READING AND ORAL LANGUAGE SKILLS OF YOUNG ADULTS WITH CHILDHOOD
DIAGNOSES OF DYSLEXIA: DEVELOPMENTAL AND COMPENSATORY PATTERNS

by

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ABSTRACT

The construct of compensation was adopted as a theoretical point of reference in a follow-up study of young adults with childhood diagnoses of developmental dyslexia (AD). Using a reading-level (RL) and chronological age-matched (CA) design, the AD’s connected discourse reading skills were evaluated to determine the extent to which they were appropriate for their age and for their level of word recognition skill. The AD sample was expected to present with deficient word recognition and lower-order oral language skills. It was also expected that individual differences in connected discourse reading achievement and information processing would be associated with differences in oral language skills. Specifically, it was expected that the AD subjects with the best connected discourse reading skills would be those with the best general knowledge and higher-order oral language skills. It was also expected that the AD would present with qualitatively different information processing to compensate for weaknesses in lower-order language and phonological coding.

Consistent with predictions, the AD group fell significantly behind the CA group on most aspects of reading skill for both accuracy and rate. The connected discourse reading achievement levels of the AD group were comparable to the younger RL group (mean age 12 years). The AD subjects, however, fell significantly below the RL group on phonological coding. For the most part, the oral language and general information skills of the AD group were comparable to the RL group. However, the AD group had significantly better scores on two measures of vocabulary knowledge. As predicted, the AD participants with the best reading comprehension skills were those with the best higher-order oral language skills. When AD subjects encountered connected discourse reading tasks for which the accuracy and speed requirements were demanding, the best predictors of reading achievement outcomes were word recognition and spelling skills. Although the achievement outcomes of the AD group were comparable to the RL group, their information processing was characterized as being qualitatively different. The
results were interpreted as providing support for a model of dyslexic reading that features an interactive-compensatory component.
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CHAPTER ONE

Developmental dyslexia or specific reading disability is one of the most common diagnoses of childhood psychopathology (American Psychiatric Association, 1994). Children who suffer from this disorder have difficulty acquiring reading skills despite average to superior intellectual ability and adequate social and educational opportunities. Although the nature of the disorder in childhood is relatively well understood, less is known about its long term consequences. This study was designed to extend our knowledge of the long term outcomes of developmental dyslexia. The study focuses on connected discourse reading skills in the early adult years. Of particular interest was the extent to which young adults with childhood diagnoses of developmental dyslexia recover from, or compensate for, their childhood reading deficits.  

A. BACKGROUND AND RATIONALE FOR THE STUDY

1. Follow-up Studies

Although some follow-up studies of children with various types of learning disabilities, including developmental dyslexia, have been conducted (see Maughan, 1995; Schonhaut & Satz, 1983; Spreen, 1988 for reviews), the majority of these studies have dealt with educational and occupational outcomes. The results from these studies indicate that the most favourable outcomes in young adulthood are associated with high

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1 The wording 'young adults with childhood diagnoses of dyslexia' is attributed to Bruck (1990; 1992; 1993) and is used in this document to describe a similar sample.
parental socioeconomic status (SES), secondary school graduation, strong parental support, and the continuation of literacy activities in either occupational or educational settings.

2. Persistence of Word Recognition Problems

Less than half a dozen follow-up studies, however, have reported data on the actual reading skills of adults with documented childhood diagnoses of dyslexia (Bruck, 1990; 1992; Felton, Naylor & Wood, 1990; Kinsbourne, Rufo, Gamzu, Palmer & Berlinger, 1991; Lefly & Pennington, 1991). Despite the relatively small number of studies, the consensus is that the majority of adult dyslexics have persistent problems in word recognition and spelling. They also appear to be impaired in several of the skills and processes that are thought to underlie word recognition skill. These include phonological awareness, phonological coding, rapid naming of letters, and knowledge of sound-symbol correspondences. Furthermore, it has been reported that phonological awareness and phonological coding (nonword reading) are poorer than expected for their age as well as their level of word recognition skill (Bruck, 1990; 1992). Thus, it appears that almost all young adults with childhood diagnoses of developmental dyslexia will be impaired to some degree in word recognition accuracy and/or rate.

3. Reading of Connected Discourse

Although there is some consistent evidence to suggest that persistent deficient single word recognition skills and processes may be inevitable sequelae of developmental dyslexia, there is less evidence to indicate how well adult dyslexics are able to read larger units of text (e.g., sentences, paragraphs, chapters and books). Lefly and Pennington (1991) reported that some dyslexics were able to achieve oral text reading

---

2 The term 'reading of connected discourse' refers to the reading of sentences, paragraphs and stories as opposed to single words or phrases. In this document it may be used interchangeably with contextual reading, or reading of prose.
scores (i.e., Gray Oral Reading Test: GORT) that were comparable to nondyslexic adults on accuracy but inferior on rate. These "compensated" dyslexics also scored as well as normal controls on a silent reading sentence comprehension measure (i.e., Peabody Individual Achievement Test). Other adult dyslexics in their sample were inferior to the compensated dyslexics on all of these text reading measures. Kinsbourne et al. (1991) identified two groups of young adults with childhood reading problems. One group performed at age appropriate levels on the GORT (i.e., Gray Oral Reading Test) and were referred to as "recovered dyslexics". A second group had persistent connected discourse reading skill deficits and thus were labelled "severe dyslexics". Bruck (1990) also found a great deal of variability in the silent reading comprehension skills of a sample of adult dyslexics who were enrolled in a Canadian university. Scores ranged from grade six to college level. These scores were comparable to those achieved by Scarborough's (1983) sample of dyslexics with self-reported rather than documented childhood reading problems. What remains unclear is why some young adults, with childhood histories of reading disabilities, are able to achieve connected discourse reading skill levels that approach the levels of normal adults, and often exceed their own levels of word recognition skill, while others do not.

4. What Predicts Connected Discourse Reading Skill of Adult Dyslexics?

Among samples of normal adult college readers, one of the best predictors of reading comprehension skill is word recognition skill (Cunningham, Stanovich & Wilson, 1990). This trend stands in contrast to Bruck's (1990) finding that there was little association between word recognition skill and reading comprehension skill in a sample of adult dyslexics. That is, some adult dyslexics with very low levels of word recognition skill scored well on the reading comprehension measure while others did not. This dissociation of word recognition skill and connected discourse reading skill has also been noted in a sample of adolescent
dyslexics (Conners & Olson, 1990). It appears, therefore, that for this population, connected discourse reading outcomes cannot be reliably predicted from word recognition skills. This prompts one to ask what other factors account for the variability in connected discourse reading outcomes among adult dyslexics.

5. The Role of Oral Language and Cognitive Skills in Reading: Empirical

Among studies of normal adult readers there is considerable evidence indicating that higher level oral language skills, (including listening comprehension, speed of lexical access, vocabulary and working memory) (Baddeley, Logie, Nimmo-Smith & Brereton, 1985; Cunningham et al., 1990; Daneman & Carpenter, 1980; Palmer, McLeod, Hunt & Davidson, 1985; Bell & Perfetti, 1994), together with word recognition skill (Cunningham et al., 1990), account for a large proportion of the variance in reading comprehension skill. In contrast, there are limited data to indicate what levels of oral language skill are acquired by adult dyslexics. It is, therefore, difficult to determine the extent to which differences in oral language skills contribute to variations in connected discourse reading skill levels among adult dyslexics. It has been suggested, however, that child dyslexics with the best adult prognoses are those with the best higher-level oral language skills and the best general information or "world knowledge" (Bruck, 1990). This suggestion was offered, in part, because of the finding that the best reading comprehenders in Bruck's dyslexic sample had the highest receptive vocabulary and childhood IQ scores. Thus, Bruck suggested that the best connected discourse reading comprehenders were able to compensate for their deficits in word recognition skill by relying on their higher-order oral language skills. This particular compensation hypothesis, however, was not directly tested.
Oral language skills and the notion of compensation are central themes in recent theories and models of reading that attempt to account for individual differences in reading skill. In the first section of Chapter Two, a historical overview of theories and models of skilled reading is presented. This section of the chapter also traces the evolution of two theories that make predictions about the way in which deficient readers function. While early models of skilled reading posited that the reading system was driven exclusively by either lower level skills (e.g., Gough, 1972) or higher level skills (Smith, 1973), more recent models stipulate that readers draw on information from both lower level (e.g., perceptual features) and higher level (e.g., vocabulary) sources. These models of skilled reading are classified as interactive models (e.g., Rumelhart, 1977).

Stanovich's (1980) interactive-compensatory model builds on the work of Rumelhart (1977) but adds a compensatory assumption. The essence of this assumption is that a reader who has a deficit in any knowledge source, whether it be lower-order or higher-order, will be more reliant on other knowledge sources. Considerable support for the interactive-compensatory model has accumulated over the last decade (see Stanovich, 1991b, for a recent review). This model, however, was developed to explain compensation and individual differences in reading at the word level.

While Stanovich's (1980) interactive-compensatory model makes predictions about the way in which a deficient reader functions at the word level, Perfetti's (1985; 1988) verbal efficiency theory implicitly does so for text. Although Perfetti's model is interactive in nature, it emphasizes the importance of the lower level or "local processes" and the limitations of a limited capacity system. The model stipulates that individual differences in reading efficiency will depend upon individual differences
in local processes (i.e., word recognition, vocabulary knowledge and word retrieval). If the local processes are weak, then working memory resources must be devoted to this relatively low level of processing leaving fewer resources available for higher level processing such as integrating larger units of text and making inferences about the content. Although verbal efficiency theory does not explicitly incorporate a compensatory assumption, the theory predicts that adult dyslexics with the poorest word recognition skills and vocabulary knowledge will be the least likely to become good reading comprehenders even if their higher level skills are strong.

Although the notion that some adult dyslexic readers can compensate for their poor word recognition skills by drawing on good oral language skills is intuitively appealing, both the empirical literature (Bruck & Waters, 1990; Bruck, 1990; Lovett, 1987) and the theoretical literature (Perfetti, 1985; 1988) suggest that this may be difficult to do. First, many investigators have noted that most dyslexic children also suffer from a range of oral language (Lovett, 1987; Mattis, French & Rapin, 1975; Vellutino, 1979) and working memory deficits (Swanson, 1992). These deficits may be either an antecedent (Scarborough, 1990) or a consequence of reading failure (Stanovich, 1986). If these oral language deficits also persist into the adult years, it may be difficult to find strengths upon which to draw in order to compensate for poor word recognition skills in adulthood. Bruck (1990) has also speculated that a certain minimum level of word recognition skill may be necessary in order to take advantage of higher-order skills to enhance accurate and efficient reading comprehension.

7. Connected Discourse Reading Skills of Adult Dyslexics: What to Expect

In summary, very little is known about the levels of connected discourse reading skill that are achieved by adult dyslexics. The few
empirical investigations that have included samples of young adults with childhood diagnoses of dyslexia suggest that there is a great deal of variability in skill levels that cannot be reliably predicted by word recognition scores. Instead, both the empirical and the theoretical literature suggest that oral language and cognitive skills may play an important role in determining connected discourse reading outcomes for this population. Although it has been suggested that adult dyslexics draw on oral language skills to compensate for deficits in word recognition skill, most of these suggestions await empirical support.

8. The Unanswered Questions

Although deficient word recognition skill appears to be one inevitable outcome for young adults with documented diagnoses of developmental dyslexia, poor connected discourse reading comprehension outcomes do not necessarily follow. Evidence for this conclusion is derived from two types of data. First, correlations between word recognition and reading comprehension outcomes are weak (Bruck, 1990). Second, some investigators have reported that a certain proportion of dyslexic children have "recovered" from (Kinsbourne et al., 1993), or "compensated" for (Lefly & Pennington, 1991), their childhood deficits by the time they reach the young adult years. What remains unclear, however, is what accounts for the range of individual differences in connected discourse reading outcomes. These variable outcomes could be attributed to measurement errors associated with: (1) psychometric differences in reading measures across studies; (2) inconsistencies in criteria for childhood diagnoses; or (3) misrepresentations in self-reported histories of dyslexia. On the other hand, the variable connected discourse reading outcomes could be associated with variations in cognitive and oral language skills thought to be associated with reading.
Although it has been suggested that many adult dyslexics draw on oral language and cognitive skills to compensate for deficient word recognition skill, there are limited data to indicate what levels of oral language skill are actually acquired by adult dyslexics, particularly for higher-order oral language skills. There is some evidence, however, to indicate that specific lower-order language skills, including phonological awareness and rapid naming skills, are impaired. Furthermore, there is a great deal of evidence to indicate that the majority of dyslexics have associated speech and language problems in childhood. On the other hand, most dyslexic children have Verbal IQ scores in the normal range. Thus, it is difficult to predict what levels of oral language skill can be expected in the adult years.

Nevertheless, the role of verbal and cognitive skills are central in contemporary interactive and interactive-compensatory theories of individual differences in reading. Thus, it is likely that a better understanding of connected discourse reading skill outcomes of adults with childhood diagnoses of dyslexia will be reached if individual differences in these associated skills are also considered. What remains unclear is the way in which higher-order and lower-order cognitive and language skills interact when this population reads connected discourse. Since both the empirical and the theoretical literature suggest that readers who have deficiencies in some aspect of reading skill may compensate for these deficits, this study was designed, in part, to test some compensation hypotheses.

9. What is Compensation?

In previous research the term compensation has been used with a variety of implied meanings with some similarities and some differences across studies. First, there seems to be implicit agreement that compensation is a relative term. That is, in each of the studies of adult
dyslexics, subjects who were thought to be compensators were those whose performance was better relative to some other group. Bruck's (1990) good compensators performed better than another group of adult dyslexics on silent reading comprehension. Conners and Olson's (1990) dyslexic adolescents performed better than a younger group of reading-level (based on word recognition skill) normal controls on a measure of sentence comprehension. They were said to have "compensated for" their word recognition deficits. Lefly and Pennington (1991), however, included a group of "compensated" dyslexics in their sample. Compensation in this context referred to having done better than expected given their childhood difficulties. Thus, in three different studies, there were three different standards against which the compensating adult and adolescent dyslexics were compared but in each of these examples, the achievement outcome was better than the comparison group.

Bruck (1990), however, also noted some performances that were not significantly different from the chosen standard and one that was worse than the chosen standard. In the former instance, the adult dyslexics, as a group, were not significantly better than the reading-level controls on silent reading comprehension. In the latter instance, the adult dyslexics were found to have pseudoword or nonword reading skills that were worse than the reading-level controls (Bruck, 1990). Thus, Bruck (1990) argued that they had achieved their word recognition skills by relying more on orthographic skills rather than phonological skills. That is their word recognition skills were not quantitatively different from the reading-level controls but they appeared to have arrived at the same skill level by different routes.

Since the term compensation has been used with a variety of connotations, some clarification of its use in this study is necessary. When researchers refer to recovered dyslexics (Kinsbourne, 1991) or
compensated dyslexics, they are referring to the individuals' adult achievement levels relative to age-matched controls and/or their own childhood achievement levels. When compensation is used in this context, no assumptions are made about the manner in which the individuals were able to achieve better than expected outcomes. The label compensated or recovered dyslexic is assigned when quantitative achievement levels are evaluated relative to a certain achievement standard or a matched control group. This is the recovery connotation. A second connotation for compensation refers to the counterbalancing nature of the information processing while reading. Conclusions about the nature of information processing are more difficult to interpret because they are usually inferential. In this study, compensatory processing is inferred when the performance of the adult dyslexics differs significantly from reading-level controls on any, or all, of the following: (1) the speed of reading; (2) achievement levels in associated cognitive and language skills; or (3) the strength of, or the nature of, the relationships between connected discourse reading skills and oral language/cognitive skills. Thus, for this study two connotations of compensation will be considered: (1) the recovery connotation in achievement outcomes; and (2) the counterbalancing connotation in information processing.

10. Purpose of the Study

The majority of previous follow-up studies of adults with childhood diagnoses of dyslexia have focussed on word recognition and spelling outcomes. Thus, the purpose of this follow-up study is to extend our knowledge of the connected discourse reading skills of adults with documented childhood diagnoses of dyslexia. The study is designed so that both achievement outcomes and information processing can be examined. Of particular interest is the extent to which adults with childhood diagnoses of developmental dyslexia recover from, and/or compensate for, their childhood deficits. It was hypothesized that individual and group
differences in connected discourse reading achievement and information processing can be attributed, to some extent, to differences in oral language and cognitive skills.

B. THE GENERAL RESEARCH QUESTIONS

The overriding questions for this study are: (1) How well do young adults with childhood diagnoses of developmental dyslexia read connected discourse? (2) What best accounts for individual and group differences in outcomes? and (3) To what extent do adult dyslexics use compensatory processing when reading connected discourse?

C. PARTICIPANTS AND RESEARCH DESIGN

A reading-level and chronological age-matched design was the methodological vehicle through which the research questions were explored. In this follow-up study, a sample of young adults who were diagnosed with developmental dyslexic at an average age of nine years was assessed. All of the dyslexic participants attended the Kenneth Gordon School for an average of three years during childhood. The Kenneth Gordon School is a private elementary school that specializes in the treatment and remediation of children with developmental dyslexia. At follow-up their mean age was nineteen. To determine the extent to which they have recovered from, or compensated for, their early childhood deficits their performances were contrasted with two control groups. The first control group consisted of young people who were the same age as the Kenneth Gordon alumni and the second control group consisted of younger children and adolescents who had the same level of word recognition skill as the Kenneth Gordon alumni. Individual differences within the alumni sample were also examined.
D. SPECIFIC RESEARCH QUESTIONS AND HYPOTHESES

The following questions are posed in this study. Following each question set the respective hypotheses are presented.

1. **Question Set One: Hypothesis One**

   1) What levels of skill do adult dyslexics achieve on various aspects of connected discourse reading? To what extent are these levels appropriate for their age and their level of word recognition skill?
   It was hypothesized that the connected discourse reading skills of this sample would not be appropriate for their age but would be appropriate for their level of word recognition skill.

2. **Question Set Two: Hypothesis Two**

   What levels of skill do adult dyslexics achieve on higher-order and lower-order oral language and cognitive skills? To what extent are these levels appropriate for their age and their level of word recognition skill?
   It was hypothesized that the adult dyslexics would have higher-order cognitive and oral language skills that were close to being age appropriate but lower-level oral language skills that were worse than expected for both their age and for their level of word recognition skill.

3. **Question Set Three: Hypothesis Three**

   What cognitive and oral language skills best account for individual differences in connected discourse reading skill among adult dyslexics?
   It was hypothesized that those with the best reading comprehension skills would be those with the strongest cognitive and oral language skills. This is the Bruck (1990) compensation hypothesis.
4. **Question Set Four: Hypothesis Four**

What is the nature of the relationship between oral language/cognitive skills and connected discourse reading outcomes among adult dyslexics? To what extent do these relationships resemble those found among normally achieving younger children and adolescents with similar levels of word recognition skill? Is there any evidence for compensatory processing among the adult dyslexics? It was hypothesized that the relationships between connected discourse reading skills and oral language/cognitive skills would vary by group. It was hypothesized that relatively good lower-order language skills would be associated with better connected discourse reading outcomes for the adult dyslexics (AD). In contrast, it was hypothesized that good higher-order language skills would be associated with better outcomes for the normally developing children and adolescents (RL). Furthermore, if the achievement levels of the AD group and the RL group are comparable but, the relationships between and among associated skills are significantly different, the adult dyslexics may be demonstrating compensatory processing.

