the organization of speech. Simultaneous processing involves the comprehension or understanding of speech or text. For example, understanding logical grammatical relationships such as "the woman pointing to the ruler with a pencil" involves simultaneous processing although the information had been presented in a successive manner.

The units that are part of a successive code at one level, may form the basis of simultaneous coding at a higher level. Neither type of coding is superior to the other, as both are required at various levels. Das, Naglieri, & Kirby (1994) view the performance of some tasks as a cyclical hierarchy of coding. An example of this as it refers to early decoding is as follows. Initially, simultaneous processing is required to recognize letter features. Then successive processing is required to order the letter feature sequences. Simultaneous processing is then required to recognize single letters which are then processed successively into letter sequences. Next comes recognition of syllables or words which are processed simultaneously. Lastly, syllable or word sequences are processed successively.

Luria's third unit, planning, is located in the frontal lobes, especially the prefrontal area. This area was the last to develop in evolutionary terms and is connected neurally to most other parts of the brain. Interestingly, Das and Naglieri (1992) report that trauma to this part of the brain does not always result in lower traditional IQ scores. Luria (1966) described planning as programming, regulation, and verification of behavior. The definition given by Das (1980) is a set of decisions or strategies an individual adopts and modifies to solve a problem and reach a goal. It involves the generation of plans and the use of foresight and flexibility. Das and Naglieri (1992) suggest the function of this unit is to organize conscious activity, to form and plan action, regulate behavior, and to make possible the correction of errors.

Recent work with the PASS model has involved a more extensive examination of planning. An important component of planning is metacognition, the awareness of and knowledge about cognitive processes. Much of planning requires individuals to be aware of the relationships between tasks and strategies, to monitor the success of the strategies and to make further decisions about alternative strategies to be used. The role of motivation in planning is strong as strategies become more effective when combined with purpose and need (Das, Naglieri, & Kirby,1994).

The term planning has been used to cover many behaviors. Parilla & Das (1996) have begun to examine planning on three levels - activity, action, and operation. At the activity level, planning can be seen as a way of aiming towards or realizing life goals such as planning for retirement. Action planning is the equivalent of problem solving. This may involve finding a solution for a particular problem or "planning in action" which involves continuous evaluation and revision. Action planning is a response to a given problem so it is oriented toward the future as well as the present. Operation planning is the equivalent of strategies which consist of working towards a solution within constraints. This type of planning has to satisfy the particular task conditions. Choosing between possible solutions need not be at a conscious level of activity in this latter type of planning. Some strategies may have become automated such as finding your car in a parking lot.

Research is mixed regarding the ability of young children to engage in planful behaviors. However, there appears to be agreement that relatively simple planning tasks are mastered by children in the early years of schooling. Performance on more complex tasks continue to develop through adolescence (Parrila & Das, 1996). Academically, planning is involved in such activities as the prewriting component of composition.

The planning ability appears to be hierarchically above coding but is dependent upon appropriate levels of attention and facility with simultaneous and successive processing.

Luria strongly emphasized the interrelationship among the three functional units. He suggested "every form of human behavior is not a property of only one of these functional parts, but requires the coordination of all three of the functional units, each of them playing its own, highly specific role, in the organization of behavioral processes." (Luria, 1974, p. 5)

Luria found that the functional systems are not completely localized in specific areas of the brain, but that activity takes place by the connected brain structures working together. Thus, the functional units are related but can remain functionally distinct. They rely on an individual's knowledge base, the interaction of the information processing units and planning, to assist in the acquisition of new knowledge. In addition, these functions depend on an appropriate state of arousal and attention. An illustration of the interconnectedness of these units may be found in a task requiring recall of a telephone number which, on the surface, seems to be primarily related to successive processing. However, the planning function may be called into play to define a variety of strategies such as chunking the digits into larger units, rehearsal, or indeed using visual imagery, a strategy linked to simultaneous processing. The planning unit must select the strategy.

The PASS Model

Das has expanded on Luria's work by operationalizing the organization of cognitive functions and by incorporating concepts from cognitive research (Das & Naglieri, 1992). Thus, Das is able to connect intelligence to brain function and to examine how knowledge is organized and accessed within memory. Das envisions the three units outlined by Luria as responding to the experiences of the individual as well as to developmental changes. In addition, they are thought of as interactive while retaining their distinct functions. Planning has to be based on information which has been analyzed and coded. These two units interact in acquiring knowledge at the same time that the person is in an appropriate state of arousal.

For over 20 years Das has worked to develop and to operationalize the components of the PASS cognitive processing model through studies of normal and atypical populations. The PASS model is composed of four components, (Planning, Attention, Simultaneous and Successive Coding) that represent Luria's three functional units. Briefly, the model works as follows. Information, in various modalities, is received through receptors. It may be received simultaneously or successively. This information forms a knowledge base which Das conceives of as the sum total of a person's experience which includes memories, attitudes, habits, inborn capacities, energy level, formal and informal education, and conscious and unconscious predispositions (Das & Naglieri, 1992). This accumulated knowledge base influences the attention, planning and coding activities which can act in an interactive fashion as long as there is an adequate state of attention. If an individual has difficulty with any of the four processes, it is likely that information is inadequately processed and so the knowledge base of the person may consist of inadequately processed information.

Das and his colleagues have developed tasks which they feel clearly define and separate the four processes of the PASS model. Factor analytic studies (Das, Kirby & Jarman, 1979; Naglieri & Das, 1988) have repeatedly provided strong evidence for the four factors, although Kranzler & Weng (1995) in a confirmatory factor analytic study found that individual differences in Planning and Attention factors were indistinguishable. This study examined only two attention tasks and three of low level planning. Researchers have developed and refined marker tasks to assess each of the four components (Das, 1972, 1973, 1985; Das & Molloy, 1975; Naglieri & Das, 1988; Naglieri, Prewett & Bardos, 1989). The Das-Naglieri: Cognitive Assessment System (1997) is a recent assessment tool containing marker tasks in the four processes.

Researchers have validated these tasks with students of various cultural backgrounds (Krywaniuk & Das, 1976; Leong, Cheng, & Das, 1985), across various ages (Naglieri & Das, 1987), levels of IQ and learning ability (Das, 1984,1985; Kirby, Booth & Das, 1996; Varnhagen, Das & Varnhagen, 1987) and achievement levels (Garofalo, 1986). Studies have been conducted with students who have developmental delays, attention deficit and learning disabilities which demonstrate the validity of the tasks in reflecting differences between these subgroups (Naglieri, Prewett & Bardos, 1989).

Examples of PASS tasks

Over the years tasks have been developed and refined which measure each of the four areas of Planning, Attention, Simultaneous and Successive Coding. The essential features of all tasks of attention involve responding to one dimension of the tasks while ignoring a competing dimension. Tasks may be categorized according to either receptive or expressive attention. The Receptive Attention Task used by Naglieri & Das (1991), consists of two pages with rows of paired letters. The student circles all of the pairs of letters on the first page which are physically the same (eg. BB not BN). On the second page the student circles all of the pairs that have the same name (eg. Bb, not Ab).

Measures of Simultaneous processing require that the student must interrelate the component parts of the test to arrive at the correct answer. While there are verbal tasks to measure this process, tasks have traditionally been non-verbal. Figure Memory is a simultaneous tasks requiring the student to copy a geometric design from a model. The student looks at the model (eg. a triangle) for five seconds, the design is removed, then the student is required to trace the original stimulus within a more complex figure which includes the original design. All of the lines have to be correct to complete a correct response.

Tasks measuring successive processing require the student to either reproduce a particular sequence of events, or answer questions that require the correct interpretation of the linearity of events. Hand Movements is a task which asks students to reproduce a series of simple hand movements which were demonstrated by the examiner. To score a correct response, all movements must be reproduced in the same order as the original.

Planning tasks should require the student to develop an approach to solving the task in an efficient and effective manner. As discussed previously, researchers are now including tasks of Planning that tap into varying levels of complexity. The task called Visual Search, requires the student to develop an efficient approach to finding a particular stimulus on the page. The student is asked to point to a picture, number, or letter in a field around the target in a stimulus box. Items are timed from the time of the initial exposure of the page to the locating of the matching stimulus item. Sample strategies include looking from left to right, or top to bottom. Items involving more complex planning have been difficult to develop due to time constraints and fitting a traditional test battery. However, Crack the Code is a recently used task which is similar to the Mastermind game. This task requires the student to discover the correct arrangement of coloured chips when given partial information about the correct code. The time required to solve the problem, and/or the number of correct items becomes the final score.

Reading and the PASS Model

The PASS model provides support for the view that a reading disability (in decoding) may not be attributed to a narrowly defined problem of phonological processing alone but may be related to underlying cognitive processes that cross a variety of domains which may be responsible for a reading disability. In order for this view to stand it is necessary to connect the processes in reading to the same processes in another area of performance such as specific areas of math.

Reading is an activity that involves all four of the PASS processes. Attention appears to be closely connected to reading. The initial level of attention is arousal. While a positive state of arousal is required for processing information, a high state of arousal can be caused by psychological states of anxiety and stress. This type of arousal can be created by students who have experienced failure in reading. Levels of arousal are high if the decoding is difficult and because more effort is expended, arousal may impede rather than help. Das, Naglieri, & Kirby (1994) suggests that the greater the arousal during the performance of a difficult task, the worse the performance.

Selective attention requires the expenditure of varying degrees of mental effort. Tasks of selective attention have separated students with a reading disability from nondisabled students (Das, Naglieri, & Kirby, 1994). Studies have shown that students with a reading disability do not have a an underlying deficiency in arousal or sustained attention (Das, 1988; Samuels & Miller, 1985). The students have a presumed difficulty with discrimination of target letters and event rate. Discrimination requires allocation of attentional resources. A quick event rate puts additional stress on the students. Memory load makes sustained attention more difficult. Students who do not have the decoding aspect of reading at an automatic level require a greater expenditure of memory and sustained attention.

Successive processing has been correlated with the decoding aspect of reading (Cummins & Das, 1977; Kirby & Das, 1977, Naglieri & Das, 1987). Words are made up of strings of letters which must be perceived in a particular order. In addition, words are related to the sounds associated with the particular letter or combinations of letters. Kirby & Das (1990) described the association of the naming or articulation of words with successive processing.

Words are either visually coded as a pattern or phonologically coded as speech sounds. Most students with a reading decoding problem are assumed to show a breakdown in the phonological coding route. Bruck (1990) suggests that even as adults, problems with phonological coding persist. Adults with decoding difficulties were less accurate than sixth grade students on a task of reading nonsense words. Fawcett & Nicholson (1995) found that their sample of seventeen year old students with dyslexia performed significantly worse than their reading age control group of eight year old students on phonological awareness tasks.

Word recognition uses both a visual code and a phonological code. The first process should be related to simultaneous coding, with the latter related to successive processing. Pronunciation predominantly requires successive processing. Planning processes could be involved in the assembly of speech sounds.

Comprehension has been linked to simultaneous processing. Das, Cummins, Kirby, & Jarman, (1979) found that comprehension at any age requires simultaneous processing. More recent research has confirmed that both simultaneous and successive processing as well as planning are involved in comprehension. (Das, Mensink, & Janzen 1990; Kirby & Gordon, 1988; Naglieri & Das, 1988).

Some studies with elementary school aged students have found significant correlations between planning and reading decoding and reading comprehension (Das,1984; Leong, Cheng, & Das,1985). Naglieri and Das (1987) report that planning became increasingly correlated with achievement as the age of the students increased. Students from grades two, six, and ten were assessed using a variety of PASS tasks. Planning and Coding correlated with reading achievement at all three grades. However, coding was more significant at grade two and planning at grade ten.

Prewitt and Naglieri (1991) found that planning accounted for a significant portion of variance in reading scores of students with a reading disability. Planning has also correlated significantly with reading decoding and comprehension in studies with elementary aged students (Das, 1984; Leong 1977). Naglieri and Das (1988) reported that planning became increasingly correlated with total achievement over grades two, four, and six.

Naglieri and Reardon (1993) conducted the first investigation into all four PASS cognitive processes, word recognition and pseudoword reading. Their results pointed to the importance of successive processing in phonological coding. These results are inconsistent with Naglieri's (1989a) suggestion that students with a learning disability have a planning deficit.

Das, Naglieri, & Kirby (1994) discuss studies of the PASS model and reading whose results don't always agree with each other. Some studies show only successive processing to be implicated in a reading disability, while others indicate both successive and simultaneous processing are involved. Yet others indicate that planning is the most significant process involved. Das suggests that a main reason for these inconsistent results lies in subject selection. Some studies of below average reading achievement do not specify the type of reading problem (decoding, comprehension, or both), other studies do discriminate between the two. Others may be confounded with students who have primary or co-morbid Attention Deficit Disorder.

Das, Naglieri, & Kirby (1994) summarize the results of studies using the PASS processes involving decoding and comprehension to that point: decoding, at the lower grades, requires successive processing, comprehension at the lower and upper grade requires simultaneous processing, at the upper grades simultaneous processing becomes involved in decoding, and planning correlates to reading achievement in general.

PASS Assessment of a Reading Disability

The PASS tasks have been able to successfully discriminate those students with a reading disability from other populations. A paper by Naglieri (1989a), suggests that three groups can successfully be differentiated using PASS tasks. Developmentally delayed students received the lowest scores in all processing areas, with their lowest score in planning and their highest in successive coding. A different pattern was evident for students with a reading disability who received the lowest scores in attention and planning and average scores in coding. Students with an Attention Deficit Disorder had the lowest scores in attention, below average scores in planning and successive coding, and average scores in simultaneous coding. Simultaneous and successive coding were found to be the best predictors of group classification.

Studies have been conducted to find out if marker tasks of successive and simultaneous processing could distinguish average and disabled readers. Das (1984) documents his own work and that of other researchers such as Leong who found that students with a reading disability performed poorly on both types of processing tasks. Das suggests that the severity of the disability can be reflected by level of difficulty with these tasks. Students who were not severely disabled performed poorly on successive tasks (Das, Snart & Mulcahy, 1982), while students who had a severe disability as in Leong's study, not only had the most difficulty with successive tasks, but also performed poorly on simultaneous and planning tasks. Snart (1994) discussed preliminary results of research which suggests that the students in her study, who were all reading at least two years below grade level, had difficulty with both sequential and simultaneous tasks.

Das further develops the notion of successive and simultaneous processing for students with a reading disability by again drawing on the work of Luria who found that people with lesions in the fronto-temporal zone had difficulty with grammatical structures. Successive processing is clearly linked in linguistic tasks which require sequential performance such as grammatical structures. However, simultaneous processing is involved in understanding relationships. Cummins and Das (1977) and Solan (1987) suggest that both processes were necessary for beginning readers, while simultaneous processing was most important for comprehension when the emphasis is not as much on decoding skills. Later studies (Das, Mishra & Kirby, 1994; Das, Snart, & Mulcahy, 1982; Kirby & Robinson, 1987) all confirm that word decoding is specific to successive processing.

Bardos (reported in Das 1994) administered PASS tasks to fourth and fifth grade students -both students with a reading disability and those without. The students with a reading disability had low scores on the reading decoding and comprehension tasks. There were no significant differences between groups in simultaneous, successive and attentional processing, but the group with reading difficulties were significantly lower than the control group in planning. This suggests that students with a reading disability may be deficient in strategy use.

A study by Das, Snart, and Mulcahy (1982) included four planning tasks as well as tasks of successive and simultaneous processing. These were administered to two groups of grades four and six students - students with a reading disability and a control group. Reading decoding showed a significant correlation with successive processing and planning for the fourth grade students. At grade six, decoding correlated significantly with successive processing, planning and simultaneous coding. Reading comprehension correlated with simultaneous processing and planning at both grades.

Das, Bisanz and Mancini (1984) found that in simple word recognition tasks, reading achievement could be predicted by performance in simultaneous, and successive processing as well as planning. However, in complex reading tasks, such as comprehension and memory for text, planning played a greater role. Kirby and Robinson (1987) and Lupart and Mulcahy (1984) support the suggestion that students with a reading disability have a planning deficiency.