**E. DISCUSSION**

It is expected that the results from this study will provide information that will enhance both our clinical and our theoretical knowledge about developmental dyslexia. These data will provide clinicians with some guidelines concerning the long term prognoses for children with developmental dyslexia. The data will also allow us to draw some conclusions about the manner in which adults with childhood diagnoses of dyslexia process information as they read connected discourse.
A. THEORIES AND MODELS OF THE READING PROCESS

1. Introduction

The complexity of the reading act has captured the interest of psychologists for several decades. As early as 1886, Cattell conducted a series of investigations on letter and word recognition, the legibility of letters, and attention span. In the same year, he published a seminal paper entitled "The Time It Takes to See and Name Objects" (Cattell, 1886 cited in Venezsky, 1984). By 1908, Huey had published what has become a classic book on reading (Huey, 1908/1968) which, in retrospect, is remarkable for its detail, its rigor, and its scope.

Although the study of reading never actually escaped the interest of psychologists during the first half of the century, the field attracted a great deal more attention at the beginning of the 1970s (see Venezsky, 1984 for a historical review) in response to theoretical developments in cognitive psychology (Neisser, 1967), psycholinguistics (Chomsky, 1970) and, somewhat later, in artificial intelligence (Rumelhart, 1977). Several theories and models of skilled reading were formulated during this era. The following section of this chapter will provide a brief historical overview of the theories and models that were precursors to three theories which are relevant to the present study: (1) Stanovich's Interactive-Compensatory model (1980); (2) Perfetti's Verbal Efficiency theory (1985; 1988); and
Conners and Olson's (1990) extended model of the Simple View of Reading (Hoover & Gough, 1990).

2. Types of Reading Models

The early models of skilled reading were classified as either bottom-up (e.g., Gough, 1972) or top-down models (e.g., Smith, 1973). This nomenclature refers to the direction in which information was thought to flow during the reading process. In bottom-up models, for instance, it was posited that the reading process was initiated by the processing of low level perceptual features and then it proceeded in stages to levels of processing which were conceptually more complex. In top-down models, the information flow proceeded from higher level processes to lower level processes. Later models that became known as interactive models (Rumelhart, 1977) portrayed the information flow as bi-directional. None of the early models, with the possible exception of Laberge and Samuel's (1974) model, made any attempt to explain how information was processed in deficient readers. In the 1980's, however, a few models did attempt to explain individual differences in reading skills. In the next section of this chapter, four types of models are reviewed: (1) top-down; (2) bottom-up; (3) interactive; and (4) interactive models that focus on individual differences.

3. Gough's Model

Gough's (1972) model was an attempt to describe the cognitive and perceptual processes that are involved in "ONE SECOND OF READING" in a fluent individual. The model posits that two parallel systems, a visual system and a vocal system, execute serial processes that eventually result in reading comprehension. In each of the two systems, the fundamental perceptual processes are executed first. After the lower level perceptual processes, such as visual pattern recognition and phonological rule decoding, have been executed, the higher level cognitive processes become involved. While Gough provided exceedingly detailed explanations of the
lower level perceptual processes in this uni-directional model, he was (by his own admission) somewhat vague about the way in which the fluent reader understands the meaning of text. In fact, he refers to this aspect of the model using mystical terminology. "Some wondrous mechanism" (p. 519), which he labels "Merlin", operates on semantic and syntactic information and deposits it in the "ultimate register" which he refers to as PWSGWTAU (i.e., the place where sentences go when they are understood).

Although this model has many shortcomings, it was considered noteworthy because of its detailed description of some of the perceptual processing involved in reading (Rumelhart, 1977) and for its attempt to consider both perception and cognition in the same model. It was subsequently criticized, however, for its serial nature and for its linear view of the relationship between perception and cognition (Lovett, 1981; Rumelhart, 1977).

There appears to be little support for the class of models, to which Gough's model belongs, that characterize the reading process as strictly "bottom-up". Subsequent empirical investigations have convincingly demonstrated that perception and cognition are more interactively entwined. For instance, letter combinations that form words or pseudowords and adhere to patterns in English orthography are more readily learned and recalled than random letter strings (see Samuels & Kamil, 1984 for a review). Moreover, evidence from analyses of oral reading errors have consistently demonstrated that there is a tendency to substitute syntactically similar errors when committing word recognition errors in the context of meaningful text (Kolers, 1970 cited in Samuels & Kamil; Weber, 1970 cited in Samuels & Kamil, 1984). Our perception of words is also influenced by the semantic context of text with some contexts making our processing more efficient and others making it less efficient (Rumelhart, 1977).
4. **Smith's Model of Skilled Reading**

At about the same time as Gough's model of reading was developed, another class of models evolved that could be characterized as conceptual counterpoints to the bottom-up models. These "top-down" or "analysis-by-synthesis" (Lovett, 1981) models, like the bottom-up models, were linear and uni-directional in nature. Smith (1971) defined the fluent reader "as a person who is able to make optimal use of all the redundancy available in a passage of text" (p. 213). Rather than conceptualizing the reading process as proceeding from the lower level perceptual features to meaning and comprehension, Smith's model posited that the higher level cognitive processes initiate and drive the reading process in fluent readers.

"Reading is not a matter of going from words to meaning, but rather from meaning to words", he claimed (Smith, 1971, p. 35). Smith also argued that nonfluent readers were more dependent on the visual or perceptual features of text whereas more fluent readers were more dependent on the context. The fluent reader, he argued, could take advantage of the knowledge of the redundancy in the text together with higher level cognitive skills and knowledge sources to form hypotheses about the meaning of the text. This model of reading, which is described in detail in several sources (Smith, 1971; 1973; 1975), as well as Goodman's notion of reading as a "psycholinguistic guessing game" (Goodman, 1973) became very influential, particularly in the educational community.

Their descriptions of fluent reading as a top-down process, however, were not supported by subsequent empirical work. In fact, the bulk of the evidence indicates that the skilled reader is very aware of details at the level of the word and the letter. Moreover, it appears to be the less skilled or deficient reader, rather than the skilled fluent reader, who is more reliant on context and semantic cues to assist word recognition (see Stanovich, 1980 for a critical review).
5. Laberge and Samuels’ Model

Laberge and Samuels (1974) developed a model of reading that became very influential for researchers with developmental and pedagogical interests. Moreover, it may be considered the theoretical forerunner of many other models of reading that emphasize the limited capacity of human cognitive resources.

The model focuses on the mechanisms by which a reader becomes fluent and has a much more dynamic flavour than some of its theoretical predecessors (e.g., Gough, 1972). The model posits that visual information is transformed through a series of stages involving a multimodal memory system. Each of these memory systems (i.e., visual, phonological and episodic) are described in some detail. For instance, the visual system proceeds in sequential steps from feature detectors, to letter codes, to a spelling pattern code and finally to a visual word code before it reaches the semantic system where it is finally understood. The critical aspect of the Laberge and Samuels model is the attention centre which is assumed to play a major role during the learning phases of reading but later becomes "expendable" (p.297). According to the model, as a reader becomes more skilled or fluent, less attention is devoted to each successive stage.

Laberge and Samuels (1974) contended that two criteria of learning to read should be considered in a developmental model: (1) accuracy and (2) automaticity. In the early stages of learning to read, that is, working toward the accuracy criterion, considerable amounts of attention are required. Another capacity demanding task of the developing reader is the re-organization or chunking of word or word units into larger units of phrases or clauses. Once the accuracy criterion is attained, however, less attention is required. Eventually after repeated exposures or practice, the reader pays little conscious attention to the task. According to the model, when all levels of processing operate automatically and fluently, attention
can then be devoted to efficient and continuous processing of the semantic aspects of text. In other words, if letter and word recognition is automatic, more attentional capacity is available to process word and sentence meanings.

Although the Laberge and Samuels (1974) model focuses on the lower level perceptual features, on letters, and on words, it was intended to be generalized to the higher-order processes that the authors claim must also become automatic for fluent reading. Although the model was subsequently updated to include some of the higher level processes (Samuels, 1977 cited in Stanovich, 1980), the updated model has not been very influential in comparison with the 1974 version. Superficially, the model appears to be a bottom-up linear stage model, but on closer examination, there are aspects of the model which suggest that Laberge and Samuels acknowledged that top-down and bottom-up processes were possibly interactive (Lovett, 1981). As Rumelhart (1977) points out, however, this acknowledgement is not the focal point of the paper since it is expressed in a small footnote which claims that "attention is momentarily focused on comprehension in SM (semantic memory)" (Laberge and Samuels, 1974, p.312).

Another feature of the model that distinguishes it from its bottom-up predecessors is its description of optional processing routes of the pathways from graphemic stimulus to meaning. This aspect of the model allows certain stages in the process to be by-passed and was therefore thought to be more consistent with empirical findings in word recognition (Lovett, 1981). These optional processing routes also represented an attempt to account for individual differences in reading which had not been previously addressed in other models.
Laberge and Samuels (1974) made two major contributions to the evolving theoretical models. First, they drew attention to the importance of automatized functions in a limited capacity system. In addition, they attempted to address some of the developmental issues that had not previously been considered in models of reading.

6. Rumelhart's Model

It was Rumelhart's contention that many of the models which predated his 1977 model were linear and uni-directional, not so much because their architects did not recognize the interaction between cognition and perception, but rather because the contemporary formalisms or representations were seriously limited in the extent to which they could adequately represent the complex nature of the reading process. Flow charts, he argued, are better suited to linear stage models. Because there were many results in the empirical literature that strongly suggested a complex interaction between higher level and lower level processes, he set out to develop a more suitable formalism that could capture the nature of these complex relationships. His purpose in writing his 1977 paper, "Toward an Interactive Model of Reading", was to suggest a formalism that would be more appropriate for modelling the reading process. Rumelhart suggested that the formalisms that were developed in the artificial intelligence tradition, specifically parallel computing applications, would provide psychologists with a more suitable form of representation. The model itself was designed, therefore, as a prototype for future models, not so much for its content as for its form. In retrospect, however, Rumelhart's model appears to have made a significant contribution to the theoretical tradition in reading for both its substantive content and its form.

The model draws heavily on two computer models that were originally developed to explain specific aspects of natural language processing: (1) The GSP, General Syntactic Processor, which was developed by Kaplan (1973,
cited in Rumelhart, 1977) and (2) HEARSAY II developed by Reddy and his associates at Carnegie-Mellon University. Rumelhart's bidirectional model posits that knowledge, from both lower level and higher level information sources, is sent to a central message centre which Rumelhart calls the "pattern synthesizer". This message centre is represented in three dimensional space and is conceptualized as a hypothesis evaluation mechanism. Taking multiple information sources (e.g., semantic, syntactic, letter string order) into consideration in an interactive fashion, the task of the message centre is to form hypotheses about the text that is being read. These hypotheses are then evaluated and the most likely hypothesis is accepted as the text representation. The hypothesis evaluation procedure, according to Rumelhart, is a computational one. Using Bayesian probability, both contextual and direct evidence are considered in the equation in a multiplicative relationship. The accepted hypothesis is the one which receives the highest score in this computational process. That is "when some criterion strength-value is obtained an hypothesis can be accepted and no further processing need be required" (p. 602).

Despite its recognized limitations, including its failure to be detailed enough to generate specific predictions and its reliance on models of oral rather than written language, the Rumelhart model has been praised for its bidirectional nature (Stanovich, 1980) and for the way in which it has conceptualized partial processing (Lovett, 1981). Moreover, the interactive component of the model was subsequently incorporated into the interactive-compensatory model (Stanovich, 1980).

7. Stanovich's Interactive-Compensatory Model

Although Laberge and Samuels' (1974) model addressed individual and developmental differences in reading to some extent, Stanovich's model is distinguished by its focus on individual differences and its attempt to explain deficient reading irrespective of the origins of the deficiency.
Consequently, this model has implications for the questions that are being posed in the present study of adults with childhood diagnoses of dyslexia.

Stanovich (1980) devotes a large portion of the paper, in which he presents the interactive-compensatory model, to reviewing a diverse body of empirical literature. First, he concludes that there is little support for either top-down or bottom-up models of reading. He then presents his own model, which takes advantage of the conceptual and representational gains of Rumelhart's (1977) interactive model, and then adds the dimension of compensation. Compensation is the element of greatest interest for explaining and potentially predicting the performance of deficient or disabled readers. This model represents the first serious attempt to account for both skilled and unskilled reading.

In the first section of the paper, Stanovich attempts to reconcile an apparent paradox in the empirical findings which were inconsistent with the predictions from top-down models of reading. Smith's (1971) model predicted that the fluent reader relied very heavily on context when reading text, not only for comprehension, but also for facilitating ongoing word recognition. Stanovich (1980) presents evidence which supports the former claim but which refutes the latter. Paradoxically, he argues, it is the less fluent reader who is more dependent on context particularly when lower level information sources such as word recognition are weak, as compared to higher level sources such as syntactic and semantic information. The reason why good readers are less dependent on context to facilitate word recognition is that the direct recognition of words is actually faster and more efficient than the hypothesis testing process suggested by Smith (1971). Stanovich's argument relies heavily on the distinction between the use of context for overall comprehension that is used for constructing a knowledge structure of the text (e.g., semantic integration), as opposed to the use of context for the facilitation of word recognition. Stanovich
argues that neither top-down nor bottom-up models are supported by empirical work and that an interactive model with a compensation assumption has greater explanatory power, particularly for deficient readers. Specifically, it is better able to account for the heterogeneity issue in dyslexic readers (Lovett, 1981).

Stanovich's model is a derivative of both the Laberge and Samuels' (1974) developmental model and Rumelhart's (1977) interactive model. The concepts of automaticity, of limited cognitive resources, and of interactive processing continue to be critical concepts in several developmental theories of reading although the emphasis has tended to change over time in response to more recent empirical and theoretical work (Stanovich, 1990). The notion of compensation, however, appears to be Stanovich's unique contribution and will continue to be an important concept in my discussion of adult dyslexics with childhood diagnoses. The essence of the model is best expressed in Stanovich's own words:

Interactive models best exemplified in the work of Rumelhart (1977), assume that a pattern is synthesized based on information from several knowledge sources. The compensatory assumption states that a deficit in any knowledge source results in a heavier reliance on other knowledge sources, regardless of their level in the processing hierarchy. Thus, according to the interactive-compensatory model, the poor reader who has deficient word analysis skills might possibly show a greater reliance on contextual factors (p. 63). The present model might best be conceptualized as a limited-capacity model with interactive-compensatory processing at the word level" (p. 58).

Stanovich's interactive-compensatory model attempts to explain individual differences in the way in which readers use information to recognize single words. The notion that deficient readers may compensate for deficient lower level processes by drawing on higher level processes is the essence of the model. The model, however, does not address how lower order skills and higher order skills might interact when reading larger units of text such as paragraphs and chapters. Perfetti's verbal efficiency
theory, however, does address individual differences in the reading of connected discourse.

8. Perfetti's Verbal Efficiency Theory

While Stanovich's model provides an account of interactive-compensatory processing in a limited capacity system at the word level, for both skilled and unskilled readers, Perfetti's model attempts to explain the processes involved in the reading of connected discourse. It is designed as a general theoretical model for explaining individual differences in reading. According to Perfetti (1988), "the central claim of the theory of verbal efficiency is that individual differences in reading comprehension are produced by individual differences in the efficient operation of local process" (p. 119). These "local processes" include semantic encoding (including lexical access which may be impaired in dyslexic readers), propositional encoding and integrative processes. If any of these processes requires substantial working memory resources, then the cost of devoting attention to these processes is a reduction in the efficiency of reading comprehension.

Perfetti (1988) argues that schema theory, which enjoys considerable popularity in some models of reading comprehension, should not be emphasized in a theory of reading that attempts to account for individual differences. Although he acknowledges the literature that indicates that reading comprehension depends on knowledge, he argues that "individual differences in specific knowledge cannot be the central explanatory factor in reading ability" (p. 117). The main difficulty with the schema explanation is that it cannot account for the observation that some readers can recall and comprehend text for which they do not have specific prior knowledge. Perfetti argues for a more generalized reading skill with efficiency defined as "the quality of processing outcome in relation to the
cost of processing resources" (p. 132).

Verbal efficiency theory, therefore, does not discount the role of schema activation in general comprehension and in reading comprehension but, rather shifts the emphasis away from schema theory toward cognitive resources, automaticity and attentional allocation. The theory posits that the different components of the reading process make varying demands on attention and memory, and that with practice and learning the demands on some components of the system can be reduced. For instance, Perfetti claims that lexical access and schema activation are potentially low cost components. In the population, which is the focus of the present study, however, one cannot assume that lexical access will be a low cost component since a large proportion of adult dyslexics appear to have difficulties with word recognition skills and some have poor receptive vocabulary (Bruck, 1990). Thus, in this population, semantic encoding may actually be a high cost item in the currencies of attention and memory. The consequence for this, or any other high cost component, is less efficient text reading accuracy, comprehension and speed.

In contrast to semantic encoding and schema activation in skilled readers, propositional encoding is expected to be a high resource cost component of the reading process. In skilled readers, semantic encoding will require few memory and attentional resources thus leaving more resources available for propositional encoding, a more resource demanding process.

Perfetti’s verbal efficiency theory suggests, therefore, that the adult dyslexic is at a significant disadvantage when reading connected discourse, particularly if several “local processes” are deficient. Moreover, even if the adult dyslexic does have relatively strong higher level conceptual skills, he/she may not be able to take advantage of these
skills if significant working memory resources must be devoted to lower level processing particularly word recognition. Since Perfetti emphasizes the importance of the "local processes" in reading comprehension, the theory predicts that adult dyslexics with the most impaired word recognition and vocabulary knowledge will be disadvantaged. On the other hand, the theory suggests that those with good working memory skills and/or efficient local processes may have an advantage.

Although Perfetti's theory does not directly address the issue of compensation, it does suggest that age appropriate connected discourse reading achievement levels may be difficult to accomplish without superior higher level skills and working memory resources, together with some minimum level of lower level skills, including word recognition (see also Bruck, 1990) and lexical access. Although the theory is an interactive theory, it is somewhat asymmetrical (Perfetti & Roth, 1987), since it places considerably more emphasis on lower level or "local processes" including word recognition and word knowledge, than it does on higher level functions such as sentence integration. Like Laberge and Samuels (1974), Perfetti emphasizes the importance of automatized lower level functions in the development of skilled connected discourse reading.

Thus, verbal efficiency theory has some important implications for understanding the long term prognoses for dyslexic readers who appear to have persistent word recognition skill deficits. The theory predicts that the dyslexic reader will be unlikely to read connected discourse efficiently if word recognition skills are weak. In Perfetti's model efficient reading is both accurate and fluent. Thus, in the present study both accuracy and speed criteria will be considered in the assessment of connected discourse reading skills in a sample of adults with childhood diagnoses of dyslexia.
9. Conners and Olson's Model: An Extension of the Simple View of Reading

Perfetti's verbal efficiency theory was developed to explain individual differences in the reading of connected discourse among the normal range of skilled and less skilled readers. It was not specifically designed to explain the nature of the reading processes in dyslexic readers. Recently, however, Conners and Olson (1990) have developed a model that attempts to specify the relationships among component skills in normal and dyslexic readers.

Drawing on the work of Hoover and Gough's Simple View of Reading (1990), Connors and Olson (1990) found support for the prediction that reading comprehension (sentence reading comprehension) is composed of two major components: (1) oral language/listening comprehension; and (2) word recognition. These two components were found to make independent contributions to reading comprehension for both normal and dyslexic readers. Although the elements or components in the model were the same for both groups, the relative contribution of each component varied by reader group. For the dyslexic group, there was more dissociation between listening comprehension and word recognition than for the normal group. For the dyslexics, listening comprehension skills were significantly discrepant from their word recognition skills, with the former being stronger. In normal readers, listening comprehension and word recognition were moderately correlated ($r = .41$) but with dyslexic readers they were virtually orthogonal ($r = .03$) or independent.

Furthermore, they found support for an elaborated version of this model in which subcomponents for each of the major components (i.e., listening comprehension and word recognition) were specified for each reader group. The componential pattern and the relative contribution of each subcomponent varied by reader group. For instance, for the normal readers, sentence memory and Kaufman's verbal ability contributed
significantly to listening comprehension. A different pattern, however, emerged for the dyslexic readers with Kaufman's verbal ability, orthographic coding and phoneme segmentation contributing significant independent variance to listening comprehension. Differences between the groups also emerged on the extent to which various components contributed to variance in word recognition. While phonological coding and orthographic coding made independent contributions to word recognition for both the dyslexics and the normals, Kaufman verbal ability also emerged as a contributor for the normals. According to Conners and Olson, "The simultaneous contribution of Kaufman verbal ability to both listening comprehension and word recognition in the normal group may explain the large amount of common variance for word recognition and listening comprehension that was found for normal readers in the basic model."

The Conners and Olson model has several obvious limitations. First, it has only been tested on one sample of adolescent dyslexics (mean age 15) and their normal twin or sibling controls (mean age 10) matched on word recognition level. The model is also limited by restricting its measurement of reading comprehension to sentence reading. Thus, many aspects of text reading, such as the integration of ideas across sentences, which are elaborated in Perfetti's verbal efficiency theory, have not been taken into account. In particular, the limitations of working memory resources are not as likely to be captured in sentence comprehension as they are in paragraph and story reading. Thus, a different pattern of relationships may emerge depending upon which type of contextual reading task is used as the dependent variable. Furthermore, if adult dyslexics are using oral language and cognitive skills to compensate for their well documented deficits in word recognition (Bruck, 1990), these processes will more likely be captured during the reading of passages which consist of several sentences.
Despite its limitations, the Conners and Olson model has implications for the present study. The model suggests that while the component processes that underlie contextual reading are the same for both normal and dyslexic readers, their relative contributions to the reading outcomes (i.e., comprehension and efficiency) may vary by group.

10. Summary

The theories and models of the reading process that are relevant for the present study were reviewed. According to these models, both lower-order processes and higher-order processes are involved in reading. Stanovich’s interactive-compensatory model (1980) introduces the concept of compensation. This model, however, was designed to explain compensatory processing at the word level. Perfetti’s verbal efficiency theory, although interactive, is somewhat asymmetrical and places considerably more emphasis on the importance of lower-order or "local processes". The theory predicts that adult dyslexics with weak local processes will be inefficient text readers even if their higher level processes such as listening comprehension and world knowledge are strong since more working memory resources will be required to process at the word and subword level. The theory suggests, along with Bruck (1990) that at least some minimal level of word recognition skill is necessary in order to read text with some facility and comprehension. The theory does not specifically address the notion of compensation nor was it designed to describe the reading system of the dyslexic reader. Conners and Olson’s (1990) recently developed model suggests that there may not be differences between the componential structure of the reading systems of adult dyslexics and normal reading-level controls during the reading of prose. What is more likely to vary by group is the extent to which various components of the reading system contribute to reading comprehension and reading efficiency outcomes.
B. THE NATURE OF DYSLEXIA: DEFINITIONS, THEORIES AND HYPOTHESES

Developmental dyslexia or developmental reading disorder is one of the most common diagnoses in childhood psychopathology. Although prevalence figures vary from approximately 2% to 8%, most estimates fall close to 4% (American Psychiatric Association, 1994). This wide range in the estimated prevalence figures reflects the diverse definitions and diagnostic classification systems which are employed across a wide range of disciplines and time frames. The purpose of this section of the chapter is to review some of the historical and contemporary theoretical descriptions of the disorder so that the issues addressed in this study may be better understood.

1. Distinguishing Developmental Dyslexia from Related Disorders

First, a distinction must be made between the developmental reading disorders and the acquired reading disorders. People with acquired dyslexia are those who were, at one time, fluent readers but became impaired in one or more aspects of reading competence following some type of trauma or brain injury (Baddeley, Logie & Ellis, 1988). According to traditional definitions, those who suffer from developmental reading disorders experience difficulty acquiring reading skills in the childhood years despite adequate sensory functioning, educational experiences and IQ. Recently, some definitions and interpretations of developmental reading disorders do not include the latter requirement (e.g., Felton & Wood, 1992; Siegel, 1988; Stanovich, 1991 a). The developmental reading disorders have been attributed to several hypothesized etiologies (Rutter, 1978) and have been referred to by a variety of labels including developmental dyslexia, developmental reading disorder (American Psychiatric Association, 1994) and specific reading disability (Stanovich, 1988). Children with developmental reading disorders may also be referred to by the more general label of learning disabled reader (e.g., Swanson, 1990). The term developmental dyslexia generally refers to the most severe forms of reading disability.
Despite these variations in the labelling and the nosology of the reading disorders, there appears to be some consensus on two important issues concerning definitions. First, the developmental reading disorders are a class of disorders that are manifested in a variety of ways in individual children. As a result, there have been many attempts to search for both theoretically (e.g., Lovett, 1984; 1987) and empirically defined subtypes in the population (e.g., Boder, 1973; Mattis, French & Rapin, 1975). Second, dyslexia remains essentially a diagnosis by exclusion (Rutter, 1978) since most definitions, whether their roots are in neurology (Critchley, 1970), education (PL-94-142) or psychology (Vellutino, 1979) define the disorder by what it is not rather than by what it is (Lovett, 1984).

2. Developmental Dyslexia: Issues and Hypotheses

Despite this characterization of developmental dyslexia as a diagnosis by exclusion (Rutter, 1978), there appears to be some consensus that the defining feature of the disorder is a failure to acquire rapid context-free word recognition skills (Compton & Carlisle, 1994; Lovett, 1987; Stanovich, 1986; Vellutino, 1979). In addition, there is a growing body of evidence that indicates that the vast majority of children with developmental dyslexia also have associated problems in some aspect of oral language skill (Lovett, 1987; Mattis, French & Rapin, 1975; Vellutino, 1979). What remains less clear is whether these deficient readers simply lag behind their chronological age mates in the timing of their reading and oral language skill acquisition or whether they also perform in a qualitatively different manner as they become older.

3. The Developmental Lag Hypothesis

Two major hypotheses have been advanced to explain the nature of the reading systems of children with developmental dyslexia. The first hypothesis is referred to as the developmental lag hypothesis and the
second is referred to as the specificity hypothesis. The essence of the developmental lag hypothesis is that children with developmental dyslexia simply lag behind their chronological peers in reading skills. Traditionally, a major assumption of the developmental lag hypothesis was that the child would "catch up" to the peer group despite a slow start (Scarborough, 1983). Recent evidence from follow-up studies, however, indicates that most adults with childhood diagnoses of dyslexia continue to have persistent problems in the accuracy and/or speed of their word recognition skills (Bruck, 1990; Felton, Naylor & Wood, 1990) even among those who, at least superficially, appear to have "compensated" (Lefly & Pennington, 1991).

4. The Specificity Hypothesis

It is the alleged specificity of dysfunction that has been the traditional defining feature of the disorder (Miles, cited in Seymour, 1990; Stanovich, 1988; Vellutino, 1978). The way in which specificity has been defined and conceptualized, however, varies. For instance some researchers have argued that qualitative differences between dyslexics and reading-level controls would provide indications of specificity (see Prior, 1989 for a recent review). Prior argues that qualitative differences in reading behaviours might include a deviant sequence of learning to read, different error patterns, or the inability to use functional reading strategies even after training has been undertaken. There is little evidence indicating that dyslexic children can be differentiated from RL controls on the basis of these "deviant" criteria.

There is evidence to suggest, however, that the specificity hypothesis may be supported if one uses a different set of criteria. For instance, most dyslexics appear to have difficulties with phonological awareness (see Adams, 1990 for a recent review), and nonsense word reading (Bruck, 1990; Olson, Wise, Connors & Rack, 1990; Prior, 1989; Rack,
These skills are immature both for their age and for their level of word recognition skill. These findings have led many investigators to argue that severe deficits in phonological awareness and phonological coding, relative to word recognition skill, are specific to this disorder.

Bruck (1990) has characterized the word recognition skills of the adult dyslexic as "arrested" rather than deviant or delayed. Although Bruck did not define this term, it is assumed to mean that certain processes are not developmentally delayed, in the sense that they will eventually "catch up", but rather that some processes may develop to a certain point and never develop further. Thus it is possible that some skills are "arrested" while other skills continue to develop. This could result in an asymmetrical pattern among componental skills that becomes more pronounced over time. By the adolescent years, this uneven pattern may result in a distinct dissociation between certain oral language skills and reading skills (Conners & Olson, 1990). Thus, what is "specific" about the dyslexic reading system, when reading connected discourse, may only become apparent if one considers the overall psychometric profile. It may be that the relationships between and among component skills are critical determinants of specificity, in addition to individual skill deficits, when evaluating connected discourse reading outcomes in this population.

One purpose of the present study was to determine the extent to which a sample of young adults with childhood diagnoses of dyslexia had recovered from, or compensated for, their childhood word recognition skill deficits. In the present study both achievement and processing outcomes are of interest. Since recovery and compensation are themes that are important in this study, a short digression will be introduced to indicate the way in which these terms will be used in this study.
5. Compensation and Recovery

According to the dictionary definition, compensate means "to counterbalance, make up for, or make amends for" (Shorter Oxford English Dictionary). In the cognitive, developmental and neuropsychological literature, investigators have often used the term compensation but seldom provide context specific definitions (but see Backman & Dixon, 1992). Investigators who have studied dyslexic populations have used the terms "recovered dyslexics" (Kinsbourne et al., 1991), "compensated dyslexics" (Lefly and Pennington, 1991) and "compensation" (Bruck, 1990) with three different implicit meanings or connotations.

In this study, the term compensation has two different connotations when referring to performance on connected discourse reading tasks. The first is the recovery connotation. If an individual has achieved reading skill achievement outcomes that are age appropriate, he can be referred to as recovered. That is, despite documented severe deficits in reading skill in childhood, the individual has managed to reach the young adult years with skills that are comparable to chronological peers. This connotation makes no assumptions about the reasons for the recovery. Recovered dyslexics, however, could have compensated for early deficits because of neurocognitive maturation, motivation or skill mastery. In this study, the reading performance of a sample of young adults with childhood diagnoses of dyslexia will be evaluated in contrast to chronological age mates to determine the extent to which they have recovered from, or compensated for, their early childhood deficits. This is simply a quantitative evaluation of their achievement levels that is comparable to the methods employed by Kinsbourne et al. (1991) and Lefly and Pennington (1991).

The second connotation of the term compensation refers to the nature of the information processing that is ongoing while the young adult dyslexics read connected discourse. If their information processing resembles chronological age mates, then there is no compensatory processing
in the young adult years. But compensatory processing may be evident even when achievement levels are comparable to the control groups. An example of compensatory processing is adjusting the speed of reading to accommodate poor 'local processes' to ensure an accurate performance outcome.

By making distinctions between the two different connotations for compensation, I hope to clarify differences in the implied meanings of compensation while reviewing several relevant follow-up studies of adults with childhood diagnoses of dyslexia. In the next section of this chapter, a selective review of some of the empirical literature will be presented, with a focus on studies that have described the reading skills and associated cognitive and oral language skills of children with developmental dyslexia or specific reading disability. Studies that have addressed the developmental lag hypothesis, the specificity hypothesis or the compensation issue will be emphasized.

C. WORD RECOGNITION AND READING COMPREHENSION SKILLS OF READING DISABLED CHILDREN

1. Reading Comprehension Skills

Several researchers have compared good and poor readers on reading comprehension skills. While the majority have concluded that poor readers are less sensitive to story grammar, and text structure, there are others who have concluded that there are no differences (e.g., Perfetti & Lesgold, 1977). The suggestion has also been made that poor readers differ from their age mates on their ability to recall information from text (Worden, 1987).
These types of studies, however, are not particularly informative since the poor or disabled readers are usually compared with chronological age controls whose better comprehension skills may be attributed to better word recognition and/or greater exposure to print. Moreover, in some of the studies in which recall was the dependent variable, subjects were asked to write their responses thereby confounding written language comprehension with written language production (e.g., Brown & Smiley, 1977, cited in Bruck & Waters, 1990). Worden's (1987) review concludes that "there is no evidence that these effects are not most parsimoniously explained by the inefficient processing in short-term memory. In particular, there is no evidence that the organization of permanent structures in semantic memory, such as the story schema, is defective in learning-disabled individuals. Any further search for major structural deficits in the organization of long-term memory, especially the story schema is unlikely to succeed" (p. 257). A similar conclusion was reached by Morrison (1987) who states that "existing evidence favours the view that comprehension per se is not deficient in disabled readers but arises as a necessary consequence of problems at the word-decoding level" (p. 46).

In order to conclude that dyslexic children have a comprehension deficit that is distinct from their word recognition skill deficit, other types of designs are required. My review of the literature thus far has not uncovered any study that was deliberately designed for the purpose of comparing reading disabled or dyslexic subjects with younger reading-level controls (based on word recognition skills) and chronological age matches on their sensitivity to text structure or their recall of prose passages. The studies that are reviewed in the next section of this chapter, however, address these issues indirectly.
2. Do Dyslexic Readers Have a Separate Comprehension Deficit?

Conners and Olson (1990) compared 172 pairs of dyslexic adolescents (mean age 15) and younger normal reading-level controls (mean age 10) on multiple dimensions of reading behaviour and related skills. The group means were identical (grade 6.5) on single word recognition scores but differed significantly on reading comprehension for both a single sentence measure of silent reading (PIAT) and a passage comprehension task (Spache). Moreover, the older dyslexics also performed significantly better on a test of listening comprehension, which required the students to listen to text passages read orally and then answer detail questions, as a measure of general verbal ability. Although the dyslexic readers' reading comprehension scores were several years behind the standard expected for their age, these data do suggest that they were able to compensate. It was inferred that they compensated for their poor word recognition skills by using their superior listening comprehension and general verbal abilities that were more age appropriate.

Lovett (1987) compared multiple dimensions of reading skill in three groups of children between the ages of 8 and 13 (mean age 10.9 years). The groups were selected according to an a priori theoretically motivated subtyping scheme (see Lovett, 1984 for its rationale). The subtypes were conceptualized to represent three points along a developmental continuum of reading skill acquisition. The most disabled readers, the accuracy-disabled children, were selected on the basis of significant impairment in the accuracy of their word recognition skills on at least four different measures of decoding. The rate-disabled readers were performing at, or above, grade level on decoding accuracy but were significantly behind on the criterion of reading speed. The third group of readers were fluent normals.
Consistent with a developmental perspective on dyslexic reading, Lovett found that the reading comprehension performance of the three reader groups corresponded to their level of word recognition performance. The most impaired readers, the accuracy-disabled, were more inaccurate in their oral reading of connected discourse, read more slowly, and answered fewer comprehension questions correctly. The rate-disabled readers, although comparable to the fluent normals on the comprehension questions, were slower and less accurate in their oral reading of prose. A second finding of interest was that the accuracy disabled children were found to suffer from a "multidimensional language impairment coupled with specific speech sound analysis difficulties and a seeming inability to automatize and consolidate single letter identities and/or names" (p. 257). This language impairment, however, was not characterized as a general verbal deficit (the groups were individually matched on Verbal IQ), but rather it appeared to be more subtle in nature and included problems with syntax and morphology, rapid automatized naming, and specific aspects of lexical access. The rate-disabled children appeared to have language skills that were comparable to the fluent normals with the exception of rapid automatized naming for visual arrays. Lovett (1987) concludes that "there is no evidence at present that either disabled reader sample has a comprehension deficit separate from their difficulties in accurately accessing textual content through print-to-sound translation processes" (p.244).

The third study which offers some insights into the reading comprehension skills of poor readers was undertaken by Bruck and Waters (1990). The purpose of the study was to examine a group of children for whom there was a dissociation between their reading comprehension skills and their written spelling skills. These subjects, who were good readers but poor spellers, were contrasted with subjects whose reading and spelling skills were comparable. The good readers-poor spellers were, therefore, labelled as the mixed group while the latter two groups were labelled good
and poor respectively. Although the study explored many aspects of the reading and spelling skills of these 6th grade students, only one aspect of the study will be reported in this section of the chapter. Their reading comprehension skills and the associated skills that were thought to determine their performance on this dimension of reading skill will be discussed.

Bruck and Waters (1990) reported that these mixed subjects (good readers-poor spellers), despite their good reading comprehension skills, had relatively poor single word recognition skills that appeared to be associated with poor knowledge of spelling-sound correspondences. It was hypothesized that their good reading comprehension scores on the Stanford Diagnostic Reading Test (SDRT) may be attributed to good test taking skills and/or to higher level language and nonverbal reasoning skills which allowed them to compensate for their weak word recognition skills. To test these hypotheses, two approaches were taken. First, a detailed evaluation of their reading comprehension skills was undertaken and second, tests of oral language skill and nonverbal reasoning were administered.

The detailed evaluation of their reading comprehension skills revealed that the mixed subjects did not differ significantly from the good readers in their ability to recall units of text nor answer follow-up comprehension questions. They did, however, take longer to read the narrative and expository texts. Moreover, they were able to execute a cloze generation (i.e., fill in the blanks) task, which required knowledge of the syntactic and semantic constraints in the language, as well as the good group. They were also more likely than the good readers to use the context to facilitate word recognition. The poor subjects, however, recalled fewer pausal units and answered fewer comprehension questions.
The results from an analysis of the associated skills battery indicated that the mixed subjects were comparable to the good subjects on the listening comprehension of text and receptive vocabulary knowledge. They did not differ significantly from either group on the nonverbal reasoning measure (Culture Fair Test). The poor subjects’ scores on the language measures were poorer than the mixed subjects’ scores.