Das, Naglieri, & Kirby (1994) believe that the PASS tasks are superior to reading tasks alone as they offer assistance in identifying children who may be at risk for reading difficulties before they encounter formal instruction. They supply evidence for this position as two of the marker tests have identified up to 80 percent of children who are having difficulty. However, this study was conducted with students who had already been identified as having a reading problem. Further research is required to examine its predictive powers by assessing pre-readers, then following their progress to determine whether or not they develop a reading problem.

Intelligence and the PASS Model

In a preliminary study, Karnes and McCallum (1983) found evidence to support the ability of the PASS model to describe the cognitive functioning of gifted students.

Das suggests that there is more to be gained in terms of direction for remediation from a process rather than an ability view of intelligence. There has been considerable research using the PASS model with students with various levels of IQ as measured by traditional tests such as the WISC-R. Following are examinations of studies which compare results of the PASS tasks used with students who have high IQ scores and students with low or average IQ scores.

A study in Great Britain by Schofield and Ashman (1987) compared three groups of grade five and six students on several measures of successive processing and planning. The group composition was based on their IQ scores from the shortened version of the WISC-R. The Below Average group had scores less than 105, the Above Average group had scores that ranged from 105 to 123, while the Gifted students were at 124 or more. This latter group also included teacher nominated students based on outstanding performance. It is worthwhile to note that these classifications are unusual given that a score of 100 is considered Average. The Below Average and Above Average groups differed on measures of attention and successive processing. The Above Average and Gifted groups demonstrated significant strengths compared with the Average students on simultaneous measures as well as in areas of high level planning. Thus, measures of simultaneous processing and planning were able to separate the high intelligence groups from the average intelligence groups. This may have implications for teaching practice as strategies for planning as well as wholistic lessons may benefit the average intelligence group.

Most of the PASS studies examining the role of intelligence, have also investigated the role of intelligence levels in connection with specific learning disabilities.

Snart, Das and Mensink (1988) compared four groups of elementary students on selected tasks of sequential, simultaneous processing, planning and attention from the K-ABC. Two High IQ groups (average IQ=117) were formed, one having significant decoding problems. There were two other groups with Average IQ (average IQ=96), one of whom also had significant decoding problems. No range of IQ scores was published nor any cut off level. Both groups of students with decoding problems, regardless of IQ, performed poorly on measures of sequential processing while the High IQ group outperformed the Average group on simultaneous processing. Attention tasks showed no difference between groups, but there was a ceiling effect for these tasks. The Planned Connections subtest revealed that High IQ compared with Average IQ increased performance but that a reading problem resulted in a decline in performance.

Das, Mensink and Mishra (1990) addressed the issue of separating a reading disability from general intelligence in order to identify the cognitive processes which discriminated students with a reading disability from their comparison groups. Three reading groups, poor (<35%ile), average (35-65%ile) and good (>65%ile) readers were formed on the basis of scores on the Word Attack, Letter, and Word Identification subtests of the Woodcock Johnson Psycho-Educational Battery. IQ scores were obtained from the Lorge-Thorndike intelligence tests. In this study students in the poor reading group also had the lowest mean IQ score. When IQ was covaried, three tasks of successive processing plus one measure of selective attention separated the poor readers. All four tasks involve the use of articulation suggesting that speech related processes are important in the process of decoding.

A comparison of the High and Average IQ groups with decoding difficulties found no discrimination between these two groups on the four variables. However, the High IQ group of poor decoders performed significantly better than the average IQ group on the following tasks: Stroop Colour-Word Reading, Name Matching, Successive Order Recall, Tokens, and Crack-the-Code.

Snart (1994) has examined gifted students with learning disabilities, who exhibited varying levels of reading achievement. When IQ scores were equivalent, she found that students with a severe reading disability (two or more years below grade level) differed from those students who satisfied the discrepancy criteria but whose reading ability was not below grade level. Students with a severe disability had difficulty with tasks of sequential and simultaneous processing in contrast to difficulty with sequential processing only for the less disabled group.

Das, Mishra and Kirby (1994) compared groups of High IQ and Average IQ students with decoding difficulties with groups of students of comparable IQ scores without decoding difficulties. The groups were formed on the basis of their Non-Verbal IQ sores; the High IQ group included students from an approximate IQ score of 110 and up. Decoding problems were defined as one year below age level. Four PASS tasks and phonemic segmentation tasks were administered to all four groups. Successive tasks as well as two tasks of attention requiring articulation and/or phonological coding, differentiated students with decoding problems from normally achieving students. Students with decoding problems were poor in specific cognitive process that required successive processing and rapid articulation regardless of their scores on an ability test of intelligence.

A recent study by Kirby, Booth and Das (1996) compared four groups of elementary students on performance on ten PASS tasks of cognitive processing. Using the Non-Verbal Scale from the WISC III, one group consisted of Average IQ (average IQ=98.5) students with a discrepancy of at least two years between their grade placement and their reading grade. The second group was composed of High IQ students (average IQ=115.7) again with a similar discrepancy between grade placement and reading grade. The reading grade was defined by the Woodcock-Johnson Psycho-Educational Battery (Woodcock & Johnson, 1977). The total reading score was used. This is composed of measures of word attack, word identification and comprehension. These groups were matched with chronologically aged students and students matched on reading grade levels.

Results indicated significant differences between the two groups of students with reading difficulties on one measure of planning, attention, and successive processing and on both simultaneous measures. Simultaneous processing was the only PASS component to consistently distinguish the two groups.The authors suggest a possible reason for the significant effect for the successive processing tasks may lie in the initial (slight) differences between the groups on measures of reading ability ie. mean scores for word attack for the Average IQ group was 6.1, and the mean for the High IQ group was 7.0. This suggests that the two groups may not be adequately matched for decoding difficulties. The Average IQ group with reading difficulties differed from the chronologically aged control group on one test of planning, one of attention, and two successive measures.

The Average IQ group with reading difficulties differed significantly from their reading grade control group on two measures of planning and the two simultaneous tasks. These were expected results due to increases of a developmental nature. Students with reading disabilities performed worse than the reading age control group on reading decoding (word attack) and three successive processing measures.

It is interesting to examine the differences in the mean scores or range of scores of the groups from the four studies referred to previously. The examination clearly demonstrates the problems involved in making comparisons between studies when group memberships significantly overlap.

Naglieri and Reardon (1993) suggest that traditional IQ measures are irrelevant to learning disabilities but that intelligence is not. Their results indicate that there may be an important relationship between intelligence, as defined by the PASS model and a reading disability when the disability is identified through a deficit in phonological coding. They suggest that successive processing deficiencies may block the ability to decode words, either as groups of letters or as whole words at the initial stages of learning to read. They further suggest that the PASS model could provide a means of identifying students with a reading disability that could replace the traditional IQ/achievement discrepancy model. In this way "a specific cognitive deficit would be consistent rather than discrepant with a specific academic deficit" (p. 132).

Questions have been raised about the utility of the PASS model and what it offers that would make it superior to traditional methods of assessment. Das and Naglieri (1992) themselves suggest that there is no need to use the PASS tasks with students who have no special problems. The advantage may lie in the assessment of students with special problems as the PASS assessment, the authors suggest, is an interactive method of examining cognitive processes. This type of assessment is then expected to lead to remediation (Das & Naglieri, 1992).

Summary

In summary, the majority of studies have found scores for successive processing to be low for students with a reading disability. Studies have also suggested that students with a reading disability have additional difficulty with simultaneous processing and planning. Two studies found that scores for successive processing tasks were low for all students with a decoding disability. However, students with a severe disability also had difficulty with simultaneous processing.

Several studies examined the PASS processes with students with a reading disability and varying IQ scores. Students with Hi IQ's were better at simultaneous processing and planning than those in the Average and Below Average range.

These studies have been difficult to compare as students have had varying degrees of severity in the reading disability. In addition, students were said to have a reading disability when decoding tasks only were used in some studies, while other studies used total reading scores which include measures of comprehension.

Remediation

Methods of assisting students to become literate may depend upon the theoretical framework of beliefs and practices of literacy. Adams (1990) does not explicitly endorse a particular method of phonics instruction but she does indicate that letter knowledge and the ability to discriminate phonemes are the best predictors of first-year reading achievement. Goodman (1967) argues that readers need to be taught how to predict words based on contextual cues. LaBerge & Samuels (1974) view reading acquisition as a series of integrated skills. Training is required in the individual components to accuracy and automaticity. Rummelhart (1988) also sees reading as a series of skills. However, remediation involves making explicit the interactions between the components. Wong (1992) promotes remedial techniques which involve metacognition. Auerbach (1989) and Teale (1987) focus upon literacy development in a sociocultural context. Interventions might consist of the promotion of an enabling environment.

Remediation and the PASS Model

Remediation, as proposed by the PASS model, has its theoretical roots in the socio-cultural view proposed by Vygotsky. The following elaboration on Vygotsky's views, particularly the zone of proximal development, is included as this forms the theoretical basis for the remedial training using the PASS model.

Vygotsky (1978) proposed two ideas, one of which contends that learning is a collaborative effort, the other that instruction need not follow the level of intellectual maturity of children. The existing level of children's cognitive competence, as measured by an abilities test, may not be able to assess their potential as much as a teach-test paradigm. Vygotsky contended that what children could do with assistance was more indicative of their potential than that which they could do alone.

Vygotsky's zone of proximal development (ZPD) is central to the PASS model of remediation. It can be described as follows:

> It is the distance between the actual development level as determined by independent problem solving and the level of potential development as determined through problem solving under adult guidance or in collaboration with more capable peers. (Vygotsky, 1978, p.85).

Das and Conway (1992) state that the use of ZPD is important for two reasons. First, ZPD is a study of cognitive development which, by its nature, is a product of the learner and his collaboration with others. While ZPD itself cannot be measured, cognitive activity can be. Secondly, using ZPD is important to diagnosis. Children who have the same initial low score on a cognitive task, vary in the amount of improvement following remediation of similar duration. Children who are mentally handicapped show little improvement. Others, who have been culturally disadvantaged may show significant improvement. It has been thought that children who have learning disabilities may have specific disabilities in cognitive function. However, they can benefit from mediated learning in other cognitive areas. For example, the verbal deficits of students with learning disabilities are specific and appear to lie in phonology as well as in the knowledge of linguistic rules. However, the disability is not limited to the verbal area as some non-verbal tasks are problematic. What Das and Conway (1992) think may be the link between the two domains is the difficulty in using signs (eg. oral and written language). The specific problem associated with the use of signs is the use of successive processing for decoding difficulties and simultaneous processing for comprehension. The question for remediation then becomes whether or not the processing skills can be taught (mediated) and internalized by the individual. Das suggests that training in the use of the two processes, in addition to attention and planning, is of benefit for students with learning disabilities. The PASS model of remediation is an attempt to globally remediate the underlying cognitive processes rather than using a more direct specific skills or metacognitive approach. Now that the theoretical basis for remediation has been examined, what follows is an examination of the research using this mediated training with an aim to see whether this approach is applicable to a reading disability.

Initial results as reported by Das and Conway (1992) came from early studies by Das et al., 1979; Krywaniuk, 1974; Krywaniuk & Das 1976. These involved the remediation of successive processing. Improvement in the successive tasks was noted in near transfer to other similar successive tasks but also far transfer to reading was obtained. In addition, Krywaniuk was able to illustrate that training in a weak skill was able to allow the student to use that skill more efficiently.

Studies by Kaufman & Kaufman (1978) also demonstrated improvement on near transfer tasks of successive processing and one task of simultaneous processing. Far transfer was found using tests of word reading. Brailsford (1981) and Brailsford, Snart & Das, (1984) used both simultaneous and successive processing strategies with reading disabled students. Results were mixed for tasks of a simultaneous nature but consistent improvement was noted on successive tasks. In addition, far transfer was noted to a standard reading inventory although not to a multiple choice reading test. Brailsford suggests a possible explanation for the difference in test results lies in the fact that the multiple choice format may constrain the reader from using the organizational strategies which were emphasized in the reading tasks.

Das has developed a program of remediation based on the four cognitive processes of attention, successive and simultaneous processing and planning. The theory underlying the program will be discussed and implications will be considered.

The program is based on the premise that remediation is most successful when it is theoretically based in cognition and when the cognitive skills are directly related to the academic skill - in this case reading. It is also based on the premise that remediation is most successful when there is collaboration between student, peers and teacher. The final premise involves that idea that transfer of learning will occur if relatively context free global processing tasks are used in combination with academic bridging tasks. These premises arise from the work of Belmont and Butterfield (1977) and Borkowski and Cavenaugh (1979) as outlined in Das and Conway (1992).

The program consists of global tasks and tasks that bridge to areas of the curriculum such as spelling and reading. The tasks differ in modality and nature of the stimuli. The role of the instructor is to give mediated assistance so that the student can infer and internalize the underlying strategy. As Snart (1994) suggests, one of the strengths of this approach is that students who have been turned off academic learning will be better motivated with the relatively free context of the remediation.

Several studies have been conducted which indicate some success in accomplishing far transfer to curriculum areas for students with a reading disability. One attempt to promote far transfer involved a series of bridging tasks to spelling (Spencer, Snart & Das, 1989). Students gained in successive processing, planning and spelling. In all three areas, students made significant gains compared to a control group who were receiving regular classroom remediation (of an unspecified nature).

Another study by Crawford and Das (1992) involved individual work with three students in which global instruction was given in successive processing with bridging tasks to the decoding aspect of reading. Results were mixed with improvement noted for tasks of near transfer but only one student improved in decoding.

Kepron, in his doctoral dissertation, (cited in Snart & Das, 1994) focused on simultaneous processing and bridging training to reading comprehension. Significant improvement was noted for silent reading comprehension and some improvement for oral comprehension.

Das, Mishra & Pool (1995) used the PASS Remedial Program (PREP). They suggest that "it facilitates the application of internalized strategies arrived at inductively for decoding and spelling but that it does not provide direct teaching of rules or exercises." (p. 66) They report significant improvement for students with a severe reading disability compared with a group of similarly disabled students who were receiving resource room teaching (of an unspecified nature).

Das et al. (1995) contrasted the full PREP program with a partial program which consisted of global only tasks and with another condition in which bridging only tasks were mediated. The complete PREP program provided the best result in improvement in word identification and word attack. The bridging only group showed no gains and the global only had modest gains on word attack.

Summary

Early studies on remediation were promising as they reported near and far transfer to successive processing and reading. Recent studies using the PREP program have reported near transfer to the PASS tasks and far transfer to spelling, decoding, and comprehension.

Problem Areas

A major problem lies in the wide variety of students included in research studies. Definitions of a learning disability are often so broad and difficult to apply operationally that Ysseldyke (1983) was able to demonstrate that about 85 percent of normal students could be classified as learning disabled using 17 of the most common definitions of a learning disability. This is also true of studies using the PASS model. The basis on which the students are selected is not always clear. In some studies they have been clearly defined as being a specific number of grade levels below their grade placement (Das, Mishra, & Kirby, 1994; Snart, 1994). In some studies, the particular area of weakness in reading has not always been clear. They may lie in decoding or in comprehension or both.

Barton and Starnes (1989) addressed the importance of group heterogeneity in research populations. They found the severity of a learning disability followed a continuum from mild to severe. An interesting pattern was found in that the ratio of males to females increased directly with the severity of the disability. Only 20 percent of their sample of students were in the severe category and all were males. They found that while there was little difference in the Full scale scores of their population, the mild to moderately disabled group had higher Verbal scores. This was reversed for the group with severe disabilities in that the Performance scores were higher.

Bain (1993), in contrast to most studies, found relative sequential processing strengths for students with a learning disability. Students in this study had a learning disability based on an achievement deficit in reading, math or written expression. A study by Das et al. (1978) included students who had a learning disability based on their difficulties with hyperactivity.

An additional problem with student selection has been the use of the discrepancy criteria. Some students have been selected as having a disability in reading even when they are reading at or above grade level because a discrepancy exists between their IQ scores and their level of achievement (Snart, Das & Mensink, 1988). It is difficult to compare studies or generalize results when the range of reading scores of students in the research is from below to above grade level.

Even when the students have been specifically identified as being disabled in reading decoding, there have been differences in grouping them based on their IQ scores. Some students placed in the Average group by one study could be placed in the Below Average in another. Students with identical IQ scores were placed in the Gifted group in one study and in the Above Average in another. Comparisons made with these studies are thus suspect.

Another area of possible confounding of research population lies in attention. Research such as that of Barkley (1990) discusses a particular disorder of attention called Attention Deficit Disorder. It is clear that this disorder is separate from a specific learning disability such as a decoding problem. While the two difficulties may occur simultaneously, they are two separate problems. Since much of Das's work on attention was done early in the development of the PASS model, at a time when students who had a specific learning disability included those with specific attentional problems, it is possible that the two disabilities have been confounded.

Another area of uncertainty lies in remediation and involves the matching of the training of specific processes with a particular type of reading problem. It is clear from the research that successive processing is linked to the sequential aspect of decoding and simultaneous processing to comprehension. What is unclear is which cognitive processes should be targeted for training in effective processing in order to improve decoding skills. This line of thinking is particularly important given research results which suggest a genetic basis to dyslexia (Cardon, DiLalla, Plomin, DeFries & Fulker, 1990; Cardon, Smith, Fulker, Kimberling, and Pennington,1994; Gilger, Pennington, & Defries, 1991; LaBuda & DeFries, 1988; Olson, Wise, Conners, Rack, & Fulker, 1989; Stevenson, 1991). Researchers have identified a chromosome associated with the disability (Cardon et al., 1994). If the problem is an inherent part of the genetic make up of the student, it seems unlikely that remedial efforts can effect a change in the specific area of weakness. Given a likely genetic involvement in a decoding disability, research is required or needs to be clarified as to which cognitive processes should be targeted for remediation, to increase performance in the areas of relative strength; simultaneous processing, attention and planning, or to improve the weak area of successive processing. Kirby and Robinson (1987) suggest that part of the difficulty that readers have is an inappropriate use of simultaneous processing, in fact using it when successive processing is called for. They suggest two explanations for the less than optimal use of processing: either there is a deficit in successive processing or the students make a poor choice of processing modes. If a decoding disability involves difficulty with successive processing, it would perhaps be appropriate for these students to be using simultaneous processing, as they would be unable to successfully use successive processing. Areas for remediation would likely be in attention, planning and simultaneous processing. This area likely requires further research before there could be direct application to classroom teaching.

Summary

A summary of the literature reveals that the PASS model of cognitive processing has been previously used successfully to discriminate various groups of students. Results have been inconsistent, due in part to varying criteria for subject selection, and/or incomplete descriptions of subjects. Students have sometimes been selected based on the discrepancy model. These students have ranged from above grade to below grade level on reading scores. Other studeies have specified a cut off criteria of number of grades below level on various tasks of reading. Some studies, particularly early ones, may have included students with ADD. In addition, studies have been conducted with students who have a reading disability and who have varying IQ scores ranging from Below Average to Superior. IQ scores have frequently been based on Full scale scores and/or Non-Verbal scores. Recent studies have included more detail but reveal a confusion of reading disability based on decoding or comprehension difficulties. Trends implicate successive processes with decoding and simultaneous processes with comprehension.

Present Study

The current study will help to add to the knowledge base concerning students with decoding difficulties as subject selection will include only those students who have a severe decoding disability based on tests of decoding only. In addition, students who have difficulty with decoding due to factors other than a specific reading disability, have been excluded. Because subject selection is clearly outlined, a clear pattern of cognitive processing may emerge for students with severe decoding difficulties.

In addition, this study is important as it is the first study to examine the four PASS processes with students who have severe decoding difficulties and who have Gifted levels of IQ as measured by their Full Scale or Verbal subscale scores.

Finally, this study is unique as it is the first to examine all four PASS processes with students who have a severe decoding disability and who are in two different Educational Divisions. The information gathered in this study will add to the literature in a meaningful way as we should be able to determine whether or not the underlying processes which are implicated in a decoding disability remain weak, even at the grade levels where students have learned to read despite their initial difficulties. The results should be able to give direction for remediation.

Chapter Three

Methodology

Sample Selection

The subjects in this study were students in Divisions II and III (grades four through nine) who attended schools within the Calgary Board of Education (CBE). Calgary is a large urban center (population approximately 750,000) in Western Canada.

Poor decoders

Students who had a decoding disability and whose Intelligence Status was in the Average range were selected, at Division II from two schools, and from one school at Division III. Students whose Intelligence Status was in the Very Superior range, and who also had a decoding disability, were drawn from various schools within the CBE.

Average decoders

Students with average decoding disability, and whose Intelligence Status was in the Average range, were selected from one school at Division II and two schools at Division III. The students whose Intelligence Status was in the Very Superior range, and who did not have a decoding disability, came from one school at each Division. These students were enrolled in a full time education program specifically designed to meet the needs of Gifted students.

Sample Description

Schools were contacted and asked to select students for the study based on the following criteria. Students who had a decoding disability must have significant difficulty with reading decoding; that is they must score below the average range (standard score <85) on a test of word attack and/or word identification such as the Woodcock Reading Mastery Tests-Revised (Woodcock, 1987). The Word Attack sub-test requires students to pronounce nonsense words; it thus measures a subject's ability to apply phonic and structural analysis skills. The Word Identification sub-test requires students to orally read a list of isolated words. Gifted students were selected based on their enrollment in congregated settings for Gifted students. A requirement for their admission to these classes is an individual psychological assessment, the results of which must be in the Very Superior range of intellectual functioning (IQ 130+). For specific admission criteria see Appendix C. Gifted students who also had a decoding disability all had individual psychological assessments. These students had intellectual levels that fell within the Very Superior range (including one standard error of measurement). These scores were obtained by either the Full Scale or the Verbal Scale. Previous research (Das, Mishra, & Kirby, 1994; Frith, 1992; Kirby & Das, 1990) has shown phonological coding and articulation to be implicated in problems with decoding, so the students were not selected on the basis of their performance on the Performance scales alone. In addition, students who were experiencing decoding problems attributable to reasons other than a specific reading disability such as emotional, behavioral, English as a second language, a specific language learning disability, and/or medical problems were excluded. Wherever possible, teachers were asked to select students from the Average range who appeared to be of the same level of intellectual ability as the students they selected who also had a reading disability.

Following parental permission, a total of sixty-six students were assessed. Of these thirty-three were male and thirty-three were female. Due to the predicted small numbers of Gifted students who also had a decoding disability, no attempt was made to select students based on gender. Although the total number of students involved in the study were equally divided based on gender, within cell gender numbers are not balanced. A study by Warrick and Naglieri (1993) found significant differences based on gender at the grade three level only. This difference was found only on tasks of Attention. Parrila & Das (1996) also did not find gender differences in their study concerning tasks of planning.

At the Division II, ten students were assessed in each category except for the Gifted students who also had a decoding disability. Five students from this group were assessed. In Division III, there were nine students in the Average Intelligence Status without a reading disability. Also in Division III, there were eight students in the Average intelligence status who additionally had a decoding disability. At Division III, there were seven students with Very Superior IQ scores who did not have a reading disability. Also at Division III there were seven Gifted students who had a reading disability. See Table 1 for the distribution of subjects by division and gender.

Due to circumstances beyond this author's control, students were not assessed during a single time period. Assessments were conducted over two time periods, April/May 1996, and February/ March 1997.

Table 1

Subjects by Gender

	Intelligence Status		Reading Status	
	Average	Gifted	RD	Non RD
Div. II	M=10	M=6	M=10	M=6
	F=10	F=9	F=5	F=14
Div. III	M=7	M=10	M=12	M=5
	F=10	F=4	F=3	F=11

Procedure

Students were given individual assessments consisting of the eight tasks in the following order: Number Finding, Matrices, Word Series, Crack-the-Code, Expressive Attention, Simultaneous Verbal, Matching Numbers, and Successive Ordering. All assessments, which were conducted individually, were completed by this author.

Instruments

Eight tasks based mainly on the experimental version of the Cognitive Assessment System (Das & Naglieri,1989) which are described in the literature were selected. These included two tasks of attention, two tasks of simultaneous processing, and two tasks of successive processing. One of each of these tasks requires performance in the verbal modality, while the remaining task required a non-verbal output. As outlined earlier, research (Das, Mishra & Kirby, 1994; Frith, 1992; Kirby & Das, 1990; Siegel, 1992) has suggested that reading problems are related to phonological problems - a verbal process. This researcher wondered if there would be a difference in the way students process tasks verbally and non-verbally, that is would the tasks which discriminate poor decoders be performed more poorly in the Verbal modality than in a non-verbal modality. In addition, two tasks of Planning were selected, one requiring a low level of planning and the other a high level. Two different level tasks were chosen because of the wide age range of the students. Parrila & Das (1996) suggest that the development of planning skills, particularly in more complex and demanding tasks, may continue into and beyond adolescence. These researchers also suggest that the lower level planning tasks which have been widely used may not be able to discriminate various groups at higher grade levels due to a ceiling effect.

Factorial validity of the PASS model has been well documented with the validity of these tasks being provided by loadings on appropriate factors in principal component and confirmatory factor analyses (Naglieri, Braden & Warrick, 1991; Naglieri, Das, Stevens, & Ledbetter, 1991; Naglieri, Prewett & Bardos, 1989). The reliability estimates for the tasks outlined below come from these sources. Raw scores were collected as norms have not been published.

<u>*Attention Tasks*</u>

Expressive Attention (Verbal). This task is similar to the Stroop test (Stroop, 1935) and has been used with other PASS measures (Naglieri, Braden, & Warrick, 1991). This task involves three conditions. The first page consists of three colour words (red, blue and green) printed in black ink in random order in eight rows of five words per row. The student is required to read the words as quickly as possible. The second page consists of eight rows of five coloured (red, green and blue) circles. Again, the student is required to say the colours as quickly as possible. The final page comprises the selective attention component through the use of an interference paradigm. It is composed of the same three colour words. However, they are printed in coloured ink which is different from the word. The student is required to say, as quickly as possible, the colour of the ink used to print the word. The score is composed of the total amount of time required to read the three pages and the total number of errors.

Number Find (Non-Verbal). In this task, the student is presented with a page of single digit numbers ranging from 1 to 6. The student is required to circle the numbers 1,2, and 3 when they appear in bold type (ie. **1,2,3**) rather than regular type (ie. 1,2,3). All of the digits are in bold or regular type in a random order. The score is composed of the total time to complete the task and the number of errors.

<u>*Successive Processing Tasks*</u>

Word Series (Verbal). This task requires the student to repeat, in exact order, a series of words which ranged from three to nine words. All of the words were highly familiar words of one to three syllables. The task was discontinued after two consecutive unsuccessful attempts. The student's score was the total number of correctly recounted word series. The maximum score was nine.

Successive Order (Non-Verbal). In this task the student is presented with an array of attribute squares. There are four arrays of increasing length. The examiner points to each array in a series in a differingent order. The student is required to point to the attribute squares in the same order as the examiner. The number of items pointed to increases in each array. The test was discontinued after two errors in any array. The score was the total number of series in all arrays which were correctly pointed to.

<u>*Simultaneous Processing Tasks*</u>

Simultaneous Verbal (Verbal). This task involves the evaluation of logical-grammatical relationships by the student. The version used in this study was the sub-test Processing Word and Sentence Structure from the Clinical Evaluation of Language Functions (CELF) (Semel, Wiig & Secord, 1987). The test consisted of twenty-six items, with each item consisting of four competing pictures. The student was asked to point to one of the four pictures that demonstrated a verbal statement such as, "the dog that is wearing a collar is eating a big bone." The task was discontinued after four consecutive errors. The task was scored for the number of correctly identified items.

The CELF was normed on populations in the United States. Populations included students with learning disabilities, however, the manual describes these students as having a language learning disability. The internal consistency reliability coefficient for the Simultaneous Verbal subtest was .85 for the normative sample. Test-retest reliability for the subtest was .97.

Matrices (Non-Verbal). This task, a subtest of the Matrix Analogies Test-Expanded Form (Naglieri, 1985b), is a standardized nonverbal test of ability (median alpha = .83). It requires the completion of figural analogies using a progressive matrix format. Each component of a matrix must be interrelated to the others, which then makes this task congruent with the requirements for simultaneous processing. This test has been previously found to load on a simultaneous factor (Naglieri & Das, 1987; Naglieri, Prewett, & Bardos, 1989). Students are required to select one of six options which best completes the abstract analogy. This task consisted of 16 items and was discontinued after four consecutive errors. The score was the number of correctly completed items.

<u>*Planning*</u>

Matching Numbers (Low level Planning). This task was adapted from the battery of tasks described in Das, Naglieri, & Kirby (1994). It was developed by Naglieri and Das (1987) and has loaded on the Planning factor in previous research (Naglieri & Das, 1988, Parrila & Das, (in press)). In this task, students are required to find two numbers that are the same, from competing numbers, on each of the eight rows on a page. There were six numbers containing the same number of digits in each row. On page one the number of digits increased in each row from one to three digits. On page two there were from three to five digits. In addition the difficulty increased as the competing numbers more closely resembled the target numbers. The student's score was composed of the total time it took to complete the two pages, and the number of errors.

Crack-the-Code (High level Planning). This task is a recent addition to the PASS battery of tasks. It has been used by Das, Mensink, and Janzen (1990). Crack-the Code is based on the game of Mastermind. It requires the student to determine the correct sequence of coloured chips when a set of information is provided in an information line. For example, item 5 contains the following information. Actual chips are used.

-Line 1;	blue, red, yellow, green	0 correct
-Line 2;	yellow, green, red, blue	1 correct
-Line 3	red, yellow, green, blue	0 correct

This task had eight items. The first item consisted of three coloured chips and two information lines. Complexity increased for each succeeding item to the final item which consisted of five coloured chips and five information lines. The task was discontinued after two consecutive errors. The score was the total number of correctly solved items.

Data Analysis

There were a total of sixty-six subjects placed in eight cells. The independent variables were Division, Reading Status, and Intelligence Status. There were eight dependent variables consisting of the eight PASS tasks: Expressive Attention, Number Find, Word Series, Successive Order, Simultaneous Verbal, Matrices, Matching Number, and Crack-the-Code. The scores for three tasks (Expressive Attention, Number Find, and Matching Number) were inconsistent with the other five tasks as the lower scores for the former tasks were superior in contrast to higher scores being superior for the latter. Comparisons were; therefore, difficult to make. To be able to make comparisons easily, the individual scores for the three tasks were transformed by subtracting the total time in seconds from 2500 and multiplying this number by the number of errors plus one. Table 2 contains the scoring information for the eight PASS tasks.

Division and group differences in the eight PASS cognitive processes were examined using a 2 by 2 by 2 multivariate analysis of variance (MANOVA). The level of statistical significance was set at .05. All significant F values which exceeded the critical values at the .05 level are highlighted. The Pillais-Bartlett test criteria for significance was selected as it provides a more robust measure for violation of MANOVA assumptions (Pyryt, 1995). Significant multivariate effects were followed by a discriminant analysis.

Table 2 *Summary of the Scoring Methods for the Eight PASS Tasks*

Task Name	Parameters	Calculation of Score	Possible range of score	Actual range
Expressive Attention (Verbal)	Secs to complete No. errors	EAT = 2500 - secs x (errors + 1)	0 - 2500	2056 - 2451
Number Find (Non Verbal)	Secs to complete No. errors	NUM = 2500 - secs x (errors + 1)	0 - 2500	688 - 2441
Word Series (Verbal)	Number correct	WRD = number correct	0 - 9	1 - 5
Sucessive Order (Non Verbal)	Number correct	SO = number correct	0 - 23	4 - 22
Simultaneous Verbal	Number Correct	SV = number correct	0 - 26	13 - 26
Matrices (Non Verbal)	Number correct	MA = number correct	0 - 16	5 - 16
Matching Numbers (Low level planning)	Secs to complete No. errors	MAT = 2500 - secs x (errors + 1)	0 - 2500	1486 - 2398
Crack-the-Code (High level planning)	Number correct	CTC = number correct	0 - 8	1 - 8

Chapter IV

Results

A 2 x 2 x 2 Division by Reading Status by Intelligence Status multivariate analysis of variance (MANOVA) was performed to test the eight research questions. MANOVA summary results are presented in Table 3. A discriminant analysis was performed on the significant effects. Mean scores are provided in Table 4. Due to wide differences in raw scores, these were converted to standard scores taking weighted means into account in order to better compare the differences between the PASS tasks. Standard score means in z score form are presented in Table 5.