These data indicated that a certain proportion of students with poor word recognition skills (13 out of 135 or nearly 10% screened in this study) were able to achieve reading comprehension skills that were comparable to students in the 6th grade with good word recognition skills by taking advantage of their good oral language skills to compensate for this weakness. In contrast, the group with both poor word recognition skills and poor reading comprehension skills also suffered from poor oral language skills and, in contrast to the good group, poor nonverbal reasoning skills. It is likely, therefore, that the reading comprehension skills of this particular poor group could be attributed to a constellation of deficits perhaps including lower IQ levels.

Although the three studies outlined in the previous section were not specifically designed to address the question of whether dyslexic children and adolescents have a separate and distinct problem in reading comprehension, their findings suggest that this is not the case. Instead, word recognition skills and oral language skills appear to be the major determinants of reading comprehension skills in both children (Bruck & Waters, 1990; Lovett, 1987) and adolescents (Conners & Olson, 1990) at various points along the continuum of reading ability. Moreover, there appears to be a strong relationship between specific aspects of oral language skill and word recognition skill that can be expressed along a developmental continuum and is related to the reading comprehension skills of the dyslexic reader (Lovett, 1987).
These data appear to support the verbal efficiency theory (Perfetti, 1985; 1988) in that the better comprehenders had better "local processes", including word recognition skills and lexical access. Moreover, the Conners and Olson (1990) and the Bruck and Waters (1990) studies provide some support for extending Perfetti's verbal efficiency theory to include compensation in text processing. The adolescent dyslexics and the good readers-poor spellers, despite their poor word recognition skills, appeared to take advantage of their better higher-order oral language skills to achieve reading comprehension scores that were superior to their word recognition scores.

3. Word Recognition Skills of Dyslexic Children

Although dyslexia has traditionally been referred to as a diagnosis by exclusion (Rutter, 1978), there does appear to be one aspect of the disorder which defines it by inclusion. There appears to be consensus in the literature that the dyslexic child can be characterized by the failure to develop accurate and automatized single word (context-free) recognition skills despite adequate instructional opportunities (Bruck, 1988; Compton & Carlisle, 1994; Lovett, 1987; Perfetti, 1985; 1988; Stanovich, 1980; Vellutino, 1979). Since there appears to be agreement on this issue, the majority of papers on word recognition skill in dyslexic populations in the contemporary literature have been directed at more subtle issues and questions.

Although there have been some case study reports in which dyslexics have read regular and exception words with equal facility (see Lovett, Ransby & Barron, 1988 for a discussion), converging evidence from a variety of well designed group studies suggest that the "regularity effect" is common in developing readers. Like normal children (Lovett, 1987), dyslexic children have more difficulty reading exception words than regular words (Bruck, 1988; Lovett, 1984; 1987; Lovett, Ransby & Barron, 1989; Olson,
Kliegl, Davidson & Foltz, 1984; Treiman & Hirsh-Pasek, 1985). Among studies which have used reading-level matched designs, some have reported no significant differences in the ability of the two groups to read nonsense or pseudowords (e.g., Bruck, 1988; Treiman & Hirsh-Pasek, 1985) while the majority have noted that there are significant differences (see Prior, 1989 and Rack, Snowling & Olson, 1992 for recent reviews). Most dyslexic readers also appear to have difficulty with sound-symbol correspondences (Bruck, 1988; Lovett, 1987). As Bruck (1988) points out "dyslexic readers are caught in a vicious circle. They do rely on phonological information for word recognition; however, because of incomplete knowledge of spelling-sound correspondences, they do not build up word-specific associations. Thus they must continue to use phonological processes and rely on inadequate spelling-sound correspondence information for word recognition" (p.66).

4. Summary

The evidence to date suggests that the defining feature of the dyslexic child is the failure to acquire accurate and/or rapid word recognition skills despite at least average intelligence and adequate environmental and instructional conditions. Although dyslexic children do not appear to employ deviant (Prior, 1989) processes for word recognition, they do appear to acquire word recognition skills more slowly than their chronological counterparts. Furthermore, the majority of dyslexic children have poor phonological coding skills (as measured by nonword reading). Dyslexic children appear to face a "catch-22" dilemma in that they rely on phonological skills despite poorer knowledge of sound-symbol correspondences.
D. ORAL LANGUAGE AND COGNITIVE SKILLS OF READING DISABLED CHILDREN AND ADOLESCENTS

The following section of the chapter reviews some of the literature that has addressed the topic of how nonreading skills are related to reading skills in dyslexic children. There is now overwhelming evidence indicating that the majority of dyslexic children are impaired in some aspect of speech and language development (Badian, Duffy, Als & McAnulty, 1991; Lovett, 1987; Mattis, French & Rapin, 1975; Perfetti, 1985; 1988; Vellutino, 1979). Moreover, there are both theoretical and empirical reasons to believe that dyslexic children and adults make extensive use of oral language skills to assist contextual reading. In the next section of the chapter, the literature on the relationship between reading and several nonreading skills will be reviewed skill by skill. In the last section of the chapter, the literature that focuses on the interrelationships among skills will be reviewed. Six major areas will be covered: (a) two lower-order language skills (i.e., phonological awareness skills and rapid naming ability); and (b) four higher-order language and information processing skills (i.e., vocabulary, knowledge of syntax and morphology, working memory and discourse listening comprehension).

1. Phonological Awareness and Reading in Children

Phonological awareness is thought to be a metalinguistic skill (Tunmer, Herriman & Nesdale, 1988) that involves knowledge of the alphabetic principle in English. It is the awareness that words are composed of sound units. These units of sound are categorized on a size continuum ranging from phonemes (single sounds), to onsets and "rimes", to syllables and finally words. An onset is a portion of a syllable which consists of a consonant or consonant cluster (e.g., b, br) and it is not obligatory in English since a syllable may start with a vowel (Barron, 1991). A rime follows an onset and consists of a vowel unit and a consonant unit (e.g., at). The linguistic term 'rime' should be distinguished from
the conventional word 'rhyme'. Rhyme refers to a verse in which two or more words sound the same at the end as in a 'nursery rhyme' even though such words would, by the linguistic definition, include a 'rime'.

Stanovich (1987) has characterized our current knowledge of the relationship between reading and phonological awareness as a "scientific success story" which is all too rare in the field of reading. What makes this body of knowledge unique in the field? Converging evidence from a variety of sources leads us to conclude the following. First, unlike some linguistic skills (e.g., vocabulary), phonological awareness is thought to be independent of IQ (Bradley & Bryant, 1983; Felton & Wood, 1992; Olson, Wise, Conners, Rack & Fulker, 1989; Stanovich, Cunningham & Cramer, 1984; Tunmer et al, 1988; Wagner & Torgesen, 1987). Second, recent behavioural genetic studies have presented evidence that phonological awareness is genetically heritable whereas orthographic awareness is environmentally determined (Olson et al, 1989; 1990). Third, there appears to be a causal relationship between phonological awareness and reading (see Barron, 1991 for a recent interpretive review). Finally, and most important for those interested in dyslexic children, phonological awareness appears to be the most important and "core" factor that distinguishes normally developing readers from dyslexic readers (Adams, 1990; Stanovich, 1986; 1988).

Hypotheses about the causal and, for some linguistic units (Barron, 1991), reciprocal relationship between phonological awareness and reading have been formulated after synthesizing evidence from a variety of sources including longitudinal data, training studies and reading-level matched designs (see Barron, 1991; Adams, 1990 and Wagner & Torgesen, 1987 for recent reviews). Since the focus of this study is on the dyslexic reader, the review which follows will concentrate on studies of this population.

As mentioned earlier, Stanovich (1988) has recently advanced an individual differences model of reading disabilities/dyslexia which
features phonological deficits as the "core" feature in the pattern of performance in dyslexic readers. Drawing on theoretical notions of modularity in language (Fodor, 1983), Stanovich posits that the "key deficit in dyslexia must be a vertical (domain specific) faculty rather than a horizontal faculty" (p. 592). Moreover, evidence for a specific deficit must be derived from demonstrations that reading disabled students are superior to "garden variety" readers (those with low IQ and generalized deficits) in more global skills, but inferior to reading-level IQ matches on specific phonological skills.

Although there are many demonstrations of the strong relationship between phonological awareness and reading in samples of average and poor readers, there are few studies that have included severely disabled readers in their samples. Two notable exceptions, however, are studies by Fox and Routh (1980) and Lovett (1987) in which three groups of children were chosen to represent three points along a continuum of reading skill acquisition. The most disabled children were the most impaired in sound analysis skills (i.e., segmenting words into phonemes and syllables). Those in the middle of the continuum, however, were not deficient on sound analysis tasks.

In the former studies, the phonological awareness task (i.e., sound analysis) was administered orally thereby controlling for orthographic input. Manis, Szczulski, Holt and Graves (1988), however, used a set of tasks which were presented visually and were thought to measure phonological sensitivity. Using a reading-level match design with dyslexic children between the ages of 9 and 14 and normal readers between the ages of 6 and 10, they found that 52% of their subjects had difficulty with phonological tasks and that an additional 24% had difficulty with both phonological and orthographic tasks.
There appears to be a hierarchy of difficulty in orally presented phonological awareness tasks (see Adams, 1990; Swanson & Ransby, 1994 for recent reviews). In ascending order of difficulty, they are: (1) rhyming tasks; (2) segmentation or sound analysis tasks; and (3) phoneme manipulation tasks. When selecting a task for subjects one must be careful to avoid ceiling effects. Ceilings tend to be reached on the first two tasks at ages 4 and 8 respectively. For children older than eight and for adults, phoneme manipulation tasks such as the traditional children's Pig-Latin game (Olson et al, 1989; Pennington, Van Orden, Smith, Green & Haith, 1990) or phoneme deletion tasks (Bruck, 1992) must be used in order to avoid ceiling effects. In the present study, phoneme counting and phoneme deletion tasks will be administered in order to avoid ceiling effects. Specific findings concerning phonological awareness tasks in adult dyslexics will be reviewed in a subsequent chapter. The rationale for including these measures in the battery for this study will then become more apparent.

2. Rapid Naming

Wolf (1991) has recently published an essay on the contribution of the neurosciences to the understanding of the relationship between naming speed and reading. Naming has been defined as "the retrieval of phonological information from long term memory" (Felton, Naylor & Wood, 1990). According to Wolf, this aspect of linguistic skill was first linked to reading by Geshwind, a neurologist, who hypothesized that colour naming accuracy was a good proxy for the skills involved in early reading, in particular the matching of a visual symbol with a verbal label. Shortly after, Denckla and Rudel (1972, cited in Wolf, 1991) using a measure of colour naming speed, found that severely disabled readers were deficient on this task. They later developed a set of tasks which require the subject to rapidly name letters, numbers, objects, and colours. These tasks were found to distinguish between groups of impaired readers compared with average
readers (Denckla & Rudel, 1976). These rapid automatized naming or "R.A.N." tasks are the most commonly used measure for a continuous naming task.

A second type of task for measuring rapid automatized naming is the discrete trials task in which a letter or object is named one at a time with latency measurements taken on each trial. According to Wolf (1991), proponents of the continuous naming task favour its use since it is a better proxy for the reading process than the discrete trials task. Data from the discrete trials tasks are thought to be more reliable.

The discrete trials tasks, however, have not consistently discriminated between skilled and less skilled readers (e.g., Stanovich, 1981; Perfetti et al., 1978, cited in Wolf, 1991). Wolf argues that these inconsistencies can be explained by developmental changes in the relationship between reading and rapid naming and in the types of reading tasks with which these results are associated. Wolf (1991) concludes that in the earliest stages of the reading process (kindergarten level), all naming speed tasks predict all later reading abilities (i.e., word recognition, reading comprehension and many subskills) but that at later stages in the reading process the relationship between the two becomes more differentiated. For instance, by grade three performance on a picture confrontation task (i.e., The Boston Naming Test: BNT) (Kaplan, Goodglass & Weintraub, 1983) which places demands on semantic knowledge, predicts reading comprehension skill (Wolf, 1991; Wolf & Obregon, 1992). On the other hand, confrontation tasks that place fewer demands on the semantic system do not.

Several studies of dyslexic children indicate that they can be distinguished from normal children on continuous rapid automatized naming tasks (Bower, Steffy & Tate, 1988; Lovett, 1984; 1987; Wolf, Bally & Morris, 1986). These tasks also discriminate well between garden variety
(with low IQ) readers (Wolf & Obregon, 1992) and children with attention
deficit disorder (Felton & Wood, 1989). Recent results from a five year
longitudinal study suggest that the naming deficit in dyslexic children is
still evident in the middle childhood years. Moreover, there is evidence to
suggest that this deficit persists into the adolescent and adult years

As Wolf (1991) points out, the rapid automatized naming tasks (R.A.N.
Colours, Letters, Numbers and Objects) are good predictors of word
recognition skill whereas the more semantically complex word retrieval
task, The Boston Naming Test (BNT), (Kaplan et al., 1983) is a better
predictor of reading comprehension in dyslexic children. The latter
measure, it has been argued (Badian et al., 1991; Wolf & Obregon, 1992),
could simply be measuring vocabulary effects which have a well known
association with reading comprehension. But when Wolf and Obregon (1992)
systematically controlled for the effects of vocabulary in this measure,
they found that the BNT was strongly correlated with reading comprehension
in dyslexic children.

Although admittedly somewhat speculative, Wolf and Obregon (1992)
propose that "connecting these findings on naming speed and reading failure
is a common timing mechanism underlying both particular language and
particular motor functions" (Wolf, 1991). They do not imply that this
timing mechanism is a single factor explanation for the developmental
dyslexias but rather that it may be one specific aspect of dysfunction
which impairs a large proportion of dyslexic readers and which persists at
least into the middle childhood years and likely beyond.

In the present study, both the BNT (adult version) and three of the
R.A.N. tasks were administered. Since efficient "local processes" are a
critical aspect of verbal efficiency theory (Perfetti, 1985; 1988), speed
and accuracy of lexical access may be an important individual differences variable which would predict contextual reading outcomes.

3. **Vocabulary**

Since dyslexic children are by most definitions characterized by average or above levels of intelligence (but see Siegel, 1988; Stanovich, 1989; 1991 a, for an alternative argument), individual differences are not thought to be attributed to general listening comprehension or verbal intelligence at least as antecedent causal factors. Stanovich's (1986) notion of 'Matthew effects' in reading, however, posits that there exists a reciprocal causation relationship between vocabulary knowledge and reading. That is poor vocabulary can be both an antecedent of poor reading and a consequence. Although dyslexic children may begin their reading careers with good or even superior vocabulary knowledge, they may be unable to sustain the expected growth curve because of their word recognition difficulties. Because they are less skilled in decoding, their exposure to the quantity and quality of text is limited relative to their chronological peers.

Although many single studies have found dyslexic children to be deficient in many aspects of word knowledge including word meanings, word relationships and morphology (Lovett, 1984; 1987; Scarborough, 1990), inferences about the nature and direction of causal relationships must be made from evaluations of converging evidence from a variety of sources including longitudinal and training studies (Stanovich, 1986). For instance, Scarborough's (1990) prospective studies of children with dyslexic parents, who later became poor readers themselves, suggest that for this population, language deficits may be an antecedent or precursor to reading failure. As early as three years of age, these subjects demonstrated deficits in receptive vocabulary and naming ability. Since these children were assessed prior to formal reading instruction, these
data lend compelling support to the hypothesis that specific linguistic deficits are a precursor to developmental dyslexia.

In some subtypes of dyslexia (i.e., rate-disabled), however, language impairments in general and vocabulary in particular have not been observed (Lovett, 1984; Lovett, 1987). It appears, therefore, that there are individual differences in the extent to which vocabulary is impaired at the time of diagnosis, differences in the extent to which vocabulary can be learned from nonprint sources, and differences in the extent to which those with good vocabulary skills can use this advantage to compensate for poor word recognition skill. Nevertheless, vocabulary appears to be a critical determinant of reading comprehension skill in both normal (Curtis, 1980; Stanovich, 1986) and dyslexic (Bruck, 1990) populations.

4. Syntax and Morphology

Deficiencies, in the ability of reading disabled children to appreciate subtle morphological details (Lovett, 1984; 1987) and process syntactically complex sentences, have been reported in a variety of studies over a couple of decades (Lovett, 1984; 1987; Scarborough, 1990; Siegel & Ryan, 1984; Vogel, 1974). Whether these represent specific deficiencies or whether they are part of a multidimensional language impairment remains unclear.

Some researchers have argued that the Siegel & Ryan (1984) study may have revealed deficits in syntactic complexity because subjects with IQ scores as low as 80 were included and thus problems in syntactic complexity may be one of a cluster of general language problems (Morrison, 1987).

In Lovett’s (1987) study, however, children were selected according to an a priori subtyping scheme that included accuracy disabled (1.5 years behind in word recognition on multiple measures), rate disabled (at grade
level for accuracy but delayed on speed) and fluent normals. These subtypes were selected to represent three points along a theoretical continuum of reading skill acquisition. Although the groups were individually matched (i.e., on age, sex, Verbal IQ and Performance IQ), the most disabled reader group, the accuracy disabled readers, were significantly behind both of the other groups. Their knowledge of oral language structure was deficient. In this study syntax and morphology were assessed with the Grammatic Closure subtest of the ITPA and the Berry-Talbot. The latter is an experimental measure which requires subjects to apply basic morphological rules on nonsense items. It is interesting to note that the accuracy disabled subjects were particularly impaired on irregular items (e.g., steal/stole the jewel; child/children). Although the accuracy disabled readers had Verbal IQ scores that were in the normal range and were comparable to the rate disabled and fluent normal group, they appeared to suffer from a multidimensional language impairment. This language impairment was of a more subtle nature than that which can be detected on WISC-R Verbal scales. There appeared to be a specific deficit in the knowledge and manipulation of oral syntax and morphology.

Although it is possible that poor oral syntax is a consequence of reading failure in this age range (i.e., 8-14), data from Scarborough’s (1990) prospective studies would suggest that it is also an antecedent to reading problems in some dyslexic readers. Whether the failure to deal with irregular morphological items represents qualitatively different processing of syntax and morphology has not been suggested. It is more likely that this difference represents a quantitative difference and is a reflection of the normal developmental sequence of natural language learning.

Whether or not difficulties in processing syntax and morphology persist into the adult years in dyslexic populations is unclear, but one investigator reported that the deficits that were apparent in an early
childhood sample (Scarborough, 1990) were not detectible by kindergarten. This finding contradicts those of Lovett (1987) who found deficits in accuracy-disabled children as old as 13 years. If deficits in syntax and morphology do persist into adolescence and adulthood, they would likely become apparent in a listening comprehension test. For this reason, a measure of syntax and morphology per se, is not included in the battery for the present study. The battery does, however, include a measure of listening comprehension and working memory, both of which are thought to require syntactic processing skills.

5. Working Memory

Working memory is a construct which is usually operationally defined as the ability to engage in simultaneous processing and storage. The construct was derived from memory experiments in which a dual task approach was taken (e.g., Baddeley & Hitch, 1974). Although some investigators use the term short-term memory when referring to a task which demands both simultaneous storage and processing (Jorm, 1983; Schacter, 1989), most use the term short-term memory (STM) to refer only to storage functions.