In the following table Division refers to Division II or Division III. Reading Status refers to students with a reading decoding disability or those students without a reading disability. Intelligence Status refers to students who are within the Average range of intellectual ability or those students within the Very Superior range of intellectual ability.

Table 3

MANOVA Summary Table

Effect	Pillais	df(hyp)	df(err)	F
Division by Reading Status by Intelligence Status	.09	8	51	.70
Reading Level by Intelligence Status	.18	8	51	1.40
Division by Intelligence Status	.29	8	51	2.56*
Division by Reading Status	.07	8	51	.51
Intelligence Status	.69	8	51	13.86**
Reading Status	.51	8	51	6.68**
Division	.46	8	51	5.42**

$p < 0.05$* $p < 0.001$**

TABLE 4: *Means and Standard Deviations for Groups for Divisions II and III*

PASS task		Average		Average RD		Gifted RD		Gifted	
		Mean	SD	Mean	SD	Mean	SD	Mean	SD
ATTENTION									
Expressive Attention	Div. II	2310.90	102.42	2262.90	170.06	2311.00	74.00	2330.30	132.41
	Div.III	2350.00	101.96	2346.62	101.80	2398.00	22.87	2391.57	49.99
Number Find	Div.II	1805.60	522.32	1930.90	365.99	1806.00	302.23	2109.90	175.87
	Div. III	2239.00	108.16	2007.37	600.66	2306.43	58.90	2396.12	39.70
SUCCESSIVE									
Word Series	Div. II	2.60	0.97	2.10	0.57	2.00	1.41	3.80	0.63
	Div. III	3.22	0.83	2.13	1.13	2.43	0.54	4.29	0.76
Successive Order	Div. II	7.70	2.16	6.50	0.97	5.60	2.07	11.40	2.41
	Div. III	9.89	3.06	6.50	1.85	7.86	2.04	12.86	5.01
SIMULTANEOUS									
Simultaneous Verbal	Div. II	21.60	3.47	22.00	1.56	23.60	0.55	24.10	1.20
	Div. III	23.00	1.23	23.00	1.06	23.29	0.76	23.57	0.98
Matrices	Div. II	9.10	2.60	8.30	2.80	13.40	1.67	14.00	0.67
	Div. III	12.89	1.83	11.25	3.06	14.86	1.07	15.14	0.69
PLANNING									
Matching Numbers	Div. II	2088.40	303.05	2176.70	237.33	2297.80	57.80	2257.60	130.86
	Div. III	2282.00	108.60	2232.75	144.84	2314.43	63.69	2349.00	61.78
Crack-the Code	Div.II	2.20	0.91	3.00	1.25	4.20	1.48	4.80	1.48
	Div. III	3.67	1.23	2.88	1.36	6.00	0.58	6.29	1.11

TABLE 5: *Z Means for Groups for Divisions II and III*

PASS task		Average	Average RD	Gifted RD	Gifted
		Mean	Mean	Mean	Mean
ATTENTION					
Expressive Attention	Div. II	-0,21	-0,63	-0,21	-0,03
	Div.III	0,14	0,11	0,57	0,52
Number Find	Div.II	-0,69	-0,36	-0,69	0,10
	Div. III	0,44	-0,16	0,62	0,85
SUCCESSIVE					
Word Series	Div. II	-0,22	-0,66	-0,75	0,84
	Div. III	0,33	-0,64	-0,37	1,27
Successive Order	Div. II	-0,28	-0,63	-0,89	0,81
	Div. III	0,37	-0,63	-0,23	1,24
SIMULTANEOUS					
Simultaneous Verbal	Div. II	-0,73	-0,51	0,36	0,63
	Div. III	0,03	0,03	0,19	0,34
Matrices	Div. II	-0,94	-1,19	0,42	0,61
	Div. III	0,26	-0,26	0,88	0,97
PLANNING					
Matching Numbers	Div. II	-0,82	-0,34	0,32	0,10
	Div. III	0,24	-0,03	0,41	0,60
Crack-the Code	Div.II	-1,00	-0,55	0,12	0,46
	Div. III	-0,18	-0,62	1,12	1,28

There was no significant effect for Division by Reading Status by Intelligence Status. In addition, there was no significant effect for Reading Status by Intelligence Status. There was no significant effect for Division by Reading Status.

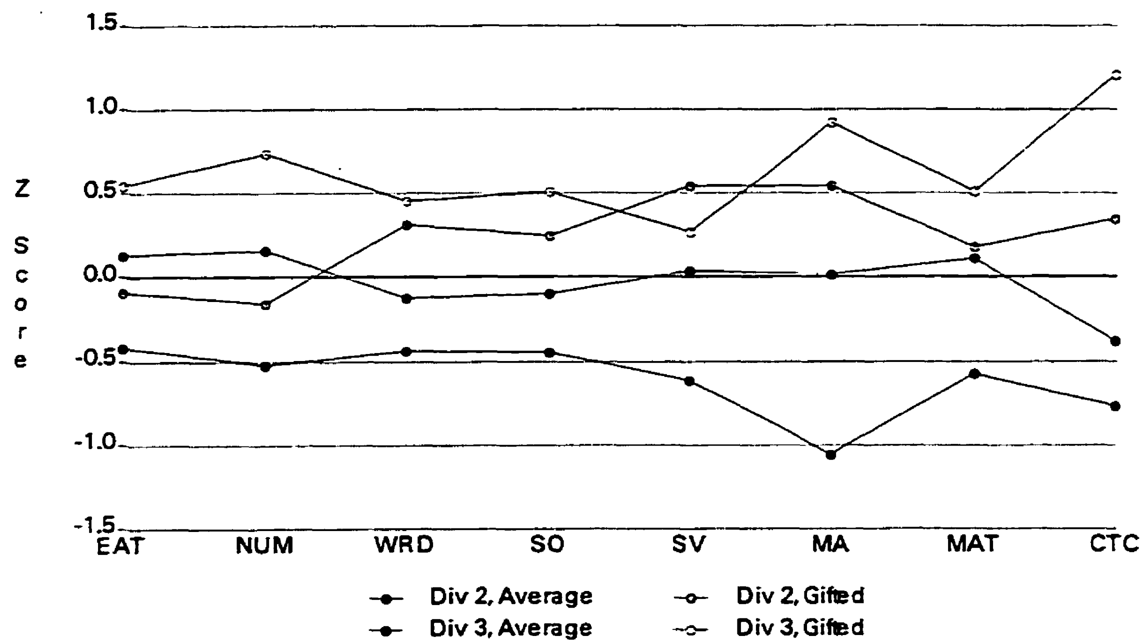
A significant effect was obtained for Division by Intelligence Status. *Pillais*= .29, $F(8,51) = 2.56, p <.02$. Mean *z* scores for Division by Intelligence are shown in Figure 2. A discriminant analysis was carried out to identify the PASS tasks that most clearly indicated differences for the groups. Standardized discriminant function coefficients, typically ranging from -1.0 to +1.0, provide an index of the relative importance of each variable in discriminating between groups. Those with the highest absolute value contribute most to group difference. The structure coefficients, ranging from -1.0 to +1.0, are correlations between dependent variables and the discriminant function scores. They are more replicable and are less affected by intercorrelations among the variables than are standardized discriminant function coefficients. Variables with the higher absolute values (.40) on both indices most clearly contribute to group differences. The contribution to group differences is more ambiguous for variables with a high absolute value on only one of the indices. Examination of the coefficients identified Matrices as most clearly contributing to group differences. The coefficients are presented in Table 6

A significant effect was obtained for Intelligence Status. *Pillais*= .685, $F(8,51)$, = 13.855, $p <.001$. Mean *z* scores for Intelligence status are presented in Figure 3. A discriminant analysis was performed and an examination of the coefficients identified two variables, Matrices and Crack-the-Code as most clearly contributing to group differences. The coefficients are presented in Table 7.

A significant effect was found for Reading Status. *Pillais*=.512, $F(8,51)$, =6.68, $p <.001$. Mean *z* scores for Reading Status are presented in Figure 4. A discriminant analysis was performed and an examination of the coefficients identified the two Successive tasks; Word Series, and Successive Order as contributing most to group differences. The coefficients are presented in Table 8.

Figure 2

Z scores by Division by Intelligence Status



EAT = Expressive Attention
NUM = Number Find
WRD = Word Series
SO = Successive Order
SV = Simultaneous Verbal
MA= Matrices
MAT=Matching Number
CTC = Crack-the-Code

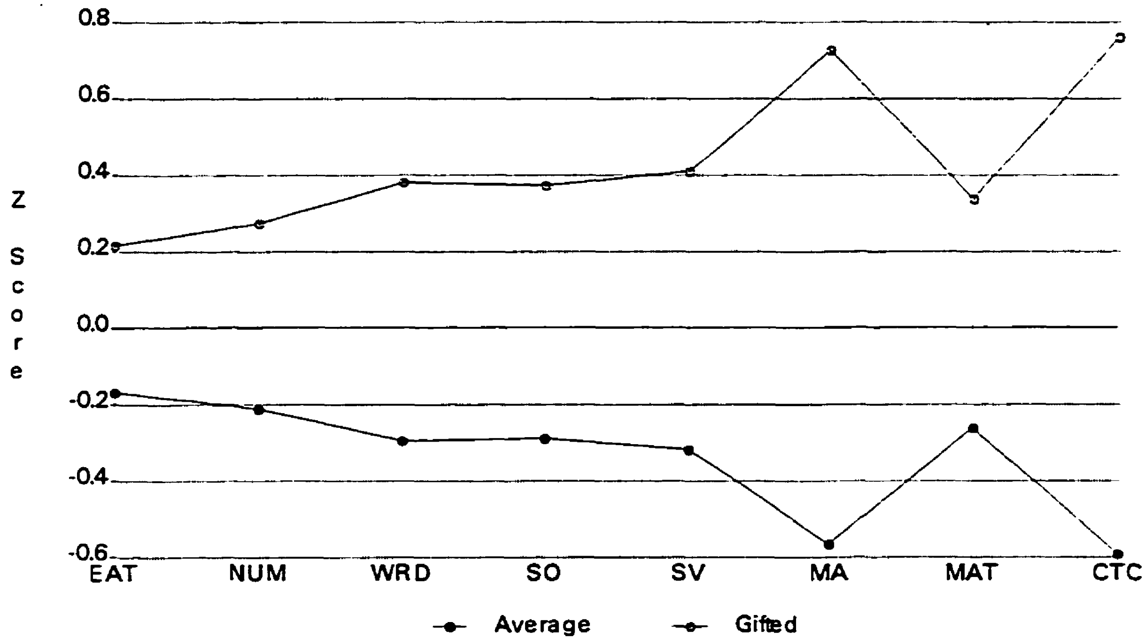
TABLE 6

Discriminant Analysis for Division by Intelligence Status

Standardized Discriminant Function Coefficients		Structure Coefficients	
Variable		Variable	
Expressive Attention	-.276	Expressive Attention	.047
Number Find	.668	Number Find	.164
Word Series	-.115	Word Series	-.064
Successive Order	-.258	Successive Order	-.120
Simultaneous Verbal	.966	Simultaneous Verbal	.384
Matrices	.698	Matrices	.409
Matching Numbers	-.258	Matching Numbers-	-.165
Crack-the-Code	-.452	Crack-the-Code	-.330

Figure 3:

Mean z scores by Intelligence Status



EAT = Expressive Attention
NUM = Number Find
WRD = Word Series
SO = Successive Order
SV = Simultaneous Verbal
MA= Matrices
MAT=Matching Number
CTC = Crack-the-Code

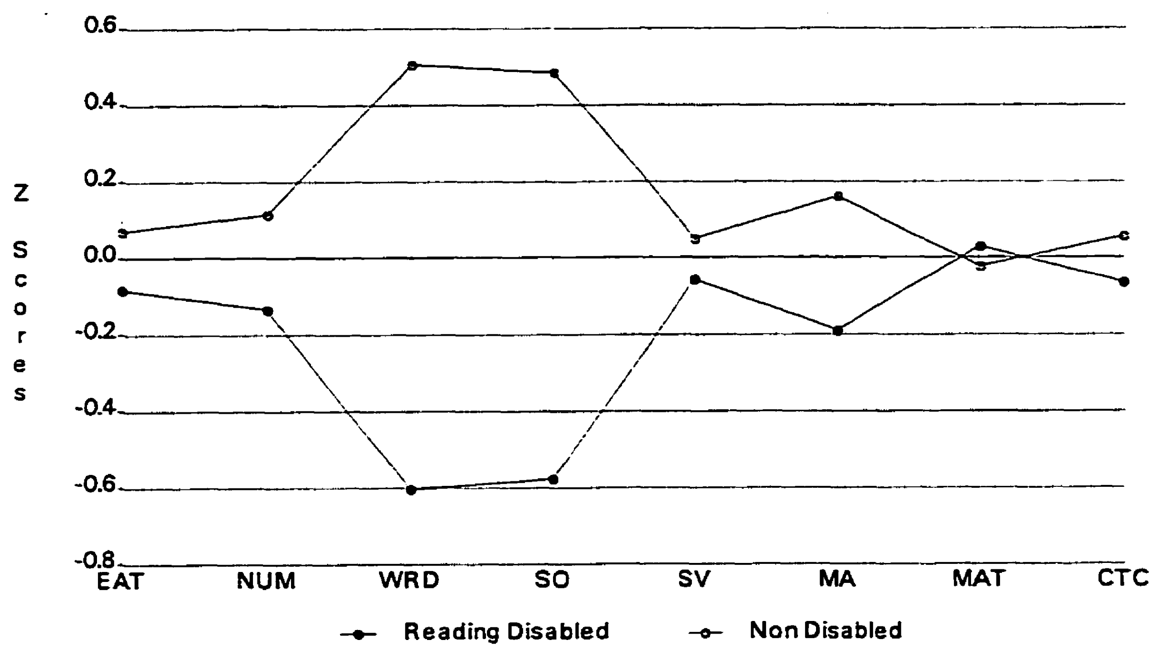
TABLE 7

Discriminant Analysis for Intelligence Status

Standardized Discriminant Function Coefficients		Structure Coefficients	
Variable		Variable	
Expressive Attention	-.210	Expressive Attention	-.128
Number Find	.307	Number Find	-.162
Word Series	.070	Word Series	.254
Successive Order	.095	Successive Order	.241
Simultaneous Verbal	.358	Simultaneous Verbal	.252
Matrices	.626	Matrices	.675
Matching Numbers	-.234	Matching Numbers	-.220
Crack-the-Code	.598	Crack-the-Code	.698

Figure 4

Mean z scores by Reading Status



EAT = Expressive Attention
WRD = Word Series
SV = Simultaneous Verbal
MAT=Matching Number
NUM = Number Find
SO = Successive Order
MA= Matrices
CTC = Crack-the-Code

TABLE 8

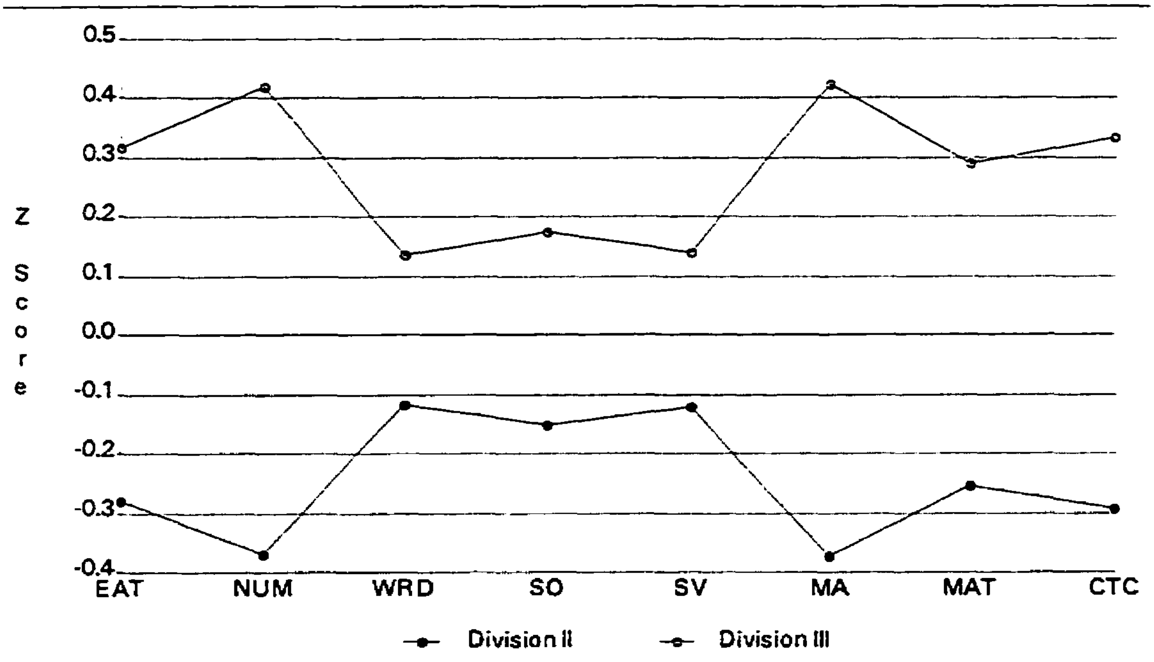
Discriminant Function for Reading Status

Standardized Discriminant Function Coefficients		Structure Coefficients	
Variable		Variable	
Expressive Attention	.005	Expressive Attention	-.074
Number Find	-.326	Number Find	-.183
Word Series	.631	Word Series	.779
Successive Order	.610	Successive Order	.749
Simultaneous Verbal	-.445	Simultaneous Verbal	.028
Matrices	-.013	Matrices	.204
Matching Numbers	-.035	Matching Numbers	.032
Crack-the-Code	.058	Crack-the-Code	.092

Finally, there was a significant effect for Division. *Pillais*= .46, $F(8,51)$, =5.42, $p < .001$. Mean *z* scores for Division are presented in Figure 5. A discriminant analysis was performed. An examination of the coefficients indicated that Matrices and Number Find contributed most to group differences. The coefficients are presented in Table 9.

Figure 5

Mean z Scores by Division



EAT = Expressive Attention
NUM = Number Find
WRD = Word Series
SO = Successive Order
SV = Simultaneous Verbal
MA= Matrices
MAT=Matching Number
CTC = Crack-the-Code

TABLE 9

Discriminant Function for Division

Standardized Discriminant Function Coefficients		Structure Coefficients	
Variable		Variable	
Expressive Attention	-.461	Expressive Attention	-.346
Number Find	-.396	Number Find	-.528
Word Series	.105	Word Series	.257
Successive Order	.219	Successive Order	.319
Simultaneous Verbal	-.063	Simultaneous Verbal	.127
Matrices	.521	Matrices	.636
Matching Numbers	-.125	Matching Numbers	-.287
Crack-the-Code	.324	Crack-the-Code	-.346

Research Question Results

1. What are the PASS processes that discriminate poor decoders from able decoders?

The PASS processes which most significantly discriminate poor decoders from average decoders were the two tasks of Successive Processing; Word Series and Successive Order. A MANOVA effect was significant for Reading Status, *Pillais*=.512, $F(8,51)$, =6.68, p <.001. Discriminant analysis indicated Word Series and Successive Order as contributing most to group differences.

2. Are the discriminatory processes the same for the two Intelligence levels, Gifted and Average?

The two Successive processing tasks which discriminate poor decoders from average decoders, are the same for both Intelligence levels. This cognitive process remains weak despite students having IQ scores in the Very Superior range. The discriminant analysis for Reading Status did not indicate significance for the two successive tasks. In addition, there was no significant MANOVA effect for Reading Status by Intelligence Status.

3. Do these processes vary with Educational Division?

Performance on the successive processing tasks do not vary with Educational Division. Students who are poor decoders have similar results on the tasks of Word Series and Successive Order regardless of whether they are in Division II or Division III. There was a significant MANOVA effect for division. However, neither task contributed to group differences.

4. Are there interactions among Division, Reading Status and Intelligence Status?

There are no significant interactions.

5. Is there an interaction between Division and Reading Status?

There is no significant interaction.

6. Is there an interaction between Division and Intelligence Status?

A significant effect was obtained for Division by Intelligence Status. *Pillais*= .29, $F(8,51) = 2.56$, $p < .02$. Matrices was the only task identified as contributing to group differences.

7. Is there an interaction between Reading Status and Intelligence Status?

There is no significant interaction.

8. Is there a difference in the way students with a decoding disability process tasks which involve verbal responses compared with non-verbal responses?

Both the discriminatory PASS tasks measuring Successive processing were weak for students with a decoding disability compared with the non-disabled control groups indicating that these students have difficulty processing information of a successive nature, regardless of modality. See Figure 4 and Table 8 for the significant MANOVA effect and the discriminant analysis.

Chapter V

Discussion

This study investigated possible differences in cognitive processing for students with a significant decoding disability. Several significant results were obtained. First, only two tasks (Word Series and Successive Order) separated students with a decoding difficulty from their non-disabled peers. Both these tasks call for successive cognitive processing. This result mirrors the trend in the literature which suggests that successive processing tasks are a significant factor underlying a decoding disability (Cummins & Das, 1977; Das, Mishra & Kirby, 1994; Das, Snart & Mulcahy, 1982; Kirby & Das, 1977; Naglieri & Das, 1987).

Two other results of significance are that these same two tasks remained the only tasks to discriminate between students with a decoding disability and their non-disabled peers regardless of their IQ scores or their Division. This study is the only one reported which has examined all four cognitive processes with students with reading difficulties, who are at significantly different grade levels. In addition, this is the only study reported which has examined the cognitive processes of severely disabled students who have Full Scale or Verbal IQ scores in the Very Superior range of intellectual functioning. Previous studies including students with above average IQ scores, have examined High Average students, or Gifted students with less severe reading problems, or students with severe problems but whose IQ scores were selected on the basis of their Non-Verbal scores.

A statistically significant result was found for the interaction of Division and Intelligence Status. Discriminant analyses implicated Matrices, a simultaneous processing task which has also been used to establish measures of non-verbal intelligence. This study found little difference in the scores for Gifted students across the two Divisions. Mean scores ranged from 13.40 to 15.14 with standard deviations ranging from .67 to 1.67. The highest possible score was 16. In contrast, students in the Average Status had mean scores which ranged from 8.30 to 12.89 and standard deviations ranging from 1.83 to 3.06. These scores suggest a ceiling effect which may have impacted upon the significant result.

This study does not provide support for those which found a significant role for attention in a decoding disability (Lupart & Mulcahy, 1984; Naglieri, 1989a). One study (Das, Mishra, & Kirby, 1994), which also focused on students with decoding problems, found that attention tasks which had an articulation component were able to separate students with decoding problems from their non-disabled peers. This current study also included one measure of attention which had an articulation component. Discriminant analysis did not support the involvement of expressive attention in separating poor and average decoders. This result should be interpreted with caution due to the fact that only one task of attention which had a verbal component was included in the study.

Another possible explanation for the difference in results regarding attention may lie in the selection of students for the studies. This study specifically excluded those students for whom there has been a diagnosis of a specific Attention Deficit Disorder. There was no such exclusionary statement for the other studies. The implication is that we cannot exclude the possibility of the involvement of students with specific attentional difficulties in previous studies.

Kirby and Das (1990) suggested that the articulation of sounds of letter combinations can also interfere with decoding. The Expressive Attention task was the only task in the current study which required the students to read and articulate words. A possible explanation for the lack of contribution for this task is that the students had the three words (red, blue, green) at a level of automatic sight word recognition. This type of reading would then require the use of simultaneous processing and so there would be no involvement of successive processing in this task.

This study does not provide support for those studies which have implicated simultaneous processing in a reading disability (Bardos, cited in Das, Naglieri, & Kirby, 1994; Das, Bisanz, & Mancini, 1984; Das, Snart & Mulcahy, 1982; Naglieri, 1989a; Snart, 1994). A possible reason for the difference in results may again lie in subject selection and the possible confounding of different types of reading disabilities. Das, Naglieri, & Kirby (1994) suggest that the more severe the decoding disability, the more that simultaneous processing became implicated. The students in this current study all had significant decoding difficulties (standard score <85) but there was no significant result for simultaneous processing.

One task of simultaneous processing, Matrices, as well as being a measure of simultaneous processing, has been regarded as a measure of non-verbal intelligence (Naglieri,1989a). Not surprisingly, this task also discriminated students on the basis of IQ scores, but not on reading levels. It is suggested that the number of tasks be increased and also a different selection of tasks be used for a further examination of the role of simultaneous processing in reading.

This study does not support the view that students with a reading disability have a deficit in planning. This study selected one measure of low level planning and one of high level planning and did not find that either task was able to discriminate students with a decoding disability from those students who do not have a disability. In fact, an examination of the mean scores of the two planning tasks found that, at Division II, the group of Average students with a decoding disability consistently outperformed the Average group of non-disabled students. The lack of significance for planning is important for its implication in remediation of a reading disability. It suggests that students with a decoding disability are able to use strategies. They may not make use of them appropriately during reading because their decoding difficulties interfere. Intervention efforts could likely involve the development of strategies to work around the decoding disability.

Many studies (Das, 1984; Das, Bisanz & Mancini, 1984; Kirby & Robinson, 1987; Leong, Cheng & Das, 1985; Lupart & Mulcahy, 1984; Naglieri, 1989b; Naglieri &

Das, 1988; Prewett & Naglieri, 1991) have implicated the role of planning in a reading disability. However, these studies have looked at reading from a variety of aspects rather than decoding processes only. This current study supports that of Naglieri and Reardon (1993) which found that planning did not play any significant role in the underlying processing of students who exhibited difficulty with word recognition and pseudoword reading.

The results of this study allow a discussion of the underlying cognitive processes which differentiate between those students who have a reading disability and fall within the Average range of intellectual achievement and those students who are within the Gifted category and also have a reading disability. An examination of the mean scores of both groups (see Figures 1 and 2), shows that simultaneous processing tasks and planning tasks clearly separated the two groups, and that this separation persisted across the two divisions.

An interesting question arising out of the literature has been who do the Gifted students with Reading Disabilities most closely resemble - students with reading disabilities or Gifted students? This is an important question from the point of view of appropriate educational planning. MANOVA results were significant and an examination of the mean scores by groups (Tables 3 and 4) clearly shows that the Gifted students with decoding difficulties most closely resemble the Average IQ group of students who also have decoding difficulties on tasks of successive processing. However, these same groups of Gifted students with a decoding disability most closely resemble the gifted non-disabled groups of students on the majority of tasks. The most significant results were obtained for Matrices (Simultaneous processing) and Crack-the-Code (Planning) for students in both Divisions. The task, Simultaneous Verbal, showed that the Gifted students with reading disabilities most closely resemble their gifted peers at Division II. While the same result was evidenced in Division III, the separation of the gifted group from the average group was not significant - likely due to the ceiling effect of the particular task.

Matching Numbers was also a task in which gifted students with reading disabilities more closely resembled their gifted peers. The result for Matching Numbers echoes that found by Parrila & Das (1996) which found that low level planning tasks (of which Matching Numbers is classified) is significant in discriminating groups only in the early grades.

Crack-the-Code, a task requiring high level planning, was able to differentiate groups at both divisions. Students who were gifted, regardless of whether or not they had a reading disability, had significantly superior scores.

In summary, the students with a reading disability who were also in the Very Superior level of intelligence most closely resemble other students in the same intelligence status who do not have a reading disability in simultaneous processing and planning. Their superior ranking on these tasks, however, was not sufficient to overcome their decoding difficulties as their decoding scores were similar to those of their Average peers with a reading disability.

While some of the older students in this study may have been had been assessed using the WISC-R, the younger students had been tested with the WISC-III. All of the gifted students and all of the students with a reading disability had been administered these tests. As the WISC - III test scores are lower compared with the WISC-R (Ackerman, Weir, Holloway & Dykman, 1995; Lyon, 1995; Sevier, Bain, Hildman, 1994) the possibility exists that some students in Division III who may have had scores near the borderline of the categories, ie. Gifted=IQ130, Average=IQ 85 may have been placed in different categories had the WISC - III been administered. This researcher did not have access to specific information about each student's intelligence test data. However, in order to examine the possibility of this difference having a significant effect, the mean scores of the students in the two divisions were compared to see if there was a significant pattern. The students from Division III, with IQ scores in the Very Superior range, consistently outperformed Division II except for Simultaneous Verbal which appeared to have a ceiling effect discussed previously. The Division III students with a reading disability consistently scored higher than Division II except for Crack-the-Code. The differences in these two tests were not significant.

Students who are gifted and have a learning disability have been described in various ways in the literature, making it difficult to compare studies. Baum (1984) has grouped gifted/learning disabled children into three categories: identified gifted students who have subtle learning difficulties, unidentified students whose gifts and disabilities may be masked by average achievement, and identified learning disabled students who are also gifted. Often these students were identified as gifted only after their referral for psychological assessment based on their academic difficulties. Of 106 books and journal articles written about gifted students with learning disabilities, this researcher found that only ten percent of the studies examined students who were reading below grade level. Students who have participated in studies using the PASS assessments have been from the third category. However, at the time of the studies, they have had achievement scores ranging from a fraction of a year below grade level to two or more years behind. In addition, many of these studies gave a reading score which was a combination of decoding and comprehension, thus making a determination of severity of decoding difficulties impossible to assess.

This study concentrated on category three students with significant decoding problems (standard score <85) relative to their chronological age or grade placement. Unlike previous studies, this study did not include gifted students with a reading disability for whom there was a discrepancy between potential and achievement when the discrepancy did not place those students significantly below their chronological age peers.

When the criteria for student selection was equivalent, ie. decoding scores a minimum of one year below grade level, (Das, Mishra & Kirby, 1994; Kirby & Robinson, 1987; Snart, Das & Mensink,1988) the trend has been to find successive processing to be implicated. When other factors were involved, ie. inclusion of students with comprehension difficulties (Das, Leong, & Williams, 1978; Ryckman, 1981; Bardos, in Das, Naglieri, & Kirby, 1994), and inclusion of other types of learning disabilities (Bain,1993), additional PASS processes were implicated.

Das, Naglieri, & Kirby (1994) have suggested that students with decoding problems have difficulty with successive processing and, with an increase in the severity of the disability, there is also increasing difficulty with other cognitive processes. This study does not support this contention. Snart, Das & Mensink (1988) found that students within the High IQ range had difficulty with successive processing only. In contrast, the students within the Average range had additional difficulty with planning. An examination of the two planning tasks reveals both involved the use of letters of the alphabet - an area which is weak for students with a decoding disability. In contrast, the current study did not use the alphabet in the two planning tasks.

This study also sought to examine possible differences in performance on tasks of cognitive processing using verbal and non-verbal modalities. An examination of the mean scores (see Figures 1 and 2) for these groups found no significant difference based on a Verbal, Non-Verbal differential. The lack of a significant discrepancy between tasks performed in the Verbal and Non-Verbal modes suggests that students with a decoding disability have difficulty with specific tasks regardless of the modality. This is in contrast to previous studies (Das, Mishra, & Kirby, 1994; Kirby & Das,1990) which suggest that tasks with an articulation component are poorly performed by students with a reading disability. However, this study used only a total of three tasks in the verbal mode, which included only a single task in successive processing, the area important in discriminating students with a reading disability.

Limitations of the Present Study

This study must be interpreted with caution due to several limiting factors. First, the sample size was relatively small, particularly for within group samples. The number of students with IQ scores in the Very Superior range and who additionally have a decoding disability of significance comprise a very small proportion of the population of school children. Despite this researcher's best efforts to locate a sizable number of Gifted students with a reading disability, by contacting all principals and resource teachers at the elementary level, very few were referred and even fewer agreed to participate in the study. There have been very few students at the Division II level who have been identified within the Calgary Board of Education. Additional Gifted students with learning disabilities have been identified within the CBE and referred to this researcher for consideration in the study, however, their disabilities were found to be in areas of attention, written expression and fine motor coordination.

A second limiting factor lies in gender differences. This researcher did not attempt to have the research population balanced along gender lines due to the expected small numbers of identified Gifted students with a reading disability. Most of the Gifted students at Division II were female while 11 of the 12 Gifted students with a reading disability were male. This gender discrepancy echoes Das' (1994) query as to why most of the students with a severe learning disability have been males.