Although the early literature on developmental dyslexia was primarily focussed on children, the initial investigations of working memory and reading were undertaken with adults. It is only recently, therefore, that investigators have considered the relationship between working memory and reading in childhood. These investigations were prompted in response to the literature that indicated that STM was not highly correlated with reading comprehension (see Jorm, 1983 for a comprehensive review). An interest in working memory was also inspired by some theoretical formulations of text processing (Just & Carpenter, 1980; 1987; Kintsch and van Dijk, 1978; Perfetti, 1985; 1988).
In 1980, Daneman and Carpenter published a paper on the relationship between working memory and reading comprehension. This study introduced a set of tasks which have become known as the reading span and listening span tasks. These tasks were designed as measures of working memory and were specifically crafted to be analogues for the functional aspects of working memory in text comprehension.

The reading span task requires subjects to read a series of sentences out loud and then recall the last word in each of the sentences. These sentences are presented on cards one at a time in sets. In the first set, there are two sentences and two final words to be recalled. In the next set, subjects are required to read three sentences and recall three final words. The test progressively becomes more demanding as sets with four, five and six sentences are encountered. This task requires subjects to simultaneously store and process information. The processing task, in this case, is the sentence reading task and the storage task is the final word recall requirement.

The listening span task parallels the reading span task. In this task subjects listen to sentences being read out loud. After each sentence is read, they must verify whether or not the statement is true or false. When all of the sentences have been heard, and verified, subjects must recall the last word from each sentence in the set. The set sizes also increase in difficulty from two to six. For this task, the processing component is the sentence verification and the storage component is the final word recall.

Using these reading span and listening span tasks with young adults in undergraduate college classes, Daneman and Carpenter (1980) reported very high and significant correlations between working memory and reading comprehension. Moreover, as predicted, these correlations differed significantly from those between reading comprehension and conventional
short-term memory measures which only tap storage functions. In these experiments two specific measures and one general measure of reading comprehension were administered. It was thought that the ability to answer fact questions and compute pronomial references were reading comprehension tasks that demanded working memory skill. The former measure of reading comprehension was moderately correlated with reading span (r = .72) while the latter was highly correlated (r = .90). Moreover, the more general measure of reading comprehension (i.e., Verbal SAT scores) was also significantly correlated with reading span (r = .59). In a second experiment, Daneman and Carpenter (1980) reported comparable correlations for oral reading span, silent reading span and listening span, all of which were significant (r's ranging from .42 to .85).

These results were important for a variety of reasons. First, the difference between the relationship between conventional STM and reading comprehension, as compared with the relationship between working memory and reading comprehension, was demonstrated using the same subject pool. Second, the results suggested that working memory may be one element which may be an important predictor of individual differences in reading comprehension. Third, Daneman and Carpenter remark that "both sets of results suggest an individual differences theory that stresses visual processes, such as time to access letter codes from visual material may not capture a significant source of variance that is common to both reading and listening comprehension" (p. 460). Finally, these results were notable because of the magnitude of the correlations and their replication in subsequent experiments (Daneman & Carpenter, 1983; Masson & Miller, 1983).

Daneman and Carpenter interpreted these results with a 'processing efficiency hypothesis'. They argued that individuals do not differ in their structural or overall working memory capacity. Instead, they argued that what accounts for differences in working memory span, or functional working
memory, are differences in the efficiency of their processes rather than their static memory capacity. Therefore, individuals who were more efficient would need to devote less attention to their reading skills and thus have more functional working memory capacity. Daneman and Carpenter argued that the background task in a working memory task must include reading if the span measure is to predict individual differences in reading comprehension. This argument is somewhat tautological since it essentially argues that those who are good in reading have better working memory capacity because they are good in reading.

Recently, Turner and Engle (1989) have advanced an alternative hypothesis concerning the relationship between working memory and reading. Using both linguistic and mathematical (i.e., digits) materials in their listening span measures, they found that both types of working memory tasks were significantly correlated with the Nelson-Denny (1981) reading comprehension measure in college undergraduates. The correlations on the verbal measures were almost twice as large in magnitude as those for the tasks which included digits. They interpreted their results as providing tentative support for the hypothesis that working memory capacity may be independent of specific reading skills but may depend on verbal skills. They also have argued that better readers do have greater structural working memory capacity and that working memory capacity is a more general phenomenon that is independent of specific task characteristics.

A recent study by Siegel and Ryan (1989) used a subtyping paradigm to examine the domain specificity hypothesis in working memory. They hypothesized that reading disabled children (RD) would experience difficulty with a language related working memory task, that an arithmetic disabled (not reading disabled) (ARITH) group would experience difficulty with a counting task, and that an attention deficit group (ADD) would not differ from a group of normal children. Their results indicated that the
reading disabled group had difficulty with both the language related and the counting working memory tasks. Consistent with predictions, the ARITH group only had difficulty with the counting working memory task and the ADD group did not differ from the normals. They concluded that deficits in working memory appear to be related to specific academic skill and that it is possible that different subtypes of learning disabilities are associated with different types of memory deficits.

Two additional studies, using samples of children, provide support for the hypothesis that reading comprehension differences are not specifically related to a linguistic system but rather to a more general component of working memory. Yuill, Oakhill and Parkin (1989) studied a sample of skilled and less skilled children in the 7 to 8 year range. The less skilled readers were adequate in their single word decoding but deficient in reading comprehension. Using a numerically based working memory task, a significant correlation (r = .55) emerged between working memory and reading comprehension. Swanson, Cochran and Ewers (1989) also found less skilled and young readers, irrespective of IQ, to be deficient on working memory tasks. In addition, this study attempted to measure different components of working memory based on Baddeley’s theoretical model (1986). For instance, a concurrent task which required subjects to sort blank cards while recalling digits was thought to place minimal demands on the central executive while sorting nonverbal shapes was thought to make demands on the central executive by the visual-spatial system. Consistent with predictions, the less skilled readers had more difficulty sorting the cards which placed greater demands on the central executive. Swanson et al (1989) concluded, therefore, that working memory deficits are "not necessarily specialized for language and may in fact reflect deficits in central executive processing" (p. 155).
Further support for the notion that working memory is generalizable across tasks has emerged from a study of skilled and less skilled child readers (Swanson, 1992). In this study Swanson administered a comprehensive experimental test of working memory, consisting of 11 subtests some of which were verbal and others nonverbal in content. Since similar correlations were found across multiple indicators of working memory and reading comprehension, Swanson concluded that these findings parallel those of Turner and Engle’s (1989) and together they support the notion that working memory is task independent.

This literature provides a limited picture of the role of working memory in the reading systems of dyslexic children since few studies of severely impaired readers have been reported. Swanson’s results (1989; 1992), however, suggest that working memory may be an important consideration for less skilled readers particularly since the group differences were found to be independent of IQ.

Verbal efficiency theory (Perfetti, 1985; 1998) predicts that dyslexic readers will have difficulty with contextual reading accuracy, rate and comprehension. The theory suggests that deficits in local processes such as word recognition and word retrieval force them to devote excessive working memory resources to their processing. If working memory is dependent on domain specific reading knowledge sources as Daneman and Carpenter suggest (1980), then the dyslexic child and adult will undoubtedly have poor working memory. If working memory is a more general system, as Turner and Engle (1989) and Swanson et al. (1989; 1992) suggest, then it is possible that some dyslexic children and adults may have good working memory skills that may contribute to better than expected (i.e., relative to word recognition skills) reading comprehension. Because of the central role of working memory in verbal efficiency theory (Perfetti, 1985; 1988), working memory tasks were included in the testing
battery for the present study.

6. **Listening Comprehension**

Although data from path analyses have suggested that phonological awareness is causally related to word recognition skills, listening comprehension, broadly defined, is thought to be associated with reading comprehension skills. The relative contribution of listening comprehension in normal readers, however, is thought to change over time. At the beginning stages of reading skill acquisition, there appears to be a weak but significant relationship between reading comprehension and listening comprehension (Stanovich, 1986; Stanovich et al., 1984), a moderate correlation in the middle grades (Curtis, 1980) and a strong correlation in adults (Daneman & Carpenter, 1980).

As noted earlier, Conners and Olson (1990) found that adolescent dyslexics achieved higher reading comprehension scores than their younger siblings despite similar word recognition skills. It was inferred that they achieved better reading comprehension scores because they were able to draw on their listening comprehension skills that were more age appropriate. Bruck and Waters (1990) reported similar findings with children.

One of the most common features of the dyslexic child's psychological profile is the marked discrepancy between word recognition skill and listening comprehension. This trend is so pronounced that it has led some investigators to argue that dyslexia should be defined by this discrepancy rather than by the traditional discrepancy between IQ and reading achievement (Stanovich, 1991a).

Good listening comprehension skill may be the most important oral language skill that distinguishes good reading comprehenders from poor reading comprehenders among adult dyslexics since it is the best oral
analogue of text processing. Moreover, it appears to be independent of word recognition skill (Conners & Olson, 1990). Given the potential for good listening comprehension to be a vehicle for compensation among adult dyslexics, a listening comprehension test was included in the battery for the present study.

7. Summary

Although the majority of dyslexic children undoubtedly suffer from specific oral language deficits, the literature indicates that there is some degree of heterogeneity in the extent to which any individual is impaired. There appears to be overwhelming evidence to indicate that most dyslexic children will have some impairments in phonological awareness. They may also have some difficulties with rapid naming depending upon how it is measured. There appears to be some variability in the extent to which vocabulary and syntax are impaired while listening comprehension appears to be a strength in most dyslexic children. Less is known about the extent to which working memory is impaired in dyslexic children, although evidence from samples of less skilled readers suggests that this aspect of information processing is related to poor reading performance. By definition, this population has adequate IQ. Thus, good nonverbal reasoning skills and good general verbal skills are expected, at least in the early years. The latter, however, may deteriorate over time as a consequence of reading failure (Stanovich, 1986). Among dyslexic children and adolescents, lower-order language skills tend to be strongly associated with word recognition skills whereas higher-order language skills tend to be strongly associated with reading comprehension.
E. CORRELATIONAL PATTERNS AMONG READING AND ORAL LANGUAGE VARIABLES IN CHILDREN

In the previous section of this chapter, the literature concerning the oral language and cognitive skills that are thought to be associated with reading skill was reviewed skill by skill. The focus in the next section of this chapter will be on the relationships between and among these skills. First, some studies that have examined the interrelationships among reading and oral language skills in normal samples will be presented. Then this literature will be contrasted with studies of dyslexic samples.

Curtis (1980) administered a comprehensive battery of reading and oral language measures to 100 skilled and less skilled readers in grades two, three, and five. It should be noted that this group was not screened for IQ, so it likely included children with a range of skill levels including some with below average IQ’s. Thus, the less skilled readers in the Curtis study may not resemble many dyslexic samples.

Curtis (1980) found that the relationship between reading and listening comprehension varied across grade and hence age levels. Listening comprehension was not significantly correlated with reading comprehension (as measured by the Diagnostic Reading Scales, 1963) in the grade two group, but it was significantly correlated with reading comprehension in the grade three and grade five groups. With the younger children (i.e., grade two), the best predictor of reading comprehension was word decoding speed which uniquely accounted for 13% of the variance. On the other hand, listening comprehension was the best predictor of reading comprehension in both grade three and grade five and uniquely accounted for 23% and 35% respectively of the variance in reading comprehension. Thus, it appears that listening comprehension becomes an increasingly better predictor of individual differences in reading comprehension skill as children become older and/or more skilled.
When regression analyses were undertaken on the skilled and less skilled grade three and grade five subjects' data, different aspects of oral language skill predicted reading comprehension success. For skilled readers, like older readers, listening comprehension was the single best predictor and uniquely accounted for 28% of the variance. For less skilled readers, however, word matching, letter vocalization and listening comprehension were the best predictors but each of these made minimal unique contributions. Despite high correlations between listening comprehension and reading comprehension, for less skilled readers, this variable contributed little unique variance. These results suggest that the less skilled readers suffered from a more general verbal deficit than is generally found in dyslexic readers (Conners & Olson, 1990).

These data suggest that listening comprehension appears to become increasingly influential in predicting reading comprehension as age and/or reading skill increases within the early elementary school years. Moreover, according to Daneman (1991), this trend persists into the adult years. In a recent review of individual differences in reading comprehension, Daneman (1991) concluded that the association between listening comprehension and reading comprehension is weak but significant for elementary level children, is moderate in the middle grades and becomes strong in the adult years for samples of normal readers.

A second study of skilled and less skilled readers (DeSoto & DeSoto, 1983) is also of interest in this discussion of correlational patterns in developing readers. In a sample of grade four students, a different pattern of relationships emerged between reading comprehension and various verbal tasks for each skill group. It should be noted that these investigators did not administer a test of listening comprehension. For the skilled readers (mean grade level in the grade 6 range), the best predictor of reading comprehension was a verbal opposites task in which the child is required to
supply an antonym for a verbally presented word. Desoto and Desoto argue, as others do (e.g., Lovett, 1987), that this task requires some manipulation of verbal material. On the other hand, for the less skilled readers (mean grade level in the second grade range), the two best predictors were a visual attention span measure and a sentence repetition task.

In both of these studies of children from community samples, selected without regard for IQ (Curtis, 1980; Desoto & Desoto, 1983), higher level oral language skills predicted reading comprehension success for the skilled readers whereas relatively lower level oral language and attention skills predicted individual differences in the less skilled reader group.

In one of the most comprehensive studies to date of dyslexic children (ages 8-13), Lovett (1987) presented correlational data from three samples of children who were selected to represent different points along a developmental continuum of reading skill acquisition. The details of the sample selection are reviewed in a previous section of this chapter. Lovett conceptualized the most severely disabled dyslexic readers (accuracy-disabled) as being at the lower end of the continuum, less impaired dyslexics (rate-disabled) were in the middle and the fluent normals were at the upper end of the continuum. In this study, age was partialled out of the correlational analyses because reader subtype differences were of greatest interest across a wide range of ages. It should be noted, however, that in the original selection process, subjects were matched individually for age across groups.

Like Curtis (1980) and Desoto and Desoto (1983), Lovett found a different pattern of relationships at different levels of reading skill acquisition. Furthermore, this study is particularly interesting because multiple measures of decoding skill and text reading were administered,
thereby offering an opportunity to examine the data for patterns that may be a function of psychometric or task differences across tests. For instance, Lovett (1987) reported a different pattern of results for reading comprehension measures than for measures of contextual reading accuracy (i.e., a paragraph read out loud) and contextual reading speed (i.e., the speed at which the paragraph was read).

The intercorrelations among the reading measures appeared to follow a pattern that varied with the type of reading measure and the level of reading skill (i.e., rate-disabled, accuracy-disabled or fluent normal). For instance, word recognition accuracy for regular words was highly correlated with contextual reading accuracy ($r = .82$) and contextual reading rate ($r = .71$) but moderately correlated with reading comprehension ($r = .56$) for the accuracy-disabled subjects. For the fluent normals, word recognition accuracy for regular words was moderately correlated with contextual reading accuracy ($r = .50$) and contextual reading rate ($r = .36$) but not significantly correlated with reading comprehension ($r = .16$). As Lovett points out, "a pattern of greater dissociation among contextual reading skills appeared to characterize groups more advanced in reading acquisition" (p. 252). Furthermore, reading comprehension and word recognition were less highly correlated than contextual reading accuracy and word recognition for all reader groups and for both regular and exception words.

Along with Curtis (1980) and Desoto and Desoto (1983), Lovett found that different aspects of oral language skills were the best predictors of reading skill in each reader group. For the accuracy-disabled group, the best predictors of five out of six reading measures were the times for the rapid automatized naming of letters and numbers followed by verbal opposites and object naming times. For the rate-disabled group, the best predictor of word recognition accuracy, contextual reading accuracy and
contextual reading rate, was the rapid automatized naming of numbers. Verbal IQ was also related to reading skill differences in this subtype but not the other two (i.e., accuracy-disabled and fluent normals). For the fluent normal sample, the best predictors of individual differences in reading achievement were the syntax and morphology measures which required subjects to manipulate oral language.

All three of these studies suggest that a different pattern of relationships exists among reading and oral language skills at different developmental levels of reading skill acquisition. What remains unclear, however, is whether these differences are simply a function of the child's level of reading skill or, in the case of the dyslexic readers, a function of their disability. The previous studies, although rich in detail, do not allow us to answer this question. Studies that use a reading-level design, however, offer a better methodological framework within which to ask such a question. The work of Conners and Olson (1990), which has been outlined earlier, suggests that while the componential structure of dyslexic and normal children of the same reading level is essentially the same, the magnitude of the relationships vary. Whether this same pattern would emerge in a comparison of the componential structure of a group of adult dyslexics, in contrast with a reading-level control group, is not known. This question, however, will be addressed as one aspect of the present study.

**Summary**

Although the relationship between reading and specific oral language skills is relatively well understood in dyslexic children, it is less clear how the various skills interrelate and how dyslexic children and adolescents differ from reading-level controls. Do older dyslexic readers present reading profiles that are similar to younger children with similar levels of word recognition skill or do they actually process information
differently and hence present an uneven profile relative to reading-level controls?. Although the literature would suggest that dyslexics with the best adult prognosis will be those who have strengths in oral language skills, it is unclear what combination of skills and resources will yield the most favourable outcomes.

F. FOLLOW-UP STUDIES OF ADULT DYSLEXICS: GENERAL OUTCOMES

1. Poor Outcomes

In 1983, Schonhaut and Satz reviewed 18 follow-up studies of learning disabled children, including some dyslexics, published between the years 1962 and 1978. The studies varied a great deal with respect to age at diagnosis, definitions for inclusion in the study, length of the follow-up period, sampling, and controls. The reviewers, therefore, questioned whether it was possible to make comparisons across studies. Moreover, the studies varied in the rigor of their methodologies. Schonaut and Satz (1983), therefore, gave each of the 18 studies a methodology quality rating and subsequently based the remainder of the review on five studies judged (albeit somewhat subjectively) to be the most adequate (i.e., Howden, 1967; Rawson, 1968; Rutter, Tizare, Yule, Graham & Whitmore, 1976; Satz, Taylor, Friel & Fletcher, 1978; Spreen, 1978). Overall, the results of these studies were somewhat pessimistic about the prognosis for the learning disabled child. They ultimately concluded that the prognosis for the learning disabled child was most optimistic for those with high socioeconomic status (SES) and exposure to intensive treatment.

They also concluded that the learning disabled child was more likely to be a school drop-out and, with the exception of the high SES child, unlikely to enter an occupation with heavy academic demands. Furthermore, their review left them uncertain about the value of early identification programmes and the effect of any form of treatment. Finally, they concluded that there was evidence for a relationship between early learning
disabilities and later anti-social behaviour.

2. More Promising Outcomes

Four years later, Bruck (1987) undertook a selective review of follow-up studies of dyslexic children and adults but concluded that the prognosis for positive outcomes in the early adult years is more optimistic than previous retrospective and correlational studies had indicated. Bruck reviewed four follow-up studies that were thought to be methodologically sound and included subjects who were selected on the basis of their actual reading and cognitive skills in childhood or early adolescence (i.e., Bruck, 1985; Finnucchi, Gottfredson & Childs, 1985; Rawson, 1968; Spreen, 1981; 1982; 1984). A summary of her synthesis of the social-emotional, occupational and educational outcomes is presented next.