A third limiting factor may lie in the division of the students along age/grade level lines. Although two broad age/grade levels were examined and significant differences were attributable to these divisions, the possibility remains that the students in grade six (Division II) may more closely resemble students in grade seven (Division III), than to students in grade four, with whom they were grouped for this study . Due to the limited numbers of Gifted students with a reading disability expected in any given population, there will likely always be a grouping of age/grade levels for research purposes.

A flaw was apparent with respect to students being assessed during two different time periods (April/May, 1996 and February/March 1997). Despite there being some ten months between assessments, this is mitigated by the realization that there is really only a two month difference in time frame in relation to the amount of time a student has been in school for any given year. That is, the students in the second round of assessment had been in school for only two months less than the students in the first round of assessment for that given year. Because none of the PASS tasks is dependent upon specific curriculum content, this two month time difference in assessment may not be significant. In order to get an indication as to its significance, the mean scores of the Gifted students without a decoding disability in Division II, who were assessed in the earlier months, were compared with the mean scores of the students who were assessed in the later months. The mean scores for the former group were the highest for seven out of the eight tasks. Their mean score on one of the tasks was even higher than Gifted students in Division III.

Another limitation of the present study was the assessment tools utilized. Due to the fact that the Das-Naglieri Assessment Battery was in the process of being published, there were restrictions on its use. This researcher developed the tasks by following the outline of the tasks from published reports and from personal communication with Dr. Das. However, it is likely that there may have been differences in the tasks from those in the Cognitive Assessment Battery.

A final limitation is a caution regarding the generalizability of this study. In particular, as this study was directed specifically to students with a decoding disability, it is not generalizable to the population of students described as learning disabled. Kavale and Forness (1984), in describing the vexing problem of heterogeneity within the learning disabilities field, call for greater efforts to be made to formalize descriptions of learning disabilities in order for a classification of subtyping to take place. This classification system should, in turn, make more relevant the wide range of activities associated with research the field of learning disabilities.

Implications

One important implication of this current study is the possible applicability in the early identification of students with a decoding disability, prior to formal reading instruction. This study found only the two tasks of successive processing were able to discriminate students with a decoding disability. The fact that these tasks do not require reading, suggests that they could be used as early identification measures in Kindergarten and Grade One, prior to formal reading instruction. Concerns have frequently been raised by researchers, parents, teachers, and students regarding early identification of students with a reading disability Hopes have been expressed that early identification will lead to earlier appropriate intervention and a consequent reduction in the affective difficulties faced by these students.

Current identification practice, within the CBE, for students with a specific learning disability, requires an expression of failure to achieve in reading. This failure in reading is usually expressed in one of several ways; in relation to chronological age peers, in relation to a particular number of grade levels below current placement (particularly difficult for those students who have been retained a year), or in relation to potential as demonstrated on an intelligence test. Once a student has been identified as having special needs, an individualized program plan (IPP) is mandated. However, the current methods by which a reading disability is expressed usually means that students have been in school at least several years prior to having their special needs formally identified.

Students with a reading disability experience emotional and/or behavioral difficulties (Coleman, 1992). These affective issues interfere in many aspects of the student's life including hindering the process of learning to read. It seems apparent that the earlier a disability is identified and appropriate remedial measures put into practice, with the presumed result of fewer or less severe reading difficulties, the less the likelihood of emotional and/or behavioral difficulties.

Affective issues are complex for gifted students who additionally have a specific learning disability (Coleman, 1992). Schiff, Kaufman and Kaufman (1981) found "the emotional issues of gifted/learning disabled students to be striking in their severity and to be more exaggerated in the pervasiveness of their impact than is typical for the conventional learning disabled population." (p.403)

Siegel (1992) has argued that there is no need for intelligence tests to be part of the identification of a reading disability. She has suggested that measures of word attack and word identification are adequate to diagnose this disability. However, Siegel's identification measures are not appropriate for students beginning, or at early levels of formal reading instruction, as they require reading.

If intelligence testing is conducted for identification purposes alone, then this study suggests that Siegel may be correct in the assumption that there is no necessity for the usual forms of intelligence testing. However, if we consider identification measures as a vital component of effective educational program planning, gathering information, not only a student's weaknesses, but also strengths, then an intelligence assessment is most appropriate.

Another implication requiring consideration concerns the role of intelligence testing in the identification of a reading disability. It is important to discuss this issue given the current trends towards "authentic assessment" and the drive towards inclusion of students with special needs in the regular classroom. These issues may arise in part given the economics surrounding education, particularly of students with special needs. Authentic assessment practices realize economic savings because no outside expert is required. The classroom teacher can conduct the assessment as part of the regular classroom practice. In the hands of a knowledgeable teacher, authentic assessment practices are valuable for diagnostic information which is directly linked to intervention.

Because assessment can occur on as frequent a basis as is required, teaching can be within the Vygotskian notion of ZPD. However, many classroom teachers have minimal knowledge of the reading process and of the processes underlying intellectual functioning. They may be aware of some of the difficulties the student has with reading yet unaware of the underlying factors. They may encounter difficulties in making connections of the cognitive processes with other curricular areas. Making the best use of the information they have acquired to plan and conduct appropriate intervention practices may be a difficult task.

The current model of requiring an individualized psychological assessment which must be done by an "expert" usually removed from the school setting, is costly, requires effort of co-ordination, and is time consuming. Because the reading disability is discrepant with this model of intelligence, it can be difficult to plan interventions.

On the other hand, with the PASS model, intelligence is consistent with a reading disability. Intelligence testing, as viewed from the PASS cognitive approach to intelligence testing, suggests that the nature of processing can alter performance. Therefore, assessment can be directly linked to remediation. The information regarding the cognitive processes implicated with a decoding disability, is directly related to intervention. Another positive consideration is that an out of school expert is not required to administer the assessment battery. A resource teacher (a teacher with some expertise and familiarity with reading and with psychological assessment) who is site-based, and who works collaboratively with the classroom teacher could administer these tasks. The resource teacher is also a member of the IPP planning team so can be involved with the process from identification, and assessment, through planning for appropriate educational interventions, and may even play a role in teaching the student

Remediation should involve not only an attempt to strengthen areas of weakness, but also involve the capitalizing on areas of strength to supplement areas of weakness, or to offer alternate methods of improvement which may circumvent or minimize working in the areas of weakness. This idea implies that, for students with a decoding disability, it is more appropriate to administer the full PASS assessment battery of tasks than just the ones which measure successive processing.

Another similar implication involving remediation, lies in the differentiation of students with a decoding disability from slow learners. There have been suggestions put forward (Stanovich, 1988) that there is little utility in discriminating students who are poor readers from slow learners. However, the implications from this current study suggest that there is utility in such a differentiation. A previously mentioned study (Naglieri, 1989a) demonstrated that slow learners perform poorly on planning tasks. This would be a limiting factor in their progress towards learning to read. The current study demonstrated that there were no significant differences in performance on planning tasks between groups of students with a reading disability and their non-disabled peers. For the student with a specific reading disability, the relative strength in planning could be a springboard into improved performance in reading.

The results of this study, in its finding that successive processing tasks are implicated in a reading disability, and that these same two tasks differentiate groups of students even at Junior High School, has implications for remediation. This study suggests that a decoding disability is linked to difficulties with a specific cognitive process (successive processing) underlying the reading disability. An implication for remediation, therefore, concerns the suggestion that improvement in successive processing may be a necessary requirement for remediation of a reading disability. Indeed, initial work in the area of remediation (Das & Conway, 1992) suggests that the remediation of successive processing resulted not only in improvement on other tasks of successive processing, but also in reading.

In contrast to some studies which suggested that students with a reading disability had difficulty with planning and its consequent involvement in using specific strategies, this current study found that students with a decoding difficulty did not perform tasks of planning to any lesser degree than groups of non-disabled students. This implies that these students are not deficient in strategy use in a general sense. They may even be knowledgeable about some specific strategies which can be employed in the reading process. However, a specific disability in successive processing, prevents or precludes them from being able to utilize these strategies with any significant degree of success during the early grades. Indeed, the students in Division II reported that they had learned how to read, although not necessarily fluently. As they still had difficulty with successive processing they may have learned to read using higher level processes such as metacognitive strategies which are part of the planning processing. The role of planning in how these students learned to read despite continued problems with word identification and/or word attack could be the subject of future research endeavors.

Implications for Future Research

In addition to the area of future research proposed above, there are other areas of significance arising from this study. A first consideration should be given to using the PASS assessment as part of a predictive study. Various studies over the years have shown that specific PASS tasks are able to differentiate groups of students. The patterns of performance for the battery of tasks are different for various groups including the learning and reading disabled. Future research projects should use a longitudinal paradigm in which the PASS tasks are administered to a group of students prior to the commencement of the formal teaching of reading. These students should then be tracked throughout their formal education to see if the assessment has predictive capabilities.

Future research in the area of remediation needs to be explored. If successive processing alone is involved in a decoding disability, the implication for remediation needs to be explored. Within this exploration there needs to be consideration of the results of remediation of successive processing alone in effecting an improvement in decoding. Consideration also needs to be given to strengthening the other three PASS areas, attention, simultaneous processing, and planning, and evaluating the results for reading improvement.

Other considerations for future research should also include an examination of the relationship of the remediation of a decoding disability, by improvement in the underlying PASS processes, to improvement in areas related to successive processing such as word encoding, for both predictable and unpredictable words.

This current study did not take gender issues into account. As there have been few previous studies into gender issues (Warrick & Naglieri, 1993), future research should examine the significance of gender in PASS assessment. Das has queried why the majority of students identified with a specific learning disability are male. Some studies have suggested that fewer females are formally identified than males due to reasons of an affective nature such as females tend to have fewer acting out behavioral problems than males. Yet another previously mentioned study (Cardon et al., 1994) examined a possible genetic link by identifying a chromosome implicated in a reading disability. As the medical field established a genetic link for the gender bias in hemophilia, so to may there be a similar finding for a reading disability. Regardless of the cause of the disability, if the underlying process implicated in a decoding disability is successive processing, then research is required to examine whether or not females have difficulty with tasks requiring successive processing in the same proportion of populations as occurs with males.

While conducting the PASS assessment, this researcher became interested in the variety of ways in which the students undertook to complete the various tasks. A sample of observed student behaviors while recalling the Word Series included rehearsing words by vocalizing them or using subvocalization, upward eye movements, closed eyes, and specific head movements. Observations of behaviors while conducting Crack-the-Code were most interesting. Students were provided with more materials than was minimally required for task completion (approximately double the number of coloured chips). Most of the students classed as gifted used the additional coloured chips to help solve the problems. In contrast, not one of the Average group took advantage of this strategy. Some students talked their way through the planning process. Some students worked on a portion of the pattern at a time, while others stared at the board, then laid down the completed pattern as a whole. After completion of the eight tasks, this researcher engaged each student in conversation about which task they found difficult or easy and how they solved each task. Most students were able to articulate a process which they were conscious of following. These observations remain anecdotal in nature. Future studies may consider capturing similar type data in a systematic form. Yet, the implications of the observations and conversations for future research is in the possible application of the PASS assessment as a diagnostic tool following a test-teach-test paradigm. This concept has greater utility in assessing potential than a single measure of ability. It falls within the parameters of Vygotsky's Zone of Proximal Development (discussed within the literature review) which, in turn, has direct application for remediation.

This study did not find significant differences in performance on tasks in verbal and non-verbal modalities. However, this study used only a total of three tasks in the verbal mode, which included only a single task in successive processing, the area important in discriminating students with a reading disability. Future research should include more tasks of successive processing in both modalities.

This study concentrated its focus on a limited conceptualization of giftedness, specifically, intellectual giftedness based on IQ scores. This same concept of giftedness has formed the basis of subject selection for previous studies. Given the various concepts of giftedness (Gardner, 1983; Sternberg, 1990), further studies are required to see if PASS assessment can discriminate between students who are gifted based on different criteria such as the verbally gifted and the mathematically gifted.

Karnes and McCallum (1983) found that using the PASS assessment with Gifted students was appealing because of its relatively culture-free assessment tasks. Future studies in the area of a specific reading disability should involve an examination of the cognitive processing of students in Canada who have come from a different culture, but who exhibit reading difficulties which are of a significantly different nature and degree from other students of a similar cultural background. In addition, because of its lack of sensitivity to items of a specific knowledge base, PASS assessment may be a valuable tool for use with students from a low socio-economic background.

Conclusion

Gallagher (1991) eloquently stated that "the stories of lost potential, of what might have been are some of the most poignant in literature. The presence of unused potential is a tragedy at both the personal and political level of society." (p. 221) Although Gallagher was referring to gifted underachievers, the same sentiment holds true for students with specific learning disabilities. These students have potential. The PASS cognitive assessment battery has the potential to assist educators not only in the identification of students with special needs, but to guide appropriate educational interventions so that these students can succeed in reaching their potential.

References

Ackerman, P., Weir, N., Holloway, C., & Dykman, R. (1995). Adolescents earlier diagnosed as dyslexic show major declines on the WISC-III. *Reading and Writing: An Interdisciplinary Journal, 7*, 163-170.

Adams, M. (1990). *Beginning to read: Thinking and learning about print.* Urbana- Champaign: University of Illinois.

Allington, R. (1991). Beginning to read: A critique by literacy professionals and a response by Marilyn Jager Adams. *The Reading Teacher, 44*, 370-395.

Ashman, A., & Das, J. (1980). Relation between planning and simultaneous successive processing. *Perceptual and Motor Skills, 51*, 371-382.

Auerbach, E. (1989). Toward a social-contextual approach to family literacy. *Harvard Educational Review*, 59, 105-151.

Ayers, R., Cooley, E., & Severson, H. (1988). Educational translation of the Kaufman Assessment Battery for Children : A construct validity. *School Psychology Review, 17*, 113-124.

Bain, S. (1993). Sequential and simultaneous processing in children with learning disabilities: An attempted replication. *The Journal of Special Education, 27*, (2), 235-246.

Barkley, R. (1990). *Attention Deficit Hyperactivity Disorder: A Handbook for Diagnosis and Treatment.* NY: Guilford Press

Barton, J., & Starnes, W. (1989). Identifying distinguishing characteristics of gifted and talented/learning disabled students. *Roeper Review, 12*, 23-29.

Baum, S. (1984). Meeting the needs of disabled gifted students. *Roeper Review, 7*, 6-19.

Belmont, J., & Butterfield, E. (1977). The instructional Approach to developmental cognitive research. In Kail & J Hagen (Eds.), *Perspectives on the development of memory and cognition.* Hillside, NJ: Erlbaum.

Berk, R. (1983). Learning disabilities as a category of underachievement. In L. Fox, L. Brody, & D. Tobin, (Eds.), *Learning disabled/gifted children: Identification and programming*. (pp. 51 - 76) Baltimore: University Park Press.

Boodoo, G., Bradley, C.,Frontera, R., Pitts, J., & Wright, L. (1989). A survey of procedures used for identifying gifted learning disabled children. *Gifted Child Quarterly, 33,* 110-114.

Borkowski, J., & Cavenaugh, J. (1979). Maintenance and generalization of skills and strategies by the retarded. In N. Ellis (Ed.), *Handbook of Mental Deficiency; Psychological theory and research.* (pp. 135 - 162). Hillsdale, NJ: Erlbaum.

Bracken, B. (1985). A critical review of the Kaufman Assessment Battery for Children (K-ABC). *School Psychology Review, 14,* 21-36.

Brailsford, A. (1981). The relationship between cognitive strategy training and performance on tasks of reading comprehension with a learning disabled group of children. Unpublished masters thesis, University of Alberta, Edmonton.

Brailsford, A., Snart, F., & Das, J. (1984). Strategy training and reading comprehension. *Journal of Learning Disabilities, 17,* 287-290.

Bruck, M. (1990). Word recognition skills of adults with childhood diagnoses of dyslexia. *Developmental Psychology, 26,* 434-454.

Cardon, L., Smith, S., Fulker, D., Kimberling, W., Pennington, J. (1994). Qualitative trait locus for reading disability on Chromosome 6. *Science. 266*, 276-279.

Cardon, L., DiLalla, L., Plomin, R., DeFries, J., & Fulker, D. (1990). Genetic correlations between reading performance and IQ in the Colorado Adoption Project. *Intelligence, 14,* 245-257.

Castell & Luke (1983). Defining "Literacy" in North American Schools: Social and Historical Conditions and Consequences. *Journal of Curriculum Studies, 15,* 373-89.

Clarizio, H., & Bennett, D. (1987). Diagnostic utility of the K-ABC and WISC/PIAT in determining severe discrepancy. *Psychology in the Schools, 24,* 309-314.

Coleman, M. (1992). A comparison of how gifted/LD and average/LD boys cope with school frustration. *Journal for the Education of the Gifted, 15*, 239-265.

Crawford, S., & Das, J. (1992). Teaching for transfer: A program for remediation in reading. *Advances in Cognition and Educational Practice, 1*, 73-103.

Crawford, S., & Snart, F. (1994). Process-based remediation of decoding in Gifted LD students: Three case studies. *Roeper Review, 16*, 247-252.

Cummins, J., & Das, J. (1977). Cognitive processing and reading difficulties: A framework for research. *The Alberta Journal of Educational Research, 23*, 245- 256.

Cummins, J., & Mulcahy, R. (1979). Simultaneous and successive processing and narrative speech. *Canadian Journal of Behavioral Science, 11*, 64-71.

Das, J. (1972). Patterns of cognitive ability in nonretarded and retarded children. *American Journal of Mental Deficiency, 77*, 6-12.

Das, J. (1973). Structure of cognitive abilities: Evidence for simultaneous and successive processing. *Journal of Educational Psychology, 65*, 103-108.

Das, J. (1980). Planning: Theoretical considerations and empirical evidence. *Psychological Research, 41*, 141-151.

Das, J. (1984). Simultaneous and successive processing in children with reading disability. *Topics in Language Disorders, 4*, 34-47.

Das, J. (1985). Aspects of Digit-Span performance:Naming time and order memory. *American Journal of Mental Deficiency, 89*, 627-634.

Das, J. (1988). Simultaneous-successive processing and planning. In R. Schmeck (Ed.), *Learning styles and learning strategies* (pp. 101-129). New York: Plenum.

Das, J., Bisanz, G., & Mancini, G. (1984). Performance of good and poor readers on cognitive tasks: Changes with development and reading competence. *Journal of Learning Disabilities, 17*, 549-555.

Das, J., Cummins, J., Kirby, J., & Jarman, R. (1979). Simultaneous and successive processes, language and mental abilities. *Canadian Psychological Review,* 20, 1-11.

Das , J., & Conway, N. (1992). Reflections on remediation and transfer: A Vygotskian perspective. In H. Haywood, & D. Tzuriel, *Interactive Assessment.* (pp. 94-118). New York: Springer-Verlag.

Das, J., & Heemsbergen, D. (1983). Planning as a factor in the assessment of cognitive processes. *Journal of Psycho-Educational Assessment, 1*, 1-16.

Das, J., Kirby, J., & Jarman, R. (1975). Simultaneous and successive synthesis: An alternative model for cognitive abilities. *Psychological Bulletin, 82*, 87-103.

Das, J., Kirby, J., & Jarman, R. (1979). *Simultaneous and successive cognitive processes*. New York: Academic Press.

Das, J., Leong, C., & Williams, N. (1978). The relationship between learning disability and simultaneous-successive processing. *Journal of Learning Disabilities, 11*, 618-625.

Das, J., Mensink, D., & Mishra, R. (1990). Cognitive processes separating good and poor readers when IQ is covaried. *Learning and Individual Differences, 2,* 423-436.

Das, J., Mensink, D., & Janzen, H. (1990). The K-ABC, coding, and planning: An investigation of cognitive processes. *Journal of School Psychology, 28*, 1-11.

Das, J., Mishra, R., & Pool, J. (1995). An experiment on cognitive remediation of word-reading difficulty. *Journal of Learning Disabilities, 18*, 66-79.

Das, J., Mishra, R., & Kirby, J. (1994). Cognitive patterns of children with dyslexia: A comparison between groups with high and average nonverbal intelligence. *Journal of Learning Disabilities, 27,* 235-242.

Das, J., & Molloy, G. (1975). Varieties of simultaneous and successive processing in children. *Journal of Educational Psychology, 67,* 213-220.

Das J., & Naglieri, J. (1997) *The Das-Naglieri Cognitive Assesment System (Experimental edition).* IL: Riverside Publishing.

Das J., & Naglieri, J. (1992) Assessment of attention, simultaneous-successive coding, and planning. In H. Haywood, & D. Tzuriel, *Interactive Assessment.* (pp. 207-232). New York, Springer-Verlag.

Das , J., Naglieri, J., & Kirby, J. (1994). *Assessment of Cognitive Processes: The PASS Theory of Intelligence.* MS: Allyn and Bacon.

Das, J., & Siu, I. (1989). Good and poor readers' word naming time, memory span, and story recall. *Journal of Experimental Education, 4,* 101-114.

Das, J., Snart, F., & Mulcahy, R. (1982). Reading disability and its relation to information integration. In J. Das, R. Mulcahy, & A. Wall (Eds.), *Theory and research in learning disabilities.* (pp. 85-110). New York: Plenum Press.

Detterman, D. (1989). The future of intelligence research. *Intelligence, 13,* 199-203.

Drummond, L. (1995) *Gifted/Learning disabilities: A quasi meta-analysis.* Unpublished document.

Edelsky, C. (1992). A talk with Carole Edelsky about politics and literacy. *Language Arts, 69,* 324-329.

Fall, J., & Nolan, L. (1993). A paradox of exceptionality. *Gifted Child Today, 16,* 46-49.

Fawcett, A., & Nicholson, R. (1995). Persistence of phonological awareness deficits in older children with dyslexia. *Reading and Writing: An Interdisciplinary Journal,* 7, 361-376.

Fedorak, G.& Yewchuck, C. (1986). The gifted learning disabled: Identification and instruction. *Education Canada, 26,* 25-29.

Fisher, G., Jenkins, S., Bancroft, M., & Kraft, L. (1988). The effects of K-ABC based remedial teaching strategies on word recognition skills. *Journal of Learning Disabilities, 21,* 307-312.

Friedman, M., Das, J., & O'Connor, N. (1981). *Intelligence and learning.* New York: Plenum Press.

Frith, U. (1992). Cognitive development and cognitive deficit. *The Psychologist, 5,* 13-19.

Gagné, F. (1985). Giftedness and talent: Reexamining a reexamination of definitions. *Gifted Child Quarterly, 29,* 103-112.

Gallagher, J. (1991). Personal patterns of underachievement. *Journal for the Education of the Gifted, 14,* 221-233.

Gardner, H. (1983). *Frames of mind: The theory of multiple intelligences.* New York: Basic Books.

Garofalo, J. (1986). Simultaneous synthesis, regulation and the factor arithmetical performance. *Journal of Psychoeducational Assessment, 4,* 229-238.

Gersons-Wolfensberger, D. & Ruijssenaars, W. (1997). Definition and treatment of dyslexia: A report by the Cmmittee on Dyslexia of the Health Council of the Netherlands. *Journal of Learning Disabilities, 30,* 209-213.

Gilger, J., Pennington, B., & Defries, J. (1991). Risk for reading disability as a function of parental history in three family studies. *Reading and Writing: An Interdisciplinary Journal, 3,* 205-217.

Gonzalez, J., & Hayes, A. (1988). Psychosocial aspects of the development of gifted underachievers: Review and implications. *Exceptional Child, 35,* 39-51.

Goodman, K. (1967). Reading: A psychological guessing game. *Journal of the Reading Specialists, 4,* 126-135.

Gunnison, J., Kaufman, N., & Kaufman, A. (1982). Reading remediation based on sequential and simultaneous processing. *Academic Therapy, 17,* 297-306.

Hansford,S., Whitmore, J., Kraynak, A., & Wingenbach, N. (1987). Intellectually gifted learning disabled students: A special study. (ERIC Document Reproduction Service No. 287242).

Humphries, T., & Bone, J. (1988). Use of IQ criteria for evaluating the uniqueness of the learning disability profile. *Journal of Learning Disabilities, 26*, 348-51.

Hunsberger, M. (1992). Teaching Reading Methods: How do pre-service teachers understand the experience of learning to read? *Journal of Educational Thought, 22*, 209-218.

Hunt, D. (1980). Intentional learning and simultaneous-successive processing. *Canadian Journal of Behavioral Science, 12*, 373-383.

Hunt, D., & Randhawa, B. (1983). Cognitive processes and achievement. *The Alberta Journal of Educational Research, 29*, 206-228.

Jarman, R. (1980). Cognitive Processes and syntactic structure: Analyses of syntactic and paradigmatic associations. *Psychological Research, 41*, 153-169.

Jarman, R., & Das, J. (1977). Simultaneous and successive synthesis and intelligence. *Intelligence, 1*, 151-169.

Karnes, F., & McCallum, R. (1983). Evidence for the Luria-Das model of information processing for gifted students: A preliminary investigation. *Educational and Psychological Research, 3*, 133-137.

Kaufman, A. (1979). *Intelligent testing with the WISC-R.* New York: John Wiley.

Kaufman, A., & Kaufman, N. (1983). *Kaufman Assessment Battery for Children.* Circle Pines, MN : American Guidance Service.

Kaufman D., & Kaufman, K. (1978). Strategy training and remedial techniques. *Journal of Learning Disabilities, 16*, 72-78.

Kaufman D., & Kaufman, K. (1979). Strategy Training and Remedial Techniques. *Journal of Learning Disabilities, 12*, 63-66.

Kavale, K. & Forness, S. (1984). A meta-analysis of the validity of Weschler Scale profiles and recategorizations: Patterns or parodies? *Learning Disability Quarterly*, *7*, 136-151.

Kirby, J., Booth, C., & Das, J. (1996). Cognitive processes and IQ in reading disability. *The Journal of Special Education, 29*, 442-456.

Kirby, J., & Das, J. (1977). Reading achievement, IQ, and simultaneous-successive processing. *Journal of Educational Psychology, 69*, 564-570.

Kirby, J., & Das, J. (1978). Information processing and human abilities. *Journal of Educational Psychology, 70*, 58-66.

Kirby, J., & Das, J. (1990). A cognitive approach to intelligence: Attention, coding and planning. *Canadian Psychology, 31*, 320-332.

Kirby, J., & Gordon, C. (1988). Text segmenting and comprehension: Effects of reading and information processing abilities. *British Journal of Educational Psychology, 58*, 287-300.

Kirby, J., & Robinson, G., (1987). Simultaneous and successive processing in reading disabled children. *Journal of Learning Disabilities, 20*, 243-252.

Kirby J., & Williams, W. (1991). *Learning problems: A cognitive approach.* Toronto: Kagan and Woo Ltd.

Kranzler, J., & Weng, L. (1995). Factor structure of the PASS cognitive tasks: A reexamination of Naglieri et al. (1991). *Journal of School Psychology, 33*, 143-156.

Krywaniuk, L. (1974). *Patterns of cognitive abilities of high and low achieving school children.* Unpublished doctoral dissertation, University of Alberta, Edmonton.

Krywaniuk, L., & Das, J. (1976). Cognitive strategies in native children: Analysis and information. *Alberta Journal of Educational Research, 22*, 271-280.

LaBerge,D., & Samuels, J. (1974). Toward a theory of automatic information processing in reading. *Cognitive Psychology, 6*, 293-323.

LaBuda, M., & DeFries, J. (1988). Genetic and environmental etiologies of reading disability: A twin study. *Annals of Dyslexia,* 38, 131-135.

Leasak, J., Hunt, D., & Randhawa, B. (1982). Cognitive processing, intervention and achievement. *The Alberta Journal of Educational Research, 28,* 257-266.

Leong, C. (1976/1977). Spatial-temporal information-processing in children with specific reading disability. *Reading Research Quarterly, 2,* 204-215.

Leong, C., Cheng, S., & Das, J. (1985). Simultaneous-successive synthesis and planning in Chinese readers. *International Journal of Psychology, 20,* 19-31.

Lovett, M., Warren-Chaplin, P., Ransby, M., & Borden, S. (1990). Training the word recognition skills of reading disabled children: Treatment and transfer effects. *Journal of Educational Psychology, 82*, 769-780.

Lovett, M., Ransby, M., Hardwick, N., Johns, M., & Donaldson, S. (1989). Can dyslexia be treated? Treatment-specific and generalized treatment effects in dyslexic children's response to remediation. *Brain and Language, 37,* 90-121.

Lupart, J. (1990). An in-depth assassment model for gifted/learning disabled students. *Canadian Journal of Special Education*, 6, 1-14.

Lupart, J & Mulcahy, R. (1984). Some thoughts on research in learning disabilities and attention. In J. Kirby (Ed.), *Cognitive strategies and educational performance*. (pp. 211 - 249). New York: Academic Press Inc.

Luria, A. (1966). *Human brain and psychological processes.* New York: Basic Books.

Luria, A. (1973). *The working brain: An introduction to neuropsychology*. New York: Basic Books.

Luria, A. (1974). Language & brain: Towards the basic problems of neurolinguistics. *Brain and Language, 1*,1-14.

Luria, A. (1980). *Higher cortical functions in man* (2nd ed.). New York: Basic Books.

Lyon, M. (1995). A comparison between WISC-III and WISC-R scores for Learning Disabilities reevaluations. *Journal of Learning Disabilities, 28,* 253-255.

Madigan, D. (1992). Family uses of literacy: A critical voice. In C. Kinzer & D. Leu (Eds.) *Literacy research, theory, practice: Views from many perspectives. Forty-first yearbook of the National Reading Conference (pp. 87-100).* Urbana-Champaign, IL: National Reading Conference.

Marland, S. (1971). *Education of the gifted and talented - Volume 1. Report to the congress of the United States by the U. S. Commissioner of Education.* Washington, D.C.: US Goverment Printing office.

Mather, N., & Udall, A., J. (1985). The identification of gifted underachievers using the Woodcock-Johnson Psycho-Educational battery. *Roeper Review, 8,* 54-56.

Naglieri, J. (1985a). Use of the WISC-R and K-ABC with learning disabled, borderline mentally retarded, and normal children. *Psychology in the Schools, 22,* 133-141.

Naglieri, J. (1985b). *Matrix analogies test-Expanded form.* New York: The Psychological Corporation.

Naglieri, J. (1989a). A cognitive processing theory for the measurement of intelligence. *Educational Psychologist, 24,* 185-206.

Naglieri, J. (1989b). Planning, attention, simultaneous, and successive cognitive processes: A summary of recent studies with exceptional samples. *The Mental Retardation and Learning Disability Bulletin, 17,* 3-22.

Naglieri, J., Braden, J., & Warrick, P. (1991). Confirmatory factor analysis of the planning, attention, simultaneous, and successive (PASS) cognitive processing model.. *Journal of School Psychology, 29,* 1-17.

Naglieri, J., & Das, J. (1987). Construct and criterion related validity of planning, simultaneous and successive cognitive processing tasks. *Journal of Psychoeducational Assessment, 4,* 353-363.

Naglieri, J., & Das, J. (1988). Planning-arousal-simultaneous-successive (PASS): A model for assessment. *Journal of School Psychology, 26,* 35-48.

Naglieri, J. & Das, J. (1990). Planning, attention, simultaneous, and successive, (PASS) cognitive processes as a model for intelligence. *Journal of Psychoeducational Assessment. 8,* 303-337.

Naglieri, J., Das, J., & Jarman, R. (1990). Planning, attention, simultaneous, and successive cognitive processes as a model for assessment. *School Psychology Review, 19,* 423-442.

Naglieri, J., Das, J., Stevens, J., & Ledbetter, M. (1991). Confirmatory factor analysis of planning, attention, simultaneous, and successive cognitive processing tasks. *Journal of School Psychology, 29,* 1-17.

Naglieri, J., Prewett, P., & Bardos, A. (1989). An exploratory study of planning, attention, simultaneous, and successive cognitive processes. *Journal of School Psychology, 27,* 347-364.

Naglieri, J., & Reardon, S. (1993). Traditional IQ is irrelevant to learning disabilities - intelligence is not. *Journal of Learning Disabilities, 26,* 127-133.

Olson, R., Wise, B., Conners, F., Rack, J., & Fulker, D. (1989). Specific deficits in component reading and language skills: Genetic and environmental influences. *Journal of Learning Disabilities, 22, 339-348.*

Parrila, R. & Das J. (in press). Development of planning and its relation to other cognitive processes.