Bruck (1987), in contrast to Schonaut and Satz (1983), concluded that childhood learning disabilities are not precursors of asocial behaviour. There was some evidence, however, that suggested that these young people may be at risk for minor social-emotional problems according to both parental and self-report assessment formats. The young people in these samples appeared to have more difficulty with the control of anger and frustration. Curiously, more adjustment problems were noted among girls than boys. Bruck suggests that there may be cultural explanations for this finding. Somewhat contrary to intuitive expectations was the finding that the severity of childhood learning disability was not related to psychological adjustment at follow-up.

Perhaps the most promising findings from this group of studies were the occupational outcomes. Unemployment rates were comparable to controls even for the most intellectually and educationally deprived subjects. Although the dyslexic adults were not well represented in demanding professions, such as law and medicine, many were successful in business
(Finucci et al., 1985) and managerial positions. Most managed to function effectively in occupations that did not require exceptional literacy skills but allowed them to capitalize on other strengths.

Although a large proportion of Spreen’s learning disabled subjects did not graduate from high school, the majority of the subjects from the other three studies managed to gain entry to college. Nevertheless, many of these adults reported difficulties with specific academic challenges, during their college experiences, including the comprehension of complex text and the completion of timed tests (Bruck, 1987). Encouraging educational outcomes were also reported in a more recent study of adults with developmental dyslexia who were involved in a genetic linkage study (Feldman, Levin, Lubs, Rabin, Lubs, Jallad & Kusch, 1993). In this study, 36 adults (mean age 43) were compared with unaffected family members. Although the dyslexic group had inferior reading and spelling skills, their educational attainment levels were comparable to their relatives. Bruck concluded that the best predictor of educational outcomes was IQ followed by SES and that "high levels of family support and understanding, adequate intelligence levels and adequate intervention programmes may dilute the association between childhood learning disabilities and educational achievement" (p. 258).

Recently, Spreen published a more detailed account of his follow-up work (Spreen, 1987) and a review (Spreen, 1988) of some of the same follow-up studies that were reviewed by the others (i.e., Bruck, 1987; Schonaut & Satz, 1983). He points out that the samples studied by both Bruck (1985) and Finucci, Gottfredson and Childs (1985) differed from his own sample. Spreen (1987) included children in his study with varying degrees of neurological impairment, and/or low IQ’s (as low as 70), and lower family SES. These differences in samples, he suspects, account for the more optimistic views and conclusions presented in Bruck’s review.
3. The Relationship Between Educational/Occupational Outcomes and Literacy Skills

A critical milestone for the young adult with a childhood diagnosis of dyslexia appears to be high school graduation (Bruck, 1985). Moreover, the occupational and educational choices that students make following high school graduation appear to be related to their literacy skills in the third decade of life.

When Bruck (1985) examined the literacy skills of 101 Canadian adults with childhood histories of reading disabilities, significant differences were noted between those who were attending post-secondary institutions and those who were employed. The students were superior on measures of oral reading accuracy, reading comprehension, single word decoding and spelling. No differences were noted in mathematics and reading rate. Of particular interest, was the finding that the groups did not differ on the severity of their disability in childhood. Among the students, those who had completed their post-secondary education were superior to their less educated counterparts on three indices of reading competence (i.e., comprehension, rate and decoding). Bruck, therefore, concluded that "the data suggest that after adolescence continued exposure to literacy tasks in demanding situations are associated with continuation of literacy skills development in learning disabled adults" (p.109).

G. READING SKILLS OF ADULTS WITH CHILDHOOD HISTORIES OF READING DISABILITIES

1. Sample Selection

The way in which samples of adult poor readers are selected varies considerably across studies. The majority of researchers who have studied poor adult readers have selected their samples on the basis of deficient reading skills in adulthood (e.g., Aaron & Phillips, 1987; Gajar, 1989;
Johnson & Blalock, 1987; Kitz & Tarver, 1989; O'Donnell, Romero & Leicht, 1990; Simpson & Byrne, 1987). Relatively few investigators have selected their samples on the basis of childhood difficulties, with a few exceptions.

Felton et al. (1990) and Decker (1989) selected their samples solely on the basis of actual childhood records. The former sample’s records were preserved by the Orton collection. Although Bruck (1990; 1992) selected her samples on the basis of childhood records, she also used an adult criterion (i.e., university and college enrollment). Others have relied on subjects’ self-reports of childhood difficulties (Lefly & Pennington, 1991; Scarborough, 1983). Despite Scarborough’s reliance on the self-report selection method, it is interesting to note that the reported reading and spelling scores for the most severe dyslexics in her sample fell within the same range as those reported for Bruck’s subjects. In both the Bruck (1985; 1990) and Scarborough (1983) samples, the subjects were characterized as having middle or upper SES. Although Felton et al. (1990) reported SES data, they did not indicate, at least verbally, the range within which the scores fell. In their analyses, both SES and IQ were used as a covariate.

2. Levels of Reading Skill in Adulthood

What level of literacy is attained by these samples of young adults with childhood diagnoses? Since each group of researchers who have conducted follow-up studies have selected different measures of reading skill, it is difficult to compare and contrast reading outcomes across samples. Reading comprehension, for instance has been evaluated with the SDRT (Blue) (Bruck, 1990), the Woodcock-Johnson (Scarborough, 1983), the PIAT (Lefly & Pennington, 1991) the Nelson-Denny (Runyan, 1991) and the GORT (Feldman et al., 1993; Kinsbourne et al., 1991; Steffens, Eilers, Gross-Glenn & Jallad, 1992). According to grade equivalent estimates, reading comprehension skills for individual subjects have ranged from grade two to college level.
Some of this variability can likely be attributed to variations in testing formats. For instance, the SDRT and Nelson-Denny tests require subjects to engage in the silent reading of paragraphs with follow-up multiple choice questions. For the PIAT, subjects read sentences silently. On the other hand, the GORT uses an oral reading format with the subject reading the target paragraphs out loud and the examiner reading the questions out loud as the subject follows a printed copy of the questions. Some of these test differences may be critical to the interpretation of achievement and processing outcomes.

In the studies that used the GORT to assess reading, the subjects' standard scores for all subtests were usually at or above the normative mean (i.e., 100). Standard scores for the Feldman et al. (1993) and the Steffens et al., (1991) samples were 105 and 107 respectively. The Kinsbourne et al. (1991) so called "recovered" dyslexics had a mean grade equivalent score of 11.3 whereas the "severe dyslexics" had a grade equivalent score of 6.0. The GORT scores for the former studies, however, were reported for the total score. It is, therefore, difficult to ascertain what the reading comprehension levels were because reading accuracy, speed and comprehension scores comprise the total score.

Using data from Bruck and Scarborough, the following pattern emerged. Reading comprehension scores fell in the grade 10-11 range as compared with the controls in the grade 12-graduate level. Word recognition scores fell in the grade 9-10 range with controls in the > grade 12 level while spelling scores fell in the grade 7-8 range in contrast with controls > grade 12. Thus, the average adult dyslexic, from these relatively privileged samples, appears to have a functional level of reading and spelling skill which certainly qualifies as literate but is clearly less proficient than expected for their age.
3. Word Recognition Skills

Bruck's (1990) study of the word recognition skills of adult dyslexics who were university students found support for the hypothesis that the same pattern of reading deficits which characterize this population in childhood persists into the adult years. When 20 adult dyslexics were compared with both reading-level controls and chronological age-matched controls, the adult dyslexics were found to differ from the controls on several dimensions of word recognition skill. The adult dyslexics differed significantly from their chronological counterparts on both accuracy and speed indices when reading single syllable and two syllable real words and nonwords. Moreover, they were less accurate in identifying real words embedded within nonwords and slower to read words in a predictable sentence context. Comparable findings were reported by Ben-Dror, Pollatsek & Scarpati (1991). These results provide support for the hypothesis that this population continues to experience difficulty with word recognition in the adult years.

If these differences were attributable to a developmental lag, then one would expect that their word recognition skills and related processes would be similar to reading-level controls. The reading-level controls and the adult dyslexics did not differ on their scores on the standardized test of single word reading since this was the variable on which the groups were deliberately matched. Differences did emerge, however, on several of the experimental measures of skills and processes which are thought to underlie word recognition skill.

Differences between the reading-level controls and the adult dyslexics emerged on the nonword reading tasks and the regular-exception word tasks. The adult dyslexics appeared to be less knowledgeable about spelling-sound correspondences and hence, Bruck inferred, were more reliant on spelling-sound correspondence decoding strategies rather than direct
lexical access for word recognition, particularly for low frequency words. Thus, they found themselves in the same "vicious circle" to which Bruck (1988) refers in her analysis of the performance of a similar sample in childhood. That is, they were more reliant on a process that was weak. Moreover, these deficits were also reflected in their spelling skills. The reading-level controls scored, on average, at the grade 11 level on the WRAT spelling test in contrast to a grade 7 level for the adult dyslexics.

Thus in this study, Bruck argued that the dyslexic adults were compensating for their deficiencies in word recognition and their associated skills, by relying on processes that were weak. The effect of this inferred compensation on achievement outcomes was not positive. Bruck chose to characterize their reading skills as "arrested" rather than deviant or delayed. Although she did not elaborate on her meaning of this term, it could be interpreted to mean that some skills develop to a certain point and then do not develop further. There was some asymmetry in the psychometric profiles of the adult dyslexics in that the scores on the nonword reading tasks (reflecting phonological awareness) were poorer than the reading-level controls despite comparable word recognition scores. This pattern is thought to be characteristic of many groups of dyslexic children (see Rack, Snowling & Olson, 1992 for a recent review).

These results are inconsistent with the traditional developmental lag hypothesis since there were quantitative differences between the reading-level controls and the adult dyslexics on many of the experimental measures in Bruck's battery. Since their orthographic skills were weak, relative to their chronological peers, they were forced to rely on phonological skills that were also weak relative to both the reading-level and chronological age matched controls. Thus, for this sample it could be inferred that there was evidence for some compensatory processing.
4. Individual Differences in Reading Comprehension Among Adult Dyslexics

Although Bruck's dyslexics were all deficient in word recognition and spelling skills, there was a wide range of individual differences on reading comprehension skills that could not be accounted for by word recognition skills. When the members of the adult dyslexic sample were assigned to either a good or poor comprehenders group, on the basis of a median split on the SDRT (Stanford Diagnostic Reading Test: Blue) silent reading comprehension subtest scores, significant differences were found between the two groups. The mean percentile score for the good group was 76 compared with 15 for the poor group. Moreover, the good comprehenders had significantly higher receptive vocabulary (PPVT) and IQ scores in childhood. The good comprehenders and poor comprehenders (based on the SDRT median split) did not differ on any aspect of single word reading, spelling or nonword errors.

These observations prompted Bruck to speculate that those adults who were good comprehenders had superior oral language skills and better "world knowledge". Bruck also suggested that the results of the "standardized reading comprehension test may not be a valid measure of comprehension but may merely assess some components of comprehension such as test-taking skills, world knowledge, vocabulary or the ability to answer multiple-choice questions". She goes on to suggest that "if the dyslexic subjects' comprehension skills were assessed in less structured and more naturalistic situations (e.g., free recall or open-ended questions), then their comprehension levels may be lower and there might also be a greater association between comprehension and word recognition skills" (p. 451).

Since her study was not designed to examine reading comprehension skills directly, there was insufficient data to test these hypotheses. Based on data from the child study (Bruck & Waters, 1990), however, she speculates that a compensation hypothesis provides a reasonable explanation
for these results. One purpose of the present study was to test Bruck's compensation hypothesis. This hypothesis is that adult dyslexics with childhood diagnoses and with the best adult reading comprehension scores, relative to other adult dyslexics will be those with superior oral language and general information skills. That is, these adult dyslexics will compensate for their deficits in word recognition by taking advantage of their relative strengths in oral language and cognitive skills. In other words, Bruck's compensation hypothesis refers to both achievement outcomes and information processing.

5. Compensated and Recovered Dyslexics

Lefly and Pennington (1991) have suggested that approximately 25% of adults with childhood reading difficulties reach the adult years with no obvious evidence of reading problems. Nevertheless, they found that a sample of "compensated dyslexics" did differ from "noncompensated dyslexics" on some of the more subtle aspects of reading and written language.

Although their "compensated" dyslexics appeared to have achieved a normal level of reading skill acquisition based on an accuracy criterion (Laberge & Samuels, 1974; Lovett, 1984; 1987) for single word reading and contextual reading accuracy, they did not reach normal skill levels on speed criteria. Similar findings were reported in two separate studies of university students with reading disabilities (Mosberg & Johns, 1994; Runyan, 1991). These researchers found that scores on reading comprehension tests were comparable for reading disabled and normal controls when time limits were extended or relaxed but discrepant when time restrictions were imposed. The Lefly and Pennington (1991) sample also demonstrated some difficulties with spelling. Although the "compensated" dyslexics were comparable to chronological controls on recognition spelling, they were poorer on spelling-to-dictation. Finally, it was noted that the
"compensated" dyslexics were more likely to be female than the "noncompensated" dyslexics. The Kinsbourne et al. (1991) sample of "recovered" dyslexics performed significantly better than "severe" dyslexics on a range of neurocognitive measures including verbal fluency and verbal memory but less well than normal controls.

Why some of these adults with self-reported (and validated with childhood records, Lefly & Pennington, 1991) childhood diagnoses of dyslexia were able to achieve near normal levels of reading skill acquisition is unclear. It is possible that some of these adults were actually rate-disabled dyslexics in childhood (Lovett, 1984; 1987) and hence did not actually achieve better than expected outcomes in the adult years. This hypothesis cannot be evaluated since neither Lefly and Pennington (1991) nor Kinsbourne et al. (1991) reported the actual scores for the childhood batteries. Assuming that these adults were comparable in reading abilities to the "noncompensated" dyslexics in childhood, it is possible that they also had better linguistic or cognitive skills that may have allowed them to achieve better than expected results relative to their "uncompensated" peers. Lefly and Pennington (1991), however, did not administer a battery of oral language tests at any point in time and the Kinsbourne et al. (1991) oral language data were collected from the samples as adults.

Lefly and Pennington (1991) also administered the Raven's Advanced Progressive Matrices Test (i.e., a measure of nonverbal reasoning), a measure of adult IQ, and a measure of general information. There were no significant differences among the groups on any of these measures. These data suggest that the better achievement levels of the "compensated" dyslexics could not be attributed to differences in general intelligence nor information, leaving differences in oral language skills as the best candidate for explaining group differences.
In the next section of this chapter, a selective review of the literature which addresses the topic of individual differences in reading skills among normal young adults will be presented. I will highlight the findings concerning the critical determinants of reading comprehension skill in the young adult age range and contrast them with the findings from the limited literature on the reading comprehension skills of adult dyslexics.

6. Individual Differences in Reading Skills: Dyslexics Contrasted with Normal Young Adults

Although there are a limited number of multivariate studies of the reading systems of young adults in the normal population, the majority have been conducted with samples of undergraduate college students. Since the sample which was selected for the present study falls in the same age range (17 to 23 years), this literature provides a standard for comparison.

Palmer, McLeod, Hunt and Davidson (1985) concluded that reading comprehension is highly related to listening comprehension and that reading speed is an independent factor that varies with visual word processing. Although their work has been applauded for its multivariate nature and for its rigor, it has been criticized for its failure to include a measure of word recognition or decoding in the assessment battery (Cunningham, Stanovich & Wilson, 1990). Baddeley, Logie, Nimmo-Smith and Brereton (1985), who also contributed to work in this tradition, found that reading comprehension is dependent on several separate components including working memory, vocabulary and a form of decoding which they termed general lexical access.

In an attempt to overcome some of the methodological shortcomings of the Palmer et al. (1985) and the Baddeley et al. (1985) studies, Cunningham et al. (1990) administered a large battery of tests to 76 college...
undergraduates. They concluded that "adult reading is more than listening ability" (p. 130). Using multiple regression and confirmatory factor analyses, they concluded that a three-factor nonorthogonal model best described individual differences among this sample of college readers. Word recognition was strongly related to reading comprehension as was general verbal comprehension. The variable referred to as "general verbal comprehension" was a composite that included vocabulary, listening comprehension (both from the Nelson-Denny), a Daneman and Carpenter (1980) working memory task and the Peabody Picture Vocabulary Test (PPVT). This composite is comparable to one used in the present study (i.e., higher-order language).

Despite some of the methodological problems that are inherent in a median split procedure (Maxwell & Delaney, 1993), the results of a median split from the Cunningham et al. (1990) study is of interest. Their results stand in contrast to the results reported by Bruck (1990), using the same procedure, on a group of adult dyslexics. In contrast to Bruck's results, the former group found that the good and poor comprehenders at the high-average end of the reading ability continuum had significantly different scores on all measures of real word and nonsense word decoding. The median score for this college sample was a grade 15 level of difficulty on the Nelson-Denny reading comprehension measure. Although Bruck did not report the median score on the measure of reading comprehension (i.e., SDRT Blue: Comprehension subtest), the mean (41st percentile) was at a grade 11.5 level.

Because of psychometric differences in scoring and reporting, direct comparisons are not possible but it appears as if the Bruck subjects were functioning at a slightly lower level than the Cunningham et al. (1990) sample on reading comprehension. What remains unclear, however, is why good and poor readers in the normal sample differed on word recognition scores
whereas the dyslexics did not. There are some differences in the word recognition indices since the Cunningham et al. (1990) measure is a combination of reaction times and error rates, whereas the Bruck accuracy and speed scores were reported and analyzed separately. It is possible that these psychometric differences would account for the discrepant pattern of results between samples. But it is also possible that the best adult readers, at both ends of the normal spectrum, rely heavily on automatized word recognition skills, whereas the poorest adult dyslexics rely most heavily on oral language and knowledge when processing large units of connected text.

7. Oral Language Skills of Adult Dyslexics

There is substantial evidence from the literature on adult poor readers, without documented childhood histories of reading problems, suggesting that the same cognitive deficits that have been observed in children with dyslexia are also evident in adulthood. There are, however, only a few studies that have described some of the associated cognitive skill deficits in samples of adults with childhood diagnoses. The associated skills that are of greatest interest to researchers in this field are two lower-order oral language skills (i.e., rapid naming and phonological awareness).

8. Lower-Order Language Skills

Felton et al (1990) assessed a group of 115 adults whose childhood records were preserved by the Orton collection. The subjects ranged in age from 20–44 years (mean age = 33.1 years) at the time of follow-up. A battery of neuropsychological tests was administered and the results were contrasted with those from chronological age matches. The battery included measures of memory, attention, phonological processing, rapid naming, visual-perceptual skills and nonword reading. After treating SES and IQ as covariates, the only tests that were discriminating measures were the
nonword reading test, the Lindamood test of phonological awareness and two
tests of rapid naming. Although three different types of rapid naming tasks
were administered, it is interesting to note that only two of them were
discriminating measures (i.e., the R.A.N. measure and a rapid alternating
stimuli measure). The Boston Naming test was not a discriminating measure.
In view of Wolf's (1991) findings, however, this result is not surprising
since the latter measure is thought to correlate more highly with reading
comprehension than with word recognition because the stimuli are more
semantically complex. Kinsbourne et al. (1991) found that the R.A.N.
measures effectively discriminated the severe dyslexics from both the
recovered and the normal group. Decker (1989) also found that the R.A.N.
measures distinguished between adults with reading disabilities and normal
controls.