Prewett, P., & Naglieri, J. (1991). Relationship between planning, simultaneous, and successive processes and academic achievement with normal, reading disabled, and developmentally handicapped students. *Journal of Learning Disabilities, 22*, 469-479.

Pyryt, M. (1995, April). *MANOVA in gifted education research: Applications and Analysis*. Paper presented at the annual meeting of the American Educational Research Association, San Francisco.

Renzulli, J. (1978). What makes giftedness? Reexamining a definition. *Phi Delta Kappan, 60,* 180-184.

Rosenblatt, L.(1985). Writing and Reading: The Transactional theory.(ERIC Document Reproduction Service No. ED292062).

Rummelhart, D. (1985). Toward an interactive model of reading. In H. Singer and R. Ruddell (Eds.), *Theoretical models and processes of reading*. (pp.722 - 750). Newark, NJ: International Reading Association.

Ryckman, D. (1981). Reading achievement, IQ, and simultaneous-successive processing among normal and learning-disabled children. *The Alberta Journal of Educational Research, 27,* 74-84.

Samuels, S., & Miller, N. (1985). Failure to find attention differences between learning disabled and normal children on classroom and laboratory tasks. *Exceptional Children, 51*, 358-375.

Schiff, M., Kaufman, A., Kaufman N. (1981). Scatter analysis of WISC-R profiles for learning disabled children with superior intelligence. *Journal of Learning Disabilities, 14,* 400-404.

Schofield, N., & Ashman, A. (1986). The relationship between digit span and cognitive processing across ability groups. *Intelligence, 10,* 59-73.

Schofield, N., & Ashman, A. (1987). The cognitive processing of gifted, high average, and low average ability students. *British Journal of Educational Psychology, 57,* 9-20.

Schuerholz, L., Harris, E., Baumgardner, T., Reiss, A., Freund, L., Church, R., Mohr, J., & Bridge D. (1995). An analysis of two discrepancy-based models and a processing-deficit approach in identifying learning disabilities. *Journal of Learning Disabilities, 28*, 18-29.

Semel, E., Wiig,E., & Secord, W. (1987). *Clinical Evaluation of Language Fundamentals-Revised.* San Antonio, TX: Psychological Corporation.

Senf, G. (1983). The nature and identification of learning disabilities and their relationship to the gifted child. In L. Fox, L. Brody, & D. Tobin, (Eds.), *Learning disabled/gifted children: Identification and programming.* (pp. 37 - 50). Baltimore: University Park Press.

Sevier, R., Bain, S., & Hildman, L. (1994). Comparison of WISC-R and WISC-III for Gifted students. *Roeper Review, 17*, 39-42.

Shapiro, K., Ogden, N., Fain, L. (1990). Temporal processing in Dyslexia. *Journal of Learning Disabilities, 23*, 99-107.

Siegel, L. (1989). *IQ is irrelevant to the definition of learning disabilities.* Journal of Learning Disabilities, 22, 469-478.

Siegel, L. (1992). An evaluation of the discrepancy definition of dyslexia. *Journal of Learning Disabilities, 25*, 618-628.

Silver, S. J., & Clampit, M. K. (1990). WISC-R profiles of high ability children: interpretation of verbal-performance discrepancies. *Gifted Child Quarterly, 34*, 76-79.

Silverman, L. (1989). Invisible gifts,invisible handicaps. *Roeper Review, 12*, 37-42.

Solan, H. (1987). A comparison of the influences of verbal-successive and spatial-simultaneous factors on achieving readers in fourth and fifth grade: A multivariate correlational study. *Journal of Learning Disabilities, 20*, 237- 243.

Snart, F. (1994, November). *Successive processing ability, IQ,and reading level in gifted and normal achieving children.* Paper presented at the biannual meeting of the Canadian Council for Exceptional Children. Calgary, AB.

Snart, F., & Das, J. (1994). A neurocognitive approach to the assessment of intelligence. *Exceptionality Education Canada, 4,* 99-109.

Snart, F., Das, J., & Mensink, D. (1988). Reading disabled children with above-average IQ: A comparative examination of cognitive processing. *The Journal of Special Education, 22,* 344-357.

Spencer, F., Snart, F., & Das, J. (1989). A process-based approach to the remediation of spelling in students with reading disabilities. *The Alberta Journal of Educational Research, 35,* 269-282.

Stanovich, K. (1988). Explaining the differences between the dyslexic and the garden - variety poor reader: The phonological-core variable-difference model. *Journal of Learning Disabilities, 21*, 590-604.

Stanovich, K. (1990). A call for the end to the paradigm wars in reading research. *Journal of Reading Behavior, 22*, 221-230.

Stanovich, K. (1991). Discrepancy definitions of reading disability. *Reading Research Quarterly, 8*, 11-24.

Sternberg, R. (1990). *Toward a triarchic theory of human intelligence.* New York: Cambridge University Press

Stevenson, J. (1991). Which aspects of processing text mediate genetic effects. *Reading and Writing: An Interdisciplinary Journal, 3*, 249-269.

Stroop, J. (1935). Studies of inference in serial verbal reactions. *Journal of Experimental Psychology, 18*, 643-661.

Tannenbaum, A. & Baldwin, L. (1983). Giftedness and learning disability: A paradoxical combination. In L. Fox, L. Brody, & D. Tobin (Eds.), *Learning disabled/gifted children: Identification and programming.* (pp. 11 -36). Baltimore: University Park Press.

Teale, W. (1987). Emergent literacy: Reading and writing development in early childhood. In J. Readence & R. Baldwin (Eds.), *Research in Literacy: Merging perspectives. Thirty-sixth yearbook of The National Reading Conference.* (pp. 45-74). NewYork: National Reading Conference.

Thorndike, R., Hagen, E., & Sattler, J. (1985). T*he Stanford Binet (4th ed.)* Chicago: Riverside Publishing.

Torgesen, J. (1989). Why IQ is relevant to the definition of learning disabilities. *Journal of Learning Disabilities, 22*, 484-486.

Torgesen, J., Wagner, R., Simmons, K., & Laughton, P. (1990). Identifying phonological coding problems in disabled readers: Naming, counting, or span measures? *Journal of Learning Disabilities, 22*, 166-68,75.

Varnhagen, C., Das, J., & Varnhagen, S. (1987). Auditory and visual memory span: Cognitive processing by TMR individuals with Down Syndrome or other etiologies. *American Journal of Mental Deficiency*, 91, 398-405.

Vaughn, S. (1989). Gifted learning disabilities: Is it such a bright idea? *Learning Disabilities Focus, 4*, 123-126.

Vygotsky, L. (1978). *Mind in society: The development of higher psychological processes.* Cambridge, MA: Harvard University Press.

Watson, C., & Willows, D. (1995). Information-processing patterns in specific reading disability. *Journal of Learning Disabilities, 28,* 216-231.

Warrick, P., & Naglieri, J. (1993). Gender differences in planning, attention, simultaneous, and successive (PASS) cognitive processes. *Journal of Educational Psychology, 85*, 693-701.

Wechsler, D. (1974). *Wechsler Intelligence Scale for Children - Revised.* NewYork: The Psychological Corporation.

Wechsler, D. (1991). *Wechsler Intelligence Scale for Children - Third Edition.* San Antonio, TX: The Psychological Corporation.

Whitmore, J. (1985). *Underachieving gifted students.* (Eric Document Reproduction Service No. 246606).

Whitmore, J. & Maker, J. (1985). *Intellectual giftedness in disabled persons.* Rockville, MD: Aspen Systems.

Wong, B. (1992). The role of regular classroom teachers in promoting strategy transfer in students with learning disabilities. In *Schools in Transition: Rethinking Regular and Special Education - Suggested Readings of the Guest Lecturers - Fall Colloquium 1992.* Calgary: Centre for Gifted Education, The University of Calgary.

Woodcock, R. (1987). *Woodcock reading mastery tests-Revised.* Circle Pines, MN: American Guidance Service.

Woodcock, R. & Johnson, M. (1977). *Woodcock Johnson psycho-educational battery.* Allen, TX: DLM Teaching Resources.

Yewchuck,C. (1984). Learning disabilities among gifted children.*Special Education in Canada, 58,* 95-96.

Ysseldyke, J. (1983). Current practices in making psychoeducational decisions about learning disabled students. *Journal of Learning Disabilities, 16,* 226- 233.

Appendix A

Dear Parent/Guardian:

My name is Lorraine Drummond. I am a teacher with the Calgary Board of Education and a graduate student in the Department of Educational Psychology at the University of Calgary, conducting a research project under the supervision of Dr. M. Pyryt as part of the requirements for a M.Sc. degree. I am writing to provide information regarding my research project "Cognitive Processes of Children With Reading Decoding Difficulties: A Comparison between Groups of Average and Gifted Intelligence Across Three Age/Grade Ranges" so that you can make an informed decision regarding your son/daughter's participation.

The purpose of the study is to examine tasks which may aid in the identification of students with a reading disability. In addition, this research seeks to find out if these tasks remain the same regardless of age or grade level or level of intelligence. Your daughter/son has been nominated by your school as a participant in this study as he/she has been identified as intellectually gifted. As part of the study, students will be asked to perform such tasks as point to pictures, arrange items in a series, find a specific picture on a page, and repeat sentences. These procedures will take approximately one-half hour at a time agreeable to all concerned parties.

Data will be gathered in such a way as to ensure anonymity. This will involve your daughter/son being assigned a number so that all tasks performed will be identified by number only. Once collected, responses will be kept in the strictest confidence, only group results will be reported in any published studies. The raw data will be kept in a locked filing cabinet in this researchers home and will be accessible only to this researcher. All files will be destroyed after two years completion of the study.

You should be aware that even if you give your permission, your son/daughter is free to withdraw at any time for any reason without penalty. Participation in this study will involve no greater risks than those ordinarily experienced in daily life.

If you have any questions, please feel free to contact me at 288-4034, my supervisor Dr. M. Pyryt at 220-5661, the Office of the Chair, Faculty of Education Joint Ethics Committee, at 220-5626, or the Office of the Vice-President at 220-3381. Two copies of the consent form are provided. Please return one signed copy to your child's school, and retain the other copy for your records.

Thank you for your cooperation

Sincerely,

Lorraine Drummond

Appendix B

Consent for Research Participation

I/We, the undersigned, hereby give my/our consent for ______________________ to participate in a research project entitled "Cognitive Processes of Children With Reading Decoding Difficulties: A Comparison between Groups of Average and Gifted Intelligence Across Three Age/Grade Ranges."

I/We understand that such consent means that ________________ will be involved in working through various tasks that examine different ways that students attend to, plan, and process information. These tasks may include pointing to pictures, arranging items in a series, finding a specific picture on a page, or repeating sentences. The approximate time to complete these tasks is thirty minutes. These will be done at the student's school during the day at a mutually agreeable time which may include recess, spares, lunch hour, or after school.

I/We understand that participation in this study may be terminated at any time by my/our request, or of the researchers. Participation in this project and/or withdrawal from this project will not affect my/our request or receipt of other services from the school board or university.

I/We understand that this study will not involve any greater risks than those ordinarily occurring in daily life.

I/We understand that the responses will be obtained anonymously and kept in the strictest confidence.

I/We understand that only group data will be reported in any published reports.

I/We understand that all raw data will be kept in a locked filing cabinet and destroyed after two years after publication of study results.

I/We have kept a copy of this consent form for my/our records. I/We understand that if at any time I have questions, I can contact the researcher at 288-4034 in the evenings, or the supervisor, Dr. M. Pyryt at 220-5661, the Office of the Chair, Faculty of Education Joint Ethics Committee, at 220-5626, or the Office of the Vice-President at 220-3381.

______________________ ______________________

signature of parent/guardian signature of parent/guardian

______________________ ______________________

date date

Appendix C

SCHOOL, PARENT AND STUDENT INFORMATION

GATE PROGRAM

The Gate Program has been established in three congregated settings by the Calgary Board of Education. Admission to the GATE Program is based on special need's criteria for those children in grades 4 through 9 who are intellectually gifted.

REFERRAL PROCEDURES

The Admissions Committee reviews all referrals to the GATE Program. Referrals are made through the School Resource Group in consultation with the Parents and should be submitted by March 14, 1997 for both elementary and junior high school placements (grades 4 through 9). The committees will determine the applicants to be admitted to GATE.

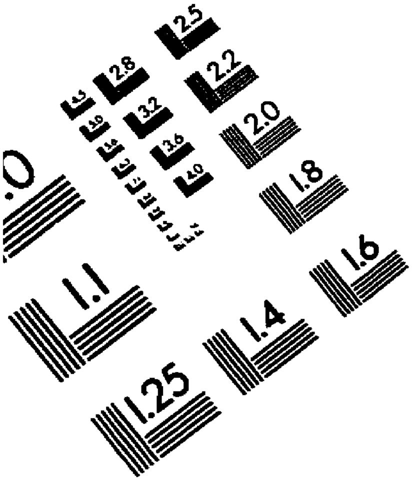
Criteria for placement in the program include:

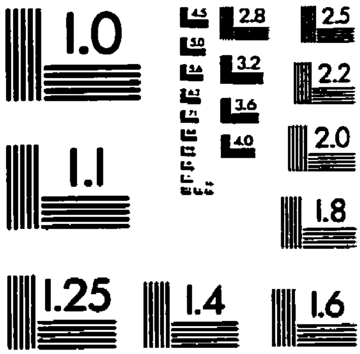
. Very superior scores on an individual psychological assessment (WISC-III)
. school nomination form in support of the GATE program
. parent nomination form in support of the GATE program
. student written response
. an IPP submitted from referring school by June 30, 1997

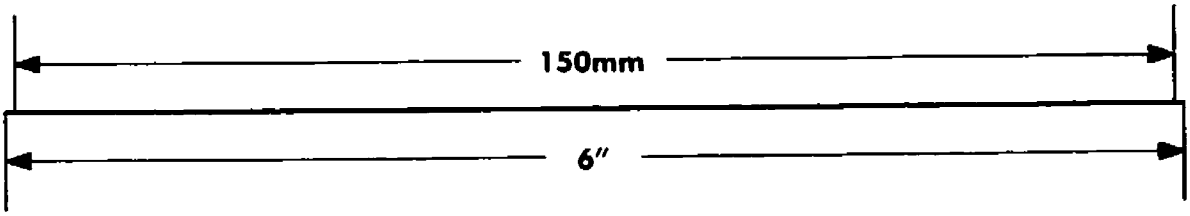
Applicants often demonstrate some of the following characteristics:

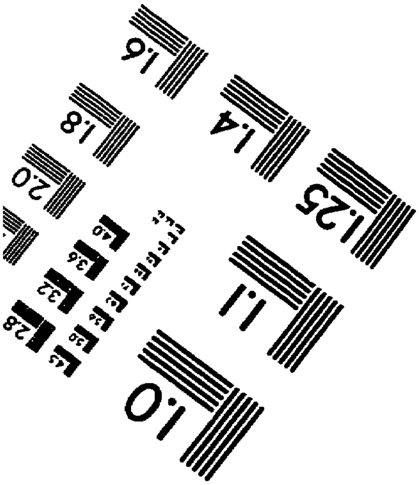
. evidence of strong task commitment
. resourcefulness (e.g. flexible and original thinking)
. demonstrated ability to work and think independently
. risk-taking in thinking and in action
. a high level of curiosity
. appropriate behavior in a variety of settings

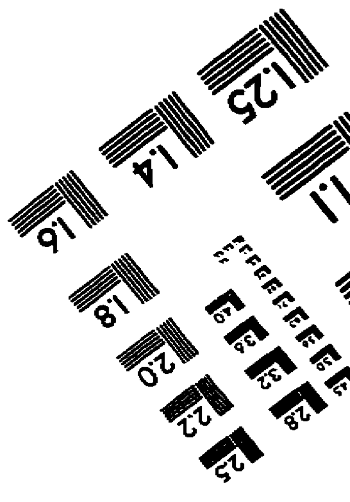
IMAGE EVALUATION
TEST TARGET (QA-3)











APPLIED IMAGE . Inc
1653 East Main Street
Rochester, NY 14609 USA
Phone: 716/482-0300
Fax: 716/288-5989