Pennington and his colleagues (Pennington et al., 1990) also
administered a test of rapid naming to a group of 3rd generation familial
dyslexics and "clinic dyslexics". In contrast to the Felton et al. (1990)
and Kinsbourne et al. (1991) results, he found no differences between the
dyslexics and the normals. It should be noted, however, that the Pennington
group used a discrete trials method for rapid naming whereas the latter
groups employed a continuous naming task. Given Wolf's review (1991), the
finding that the discrete trials method did not detect group differences
among adults is not surprising. The discrete trials task does not appear to
be as good an analogue of the reading processes as the continuous tasks
(e.g., R.A.N.). It is unclear from Felton et al.'s (1990) study whether the
rapid naming deficits on the continuous tasks could be accounted for by the
level of reading skill and/or degree of print exposure in this sample since
they did not contrast the adult dyslexics with reading-level controls.

The finding that nonword reading and phonological processing were
discriminating measures is consistent with other studies of adult dyslexics (Bruck, 1990; 1992) and with 3rd generation familial dyslexics (Pennington et al., 1990). Difficulties with subtle aspects of speech perception have also been observed in adults with familial dyslexia (Steffens et al., 1992). Poor phonological skills have also been observed in other adults with poor reading skills whose childhood status is unknown (Blalock, 1987; Kitz & Tarver, 1989; Pratt & Brady, 1988). Although there has been some suggestion that deficits in phonological awareness may simply be one consequence of lower cognitive ability in some of these adult groups (Simpson & Byrne, 1987), among dyslexics it appears to be a defining feature which persists into the adult years.

A recent study by Bruck (1992) was specifically designed to address some developmental issues concerning the relationship between reading and phonological awareness. Bruck assessed both children and adult dyslexics and contrasted their performance with normal children in grades one, two and three and with a sample of normal college students. She used three different phonological awareness tasks; syllable counting, phoneme counting and phoneme deletion. Her conclusions extend the findings of previous research in this area and deal with issues of persistence, causality and development. A summary of her conclusions are presented below.

Both dyslexic children and adults are below age expectations on phonological awareness tasks and they do not use orthographic information to the same extent as normals. A more profound finding is that both child and adult dyslexics perform less well on phonological awareness tasks than reading-level controls. Moreover, relative to their age mates, their phonological awareness develops very little as they become older or more skilled in word recognition. An exception, however, was found for onset-rime tasks which do appear to develop as a function of age and level of reading skill.
Thus dyslexic children appear to begin their reading careers with poor phonological skills and are consequently delayed in their acquisition of word recognition skills. In normal children, it is thought that their repertoire of known words begins to grow more rapidly as their knowledge of orthographic patterns and phonological patterns are integrated. That is, phonological awareness promotes orthographic skills and vice-versa (Barron, 1991; Bruck, 1992; Lovett, 1991). The dyslexic child, however, appears to be unable to integrate these two interdependent knowledge sources because phonological awareness skills are weak and are not enhanced by a growing repertoire of orthographic knowledge. Thus the reciprocal relationship between orthographic knowledge and phonological knowledge accounts for the failure to acquire word recognition skills at the same rate as chronological peers. Moreover, these deficits in phonological awareness appear to persist and hence influence the course and nature of word recognition skill acquisition over several years.

9. Higher-Order Language Processing

The higher-order language processes of dyslexic adults with childhood diagnoses have received limited attention. Kinsbourne et al. (1991) reported that there were no significant differences between dyslexics and normal controls on the BNT, a test of picture naming accuracy or lexical access. Verbal fluency (FAS and Categories) and verbal learning (CVLT) were discriminating measures. I am not aware of any studies of adult dyslexics with childhood diagnoses in which listening comprehension and/or working memory have been assessed.

10. Orthographic Processing and Print Exposure

Although there is evidence to indicate that phonological skills account for a large proportion of the variance in word recognition in normal adult readers, there is still some remaining variance in word recognition that is thought to be accounted for by orthographic processing.
skills or the "ability to form, store and access orthographic (visual images of letters, words) representations" (Stanovich & West, 1989). Orthographic processing skills have been found to be independent predictors of word recognition skill (Conners & Olson, 1990; Olson, Wise, Conners & Rack, 1990) and to have a causal relationship with exposure to print (Stanovich & West, 1989). The more often one is exposed to written material, the more likely one is to develop better orthographic processing skills.

The notion of exposure to print is important for the present study for two reasons. First, one assumption underlying the logic of the reading-level matched design is that subjects who are matched on levels of word recognition skill will also be matched on corresponding degrees of exposure to print (Backman, Mamen & Ferguson, 1984). It has been argued that one's level of word recognition skill limits one's exposure to print (Stanovich, 1986) particularly in instructional settings. Second, exposure to print may be an important predictor of outcome among adult dyslexics. In preparation for the present study, I hypothesized that adult dyslexics who are the best text readers (for accuracy, speed and comprehension) would be those who, despite deficient word recognition skills, have been exposed to print more often over the years than their less proficient (text reading) adult dyslexic peers.

An exposure to print advantage may be one of several possible factors that allows some adult dyslexics to compensate for deficient phonological awareness skills. However, to my knowledge, this aspect of orthographic processing skill has not been considered in any of the well controlled studies of adult dyslexics to date.

Recognizing the potential importance of print exposure as a factor to be considered when unravelling some of the mysteries of the normal reading
process, Stanovich and his colleagues (Cunningham & Stanovich, 1990; 1991; Stanovich & West, 1989) have recently developed a new approach to its measurement. Their approach was designed to overcome some of the disadvantages of traditional self-report instruments in which subjects were typically asked how many hours per week they read various types of materials. The major problem with these types of questions was that subjects tended to answer in a socially acceptable fashion thereby inflating their scores on measures of volume of print exposure or reading activity.

Stanovich and his colleagues (1989; 1990; 1991; 1993) have developed four tests to measure print exposure or amount of reading practice more efficiently although admittedly retrospectively: (1) The Author Recognition Test (ART); (2) The Magazine Recognition Test (MRT); (3) The Newspaper Recognition Test (NRT); and (4) The Title Recognition Test (TRT). The first three print exposure measures were developed for adults while the latter was developed for children. In each test, the subject is given a list of titles (TRT, NRT, MRT), or authors (ART). Some of these are actual titles and some are foils. The subjects are asked to indicate which are the real titles.

Stanovich and West (1989) reported that college undergraduates scored higher on the MRT than the ART. This is not surprising since the reading of magazines is a less demanding task than book reading. Furthermore, one is more likely to become acquainted with magazine titles in the course of every day visits to supermarkets, doctors' offices and other public places. Scores on the ART were associated with both orthographic and phonological tasks but once the effect of phonological tasks was removed, the ART continued to account for a sizable proportion of the variance in word recognition. MRT was not an independent predictor of word identification nor orthographic/phonological experimental tasks but was a significant
predictor of reading comprehension (after ART was entered). Why this is so is not clear. In a subsequent factor analysis, ART loaded on both phonological and orthographic factors. It had been expected that it would be associated with phonological tasks but its role as an independent predictor of orthographic tasks was of particular interest.

The TRT was developed as a children's version of the ART. Rather than being required to recognize names of popular authors, children are required to recognize the names of popular children's book titles. Findings similar to those of Stanovich and West (1989) emerged when Cunningham and Stanovich (1990) administered the test to a sample of 4th, 5th, and 6th grade children. The TRT, like the ART was sensitive to individual differences in word recognition skill that could not be accounted for by phonological processing skill. Its relationship to reading comprehension is unclear, however, since Cunningham and Stanovich (1990) did not include a comprehension measure in their battery. In a subsequent study, however, the TRT was found to be an independent predictor of verbal skill including word knowledge, verbal fluency, and general knowledge even after the effects of general ability and phonological processing skills were partialled out.

These studies clearly indicate that the ART and the TRT are good predictors of individual differences in word recognition skill. Their relationship to reading comprehension, however, is less clear. While the ART proved to be the better predictor of word recognition skill, the MRT contributed to some variance in reading comprehension skill differences. In any case, taken together, these three measures appear to more useful indices of print exposure than previous measures have been.
F. SUMMARY CONCLUSIONS, RATIONALE and PURPOSE FOR THE PRESENT STUDY

1. Summary

In the past, the majority of follow-up studies of adults with childhood reading and learning disabilities have focussed on general educational and occupational outcomes. Taken together, these studies suggest that the most favourable outcomes in young adulthood are associated with higher parental SES, higher childhood IQ levels, secondary school graduation, parental support and the continuation of literacy activities in either occupational or educational settings.

Recent follow-up studies have focussed more specifically on the actual reading performance of adults with childhood diagnoses of dyslexia. These studies have tended to concentrate on the word recognition skills of adult dyslexics. Despite the relatively small number of studies, the consensus among them appears to be that the majority of adult dyslexics have persistent problems in word recognition and spelling. They also appear to be impaired in several of the skills and processes that are thought to underlie word recognition including phonological awareness, rapid naming of letters, and knowledge of sound-symbol correspondences (inferred from poor results on nonword reading). Furthermore, it has been reported that phonological awareness and nonword reading are poorer than expected for their age as well as their level of reading skill. Rapid naming of letters has been reported to be poorer than expected for age but it is not known whether this skill is poorer than expected for their reading level. A consistent trend emerges from these reports on word recognition skill leading one to conclude that almost all adult dyslexics will be impaired to some degree in word recognition accuracy and/or rate. Nevertheless, many appear to acquire skill levels that allow them to engage in functional reading tasks.
2. Unanswered Questions

In contrast, the literature on connected discourse reading skills is sparser and less clear. One finding that is particularly intriguing, however, is that many adolescent and adult dyslexics score better than expected on connected discourse reading measures despite persistent word recognition deficits. In contrast to normal adult readers, there appears to be little association between word recognition skills and reading comprehension skills among adult dyslexics. Some adult dyslexics with very low levels of word recognition skill score well on tests of reading comprehension whereas others do not. This dissociation of word recognition skill and text reading skill has been noted in samples of normally achieving young readers (Curtis, 1980), and in samples of older dyslexic children (Lovett, 1987), and dyslexic adolescents (Conners & Olson, 1990). What remains unclear, however, is what accounts for this dissociation.

Among normal adults, both word recognition and general verbal listening skills appear to be important predictors for connected discourse reading outcomes. In the few studies of adult dyslexics, there has been little attention devoted to the role of higher-order oral language and cognitive skills in predicting connected discourse reading achievement outcomes. Decker (1989) and Kinsbourne et al. (1991), however, found that verbal fluency was poor in samples of adult dyslexics. It is argued that many of the unanswered questions concerning the adult sequelae of developmental dyslexic can be addressed by gathering oral language and cognitive data.

For instance, it has been hypothesized in three different studies that some form of compensation may be the explanatory mechanism in predicting group and individual differences in connected discourse reading success. It is difficult to determine the extent to which this compensation hypothesis could explain these differences since the construct of
compensation has been applied inconsistently. Comparisons across studies are also difficult because different aspects of connected discourse reading skill have been measured. Finally, none of the published studies to date have directly tested any form of the compensation hypothesis although there is indirect evidence to suggest that this hypothesis is promising.

I. THE PURPOSE OF THE STUDY

The purpose of the present study was to extend our knowledge of the connected discourse reading skills of adults with documented childhood diagnoses of developmental dyslexia. The study is designed as a follow-up study and examines both achievement outcomes and processing outcomes. Of particular interest is the extent to which adults with childhood diagnoses of developmental dyslexia recover from, or compensate for, their early childhood deficits.

The empirical literature has indicated that it is difficult to predict what variables are associated with individual and group differences in achievement outcomes. The theoretical literature, however, would suggest that oral language and cognitive skills are closely associated with connected discourse reading skills. Thus, another purpose of the study was to determine what levels of oral language skill are actually acquired by young adults with childhood diagnoses of dyslexia.

In summary, the first purpose of this follow-up study was to determine what achievement levels are acquired by a sample of young adults with childhood diagnoses in the following skills: (1) connected discourse reading; (2) related reading and written language; and (3) lower-order and higher-order oral language and (4) cognitive. The second purpose of the study was to determine what oral language skills are associated with the best connected discourse reading outcomes. The third purpose of the study
was to determine the extent to which adult dyslexics use compensatory processing while reading connected discourse. Inferences about compensatory processing are derived from examining the relationships between and among reading, oral language and cognitive skills. In the next section of this chapter, the research questions for this follow-up study are presented.

RESEARCH QUESTIONS

1. Question One

What levels of skill do adult dyslexics achieve on various aspects of connected discourse reading? To what extent are these levels appropriate for their age and their level of word recognition skill?

a) Question One: Comments and Predictions

Recovered?: If the adult dyslexics perform as well as their chronological peers on measures of connected discourse reading, using both accuracy and speed criteria, then they will have recovered from their early reading deficits. If this result is observed, one could infer that either environmental or biological factors are responsible for the change. Possible candidates for positive environmental influences are good instruction/treatment or high levels of print exposure. An alternative hypothesis is that the positive change could be attributed to neurocognitive maturation (Kinsbourne et al., 1991). Since the empirical literature indicates that the majority of adults with documented childhood diagnoses of dyslexia continue to have difficulties in some aspect of reading skill, it was expected that the sample selected for this study would not have fully recovered.

Developmentally Delayed?: If the connected discourse reading skills of the adults with childhood diagnoses are comparable to younger children and adolescents or word recognition reading-level controls, then there will be support for the developmental lag hypothesis. It was expected that the
younger children and adolescents would have an advantage in phonological coding (i.e., nonword reading), whereas the adult dyslexics would have a slight advantage in silent reading comprehension when time limits are liberal.

2. **Question Two**

What levels of skill do adult dyslexics achieve on higher-order and lower-order oral language and cognitive skills? To what extent are these skills appropriate for their age and their level of word recognition skill?

b) **Question Two: Comments and Predictions**

The literature would suggest that the adult dyslexics will be deficient in lower-order oral language skills. They may, however, have specific strengths in higher-order language skills.

3. **Question Three**

What cognitive and oral language skills best account for individual differences in connected discourse reading outcomes among adult dyslexics?

a) **Questions Three: Comments and Predictions**

It was hypothesized that those with the best reading comprehension skills would be those with the strongest oral language and cognitive skills. This is the Bruck (1990) compensation hypothesis. The argument is that better achievement in connected discourse reading will be associated with better oral language and cognitive skills. To answer this question about achievement outcomes adult dyslexics are evaluated relative to their dyslexic peers.
4. **Question Four**

What is the nature of the relationship between oral language, cognitive and connected discourse reading skills among adult dyslexics? Is there any evidence for compensatory processing among adult dyslexics with childhood diagnoses of dyslexia?

a) **Question Four: Comments and Predictions**

While questions one and two refer to achievement outcomes, question four refers to processing outcomes. Compensatory processing may be evident, or not, irrespective of achievement outcomes. To evaluate the extent to which compensatory processing is evident, a variety of data will be considered. Compensatory processing will be inferred under three different conditions.

First, it is possible that adult dyslexic readers may compensate for weak 'local processes' when they read connected discourse by adjusting their rate. Thus, adult dyslexics may be comparable to controls on accuracy but slower on speed (Lefly & Pennington, 1991).

Second, readers may differ from controls on their oral language and cognitive skills. For instance, it was expected that adult dyslexics would have relatively poor lower-order oral language skills and poor phonological coding but better higher-order language skills. With this profile, it is possible for adult dyslexics to present with connected discourse achievement outcomes that are comparable to controls but have arrived at the same destination via different information processing routes. Evidence for compensatory processing, therefore, might be derived by examining patterns in the profile of oral language and cognitive skills. When evaluating the interrelationships among component skills and connected discourse reading skills, an adapted version of the Conner’s and Olson componential model (1990) provides a point of reference. Since predictions
for question four are related to this model, it is presented below.

The model in Figure 1 depicts a set of relationships among the reading and oral language variables that are thought to be associated with reading comprehension. The model is an adaptation of the Conners and Olson (1990) model but it includes more aspects of oral language skill. The main structure of the Conners and Olson model, which is based on Hoover & Gough (1989), is retained. This structure reflects the independence of word recognition and reading comprehension skill which has been noted in previous empirical investigations of dyslexic children (Lovett, 1987), adolescents (Conners & Olson, 1990), and adults (Bruck, 1990). Lower-order oral language skills are most closely associated with word recognition skill whereas higher-order language and cognitive skills are associated with reading comprehension. It is predicted that the elements in this hierarchy will be the same for adult dyslexics and reading-level controls but the extent to which each relationship contributes to reading comprehension outcomes is expected to vary by reader group.

Summary

In order to evaluate the long term connected discourse reading skills of adults with childhood diagnoses of dyslexia, both achievement and information processing outcomes will be evaluated. The achievement outcomes will be contrasted with control groups to determine the extent to which the skills of the adult dyslexics are appropriate for their age and their level of word recognition skill. To understand the individual and group differences in achievement outcomes, it will be necessary to evaluate oral language and cognitive skills. It is expected that connected discourse reading outcomes will be predicted, in part, by oral language and cognitive skills in this population. In Chapter Three, the methodologies for this follow-up study are presented.
CHAPTER THREE

METHODOLOGY

A. DESIGN

Traditionally, investigators who were interested in reading disabled populations employed a two-group design in which the reading disabled or dyslexic group was compared with a group matched for chronological age (CA). Results from this type of two-group design, however, are difficult to interpret. When discrepancies in language or cognitive variables are found, between a dyslexic group and an age-matched (CA) group, it is difficult to identify the locus of these observed differences. The differences could be attributed to a reading disability, to the developmental level of reading skill, and/or to the amount and types of print exposure and reading experiences.

To overcome these difficulties with interpretation, some researchers have employed a type of correlational design (Jackson & Butterfield, 1989) that was developed specifically for the study of reading and is particularly useful for investigations of reading disability. Although the reading-level-match design was originally proposed by Guthrie in 1973 (cited in Jackson & Butterfield, 1989), it was rarely implemented during the subsequent decade. Recently, however, it has enjoyed popularity in response to a paper by Backman et al. (1984), in which its value for the study of reading disabled populations was highlighted.

In a reading-level design, the dyslexics are not only contrasted with CA peers but are also contrasted with a group of younger children or adolescents who are matched to the dyslexic group on a specific aspect of
reading skill. In the present study, the younger reading-level controls (RL) were matched with the adult dyslexics on single word recognition skill (i.e., the raw scores on the Wide Range Achievement Test-Revised (WRAT-R, Level II) (Jastak & Wilkinson, 1984). This match was made using the adult word recognition scores for the adult dyslexics with childhood diagnoses. The adult dyslexics (AD) were also contrasted with a second group who were matched for chronological age (CA). The advantage of this three-group reading-level design, in contrast to the traditional two-group design, is that differences among groups can be interpreted more precisely.

When the results, reported in Chapter Four, indicate that the dyslexics are comparable to the CA controls on a particular cognitive or linguistic skill, then the variable is likely associated with age rather than with reading skill. On the other hand, if the dyslexics are comparable to the RL controls but both are inferior to the CA controls, the variable is likely associated with their developmental levels of word recognition skill and/or their corresponding levels of print exposure (i.e., reading experience). But if the dyslexic group (AD) performance is significantly different from the performance of both the reading-level controls (RL) and the chronological controls (CA), then the variable of interest is more likely associated with the reading disability.

B. PARTICIPANTS: SELECTION CRITERIA AND PROCEDURES

In the present study, three groups of participants were selected: (1) a group of young adults (17 to 23 years) with documented diagnoses of developmental dyslexia in childhood (AD); (2) a group of average young adults (17 to 23 years) who were not diagnosed with dyslexia or any other type of learning disability in childhood or adolescence who served as the chronological (CA) controls and (3) a group of average younger children and adolescents who served as the reading-level controls (RL).
1. Adult Dyslexics with Childhood Diagnoses of Dyslexia (AD Group)

To qualify for the study, the adult dyslexics must have been identified, by a qualified educational consultant or registered psychologist, as having reading difficulties in childhood despite at least average intelligence and adequate social and educational opportunities. To qualify as having average intelligence in childhood, the adult dyslexics must have achieved a score in the average range or above (i.e., not lower than one standard deviation below the mean) on at least one of the following tests: (1) the Wechsler Intelligence Scale for Children: Revised (WISC-R) (Wechsler, 1974); (2) the Stanford-Binet Intelligence Test Form L-M (Terman & Merrill, 1960); (3) the Stanford-Binet Intelligence Test: Fourth Edition (Thorndike, Hagen & Sattler, 1986); or (4) the PPVT (Dunn & Dunn, 1959) or the PPVT-R (Dunn & Dunn, 1981). To qualify as dyslexic, the participants’ files must have indicated that they had difficulty learning to read. Since the potential subjects had been assessed in childhood by several psychologists or educational consultants who administered a variety of tests in many age ranges, some clinical judgement was applied in the decision to include any particular alumnus on the mailing list. To evaluate difficulty in the acquisition of decoding skills, the children’s scores on measures of single word recognition, spelling, oral reading, alphabet knowledge and sound-symbol correspondences were considered. Scores below one standard deviation on at least one of these measures was necessary for inclusion on the mailing list. Even though the battery of childhood tests had been selected and administered according to individual differences and preferences, evidence of difficulties in acquiring word recognition and/or phonological skills was the major criteria for inclusion. The psychometric profiles of subjects who actually responded to the invitation to participate in the study are presented in Chapter Four. Participants who were diagnosed with some other form of childhood psychopathology, including attention deficit disorder, conduct disorder or depression, were not considered eligible and were excluded from the mailing list.
All of the AD participants were alumni of the Kenneth Gordon School in Burnaby, British Columbia, a suburb of Vancouver and/or the Fraser Academy in Vancouver. The Kenneth Gordon School is a private school that has been in operation for more than twenty years and specializes in the education of children and adolescents (Kindergarten to Grade 6) with developmental dyslexia or specific reading disabilities. Traditionally, the Kenneth Gordon faculty have adopted a reading curriculum that is based upon the Orton-Gillingham approach to reading and spelling instruction. The Orton-Gillingham programme employs a multisensory approach to phonetic instruction with an emphasis on letter/sound relationships, rhyming, word families and the memorization of phonograms. The school selects a relatively homogeneous group of children with respect to socioeconomic status and psychometric profiles. The Fraser Academy is a private secondary school for adolescents with various types of learning disabilities. Many families, students, and members of the Boards of Directors have been involved with both schools.

Thus, the AD participants were selected on the basis of a documented childhood diagnosis of developmental dyslexia. Neither their adult reading performance nor their occupational/educational status in adulthood were considered in the selection process. These selection criteria differ, to some extent, from those used for other samples of adult dyslexics that are described in the literature. Other samples have been selected on the basis of: (1) a self-reported childhood diagnosis (e.g., Scarborough, 1983); (2) adult reading skills (Johnson & Blalock, 1987; Lefly & Pennington, 1991) or (3) documented childhood diagnosis and adult educational status (e.g., Bruck, 1990; 1992).

The present sample resembles two samples in the literature: (1) the sample selected by Felton and colleagues (1990) because their participants were selected solely on the basis of childhood records preserved by the
Orton Society; and (2) the Bruck (1990) sample for whom the selection procedures and criteria were similar. In the Bruck sample all subjects had WISC IQ scores higher than 85. There was evidence in the childhood files that the children had had difficulty acquiring reading skills. Both "clinical judgement" and scores from a particular reading test were considered. Specifically, reading achievement in childhood was evaluated by scores on the Durrell Test of Reading Difficulty. The subjects had scores that were at least 1.5 grade level points below on at least one subtest and below grade level on both the word recognition and oral reading (i.e., paragraphs) subtests.

To select potential participants who met the pre-established criteria, all of the files of the Kenneth Gordon Alumni were reviewed (N = 185) in the winter of 1993. Files of alumni, whose birth dates indicated that they would be between the ages of 17 and 23 in the spring/summer of 1993 and who met the psychometric screening criteria, were marked with yellow stickers (n = 54). Staff of the Kenneth Gordon School then cross-referenced the students' names with a list of mailing addresses. Next, two letters were mailed to each of these 54 alumni informing them of the study and inviting them to participate. The letters were addressed to both the students and their parents. The first was a letter on U.B.C. letterhead from the investigator and her supervisor and the second was from Ellen Baglot, the Principal/Administrator of the Kenneth Gordon School. Copies of these letters are presented in Appendix 1 and Appendix 2, respectively. Also included in the envelope was a response card with prepaid postage. Alumni who were interested in the study were invited either to phone the office at U.B.C. or to indicate their interest on the response card so that we could call them.

The "office" telephone line to which alumni were asked to respond was for a cellular phone with an easy-to-remember number (i.e., 880-2345). I
specifically requested an easy number from the B.C. Telephone Company for this research project. I carried the phone for 18 hours a day from February, 1993 through to June, 1993. This strategy was implemented for both practical and clinical reasons. First, there was less likelihood of missing telephone calls when they could be answered immediately. Second, I anticipated that the Kenneth Gordon alumni would feel uneasy about a history of reading problems and would appreciate a courteous, immediate and informed response to their calls.

Thirty-three people (i.e., either the young alumni or a parent), (i.e., 61% of those to whom letters were sent) contacted the office to express their interest or to ask questions. Of these, 23 (43%) young people made appointments to come to the clinic for the four-hour testing session. Only one potential participant did not arrive for a scheduled appointment. Most of the AD participants indicated that they were motivated by the $50.00 honorarium offered for their participation in the study. Others indicated that they wanted to do whatever they could to help the younger children presently attending the school. In many of the families, who responded to our correspondence but did not make appointments, it appeared that the parent/s were more interested in the study than the Kenneth Gordon alumni. Twenty-one (39%) potential participants did not respond to the letters in any manner. Since there was an average of 10 years from the time they last attended the school until the letters were mailed, it is believed that many of the addresses were incorrect. For those who did make appointments, every effort was made to schedule the appointment times for their convenience. Morning, afternoon and evening appointments were scheduled both during the week and on weekends.

2. Chronological Controls (CA Group)

To qualify as a CA control, participants were required to fall within the same age range as the AD participants (17-23 years) and to come from
similar socioeconomic backgrounds. The CA participants did not have a
diagnosis of dyslexia or any other type of learning disability or
psychopathology in childhood. Since childhood IQ scores were not available
for the CA controls, IQ was estimated by the Raven’s Progressive Matrices
Test (Raven, Court & Raven, 1986) and the Peabody Picture Vocabulary Test-
Revised (PPVT-R) (Dunn & Dunn, 1981). The Raven’s is a nonverbal test of
analytical intelligence (Carpenter, Just & Shell, 1990) and the PPVT-R is a
test of receptive vocabulary. Potential participants who scored more than
one standard deviation below the mean on the Raven’s (n = 1) and anyone who
indicated that she/he had been in a programme for gifted students on the
School Information Form (n = 1) was not included in the analyses.

In order to control for socioeconomic status and other environmental
variables, we asked every AD participant to recommend a friend who did not
have reading disabilities as a child to also participate in the study. Only
three AD participants recommended or brought a friend with them to the
sessions. Thus the intended selection process for the CA group was
modified. Since I did not want to select participants with any educational
or occupational bias, the CA participants were recruited from a variety of
recreational and church organizations in the Lower Mainland. Other CA
participants were acquaintances of the present staff of the Kenneth Gordon
School. This selection process was successful in that there were no
significant differences between the CA group and the AD group with respect
to socioeconomic status, as measured by father’s occupation and mother’s
highest grade level in school. These data appear in Table 1 and are
outlined in detail in Chapter Four.

3. Reading Level Controls (RL Group)

The RL controls were younger children and adolescents who were
average achievers for their age and grade as indicated by their parents
and/or report cards. These participants were selected to match the AD
participants on socioeconomic status, and the raw scores on the single word recognition scores from the WRAT-R II. Although the Level II version of the WRAT-R would not normally be administered to children younger than 12 years of age in clinical/school settings, for this research it was necessary to disregard this aspect of the standardized procedures to ensure consistency across groups. Since some of the AD participants had word recognition levels that were lower than grade 6, the grade level usually associated with age 12, it was necessary to select some younger RL children as matches. The youngest RL participant was 9 years old.

The reading level controls were not selected through the public school system. Instead, the RL participants were referred by staff, families, and local consultants who were associated with the Kenneth Gordon School. Several of these younger children and adolescents were unaffected siblings of current students of the Kenneth Gordon School (n = 8). Like the CA controls, their IQ’s were estimated by the Raven’s Progressive Matrices (Raven et al., 1986) and the PPVT-R (Dunn & Dunn, 1981). To be eligible for the study, the RL participants were required to be of at least average intelligence, as estimated by one of the latter tests. Since all the RL participants were minors, parental consent was required for participation. The parent consent form is presented in Appendix 3 and the subject consent form is presented in Appendix 4.

4. Sample Size

A total of 70 participants were tested. There were 23 CA controls, 24 RL controls and 23 AD participants. Test results and data are not reported for four of these participants. One CA participant was eliminated because of a very low score on the Raven. One RL participant was eliminated because of some errors in test administration. Another was eliminated because of high SES scores and a history of participation in programmes for gifted students. One AD participant was eliminated because the childhood history
was unclear.

C. TESTING PROCEDURES AND EQUIPMENT

1. Schedules and Location

Participants were tested in the Psycho-educational Research and Training Centre at the University of British Columbia under standard conditions in a quiet room with no distractions. The average total testing time per participant was four hours with a range from 3.5 to 4.5 hours. Many of the older CA and RL participants finished the tasks in less than four hours, whereas some younger RL participants and many AD participants took longer than four hours to complete the battery. At least two breaks were scheduled for each participant. Additional breaks were arranged if participants so wished. For all participants, the testing session was conducted on a single half-day or evening.

The test administration session was preceded by the completion of the Information Form (Appendix 5). This routine served as an "ice-breaker" and ensured that the screening criteria were met. For all the other tests and measures, the order of administration was arranged so that there was variety in the types of tests administered. Testers were encouraged to vary the order for individual participants to ensure that the participants were able to experience success at regular intervals throughout the session.

2. Tester Qualifications and Training

I personally tested the majority of the participants in the project. I am an experienced clinician, special education teacher and educational consultant. Two research assistants assisted me with the testing of the remaining participants. The first research assistant holds an undergraduate degree in experimental psychology. Several training sessions were conducted with volunteer pilot participants for this research assistant. The second research assistant was a third-year master's level student in school
psychology with 15 years of experience as a school teacher, psycho-educational consultant and clinician. This research assistant was familiar with the procedures for the standardized measures but was trained to administer the experimental tests with some volunteer pilot participants. Both research assistants had the opportunity to observe me administer the complete battery with both children and adults. Furthermore, I observed both research assistants while they tested at least three participants to ensure that the administration procedures were consistently applied. Both research assistants were paid an honorarium for their participation in this project.

3. Testing Materials and Data Processing Equipment

All testers had a testing manual that included the administration procedures for all tests. In addition, all of the response protocols had the administration instructions clearly typed at the top of the page so that the testers could refer to them. For timed tests, all testers used hand-held stopwatches. All testers were equipped with a clipboard that was used during each administration to ensure that participants could not see the response protocols. Two sets of testing materials were available in two separate file boxes. The test materials were arranged alphabetically for easy retrieval. Eighty test protocol folders were prepared before any of the participants were tested. These folders were stored in a locked file cabinet. Each folder contained every response sheet that the testers would require. Protocols were printed on colour-coded paper so that the testers could find materials quickly and effortlessly.

4. Recording Procedures

As each test was administered, the protocols were marked with the participant's group designation (e.g., CA, RL, or AD) and a personal identification number. Numbers were assigned to participants, in order, according to the date of testing. For instance, the first participant to be
tested was CA-01 and one of the last was AD-67. This record keeping system ensured individual participant confidentiality without sacrificing the accurate recording of group identification on participant protocols. Participants' names did not appear on any test protocol.

5. **Computer Equipment**

The statistical software programmes for this research were run on an IBM-PC 486 computer. Preliminary scoring, exploratory data analyses and some minor calculations were executed by the Minitab Statistical Software for PC use (Release 8). All other analyses were undertaken with the PC version of BMDP (Dixon et al., 1990), BMDP/DYNAMIC (Release 7).

D) **FOLLOW-UP TEST BATTERY: CA, RL and AD**

The follow-up test battery was administered to all participants in all three groups and consisted of six sections or sets: (1) School History and Demographic Information; (2) Reading Skills and Exposure to Print; (3) Oral Language Skills; (4) Memory Skills; (5) General Information Skills; (6) Nonverbal Reasoning; and (7) Written Language Skills.

1. **Information Form**

The Information Form was completed by the testers at the beginning of the testing session. Its main purpose was to gather demographic and school history information. Some of the information gathered was used to match the three groups and to confirm the selection criteria, while some of it was used to examine individual differences within the adult dyslexic (AD) group. The Information Form is included in Appendix 5.

a) **Socioeconomic Status**

Since SES has been found to be one of the best predictors of outcome in dyslexic populations (Bruck, 1985; Schonaut & Satz, 1983), data were collected on this variable. Since the sample included young adults,
children and adolescents, the SES indices for their parents, rather than for the participants themselves, were recorded. Two indices of SES were considered: 1) father's occupation and 2) mother's highest grade successfully completed in school. Using these indices of SES, the control groups were selected so that the participants' family SES levels were comparable.

The quantitative indices of SES, based on fathers' occupations, were derived from a socioeconomic index that was developed using data from the 1981 Canadian census (Blishen, Carroll & Moore, 1987). This index is a numerical score that was derived from a regression equation that considers median income levels and educational level per occupation. In this formulation, both income and educational levels were weighted equally. Furthermore, unlike previous Canadian SES indices, this index considers both genders in the data used for its development (Blishen et al., 1987). The scale includes 514 occupations with a mean score of 42.74, a standard deviation of 13.28 and a range from 17.81 (i.e., newspaper carriers and vendors) to 101.74 (i.e., dentists). In the present study, if the mother was the head of household, then the mother's occupation was used to compute the "Father's occupation" SES index.

In addition, data on mothers' highest grade level, a sensitive indicator of SES (Willms, 1990), were collected. Participants or their parents, in the case of the younger children, were asked to indicate the highest grade or degree attained by the mother.

b) School History

The school history section of the Information Form had two purposes. First, the criteria for sample selection were verified. For instance, the question, "Were you ever enrolled in a program for gifted children?" was asked. Participants who were labelled gifted were not eligible for
inclusion as control participants unless there was a comparable match among the AD group (i.e., an AD participant who was also thought to be gifted in childhood). The Information Form also asked if participants were ever enrolled in French Immersion programmes. Participants were asked if they ever spent any time in a special school or programme for children with reading problems and if they repeated any grades. Finally, participants were asked to indicate the highest grade level in which they were enrolled and/or had completed.

c) Occupational History

Participants were asked to indicate, by year, their occupational history. Information concerning occupation/titles and job responsibilities were requested. Occupational data was found to be associated with literacy outcomes in a previous investigation (Bruck, 1985). Adult dyslexics who were either in occupations with low literacy demands or who had not graduated from high school tended to have poorer literacy skills.

d) Demographic Information

Information concerning family composition, marital status (for the adults), date of birth, current address and phone number were also compiled. These data were used for practical and descriptive purposes.

2. The Reading and Spelling Battery

The reading/spelling battery consisted of tests of both lower-order and higher-order skills. There were measures of single word recognition, pseudoword or nonword reading, and spelling. The higher-order reading skills battery included measures of connected discourse reading comprehension, speed and accuracy.

a) Wide Range Achievement Test-Revised

The reading subtest of the Wide Range Achievement Test-Revised (WRAT-
R, Level II) (Jastak & Wilkinson, 1984) was administered. This subtest is a test of single word recognition accuracy. Participants are required to read, aloud, single words that are ordered according to difficulty. The test is terminated after a ceiling of 10 consecutive errors is reached. The Level II test was used since it is designed for participants between the ages of 12 and 75.

The manual reported that test-retest reliability coefficients are above .79 and that most coefficients fall above .92 (Jastak & Wilkinson, 1984) when all subtests are considered. An informal review of the WRAT-R Level II Reading subtest content revealed that the corpus of words that was selected appeared to include both phonetically predictable (e.g., grunt) and irregular words (e.g., toughen). Although the majority of studies of concurrent validity were undertaken with the total test scores (i.e., Reading, Spelling and Arithmetic), the results indicated that the WRAT-R correlates adequately with similar achievement tests (Harrison, 1985).

One reviewer has suggested that caution be exercised when using this test with adults since the characteristics of the adult standardization sample are very vaguely described in the manual (Harrison, 1985). Nevertheless, it is argued that the WRAT-R Level II was an appropriate measure to use in this study for three reasons. First, as expected, the reading levels of the AD sample closely resembled those of younger adolescents and children. Second, since this measure was used in two recent follow-up studies of adults with childhood diagnoses of dyslexia (Bruck, 1990; 1992), its use allowed comparisons with these samples. Finally, since many of the adult dyslexics (AD) were selected on the basis of their WRAT-R scores in childhood, comparisons over time were also possible.

b) Bruck's Matched Word/Nonword Reading Task

The Bruck Word Reading test (Bruck, 1990) consists of 40 phonetically...
predictable words. This test is an experimental measure. The Bruck nonword test is a companion to the Bruck real word test. It consists of 40 nonwords, including 20 one syllable nonwords or pseudowords (e.g., plit) and 20 two syllable nonwords (e.g., pimsot). These 40 nonwords are matched with the 40 real words on length, number of syllables, and orthographic structure. Bruck did not report reliability data for this experimental measure but its contrasted groups validity is of interest. Bruck's adult dyslexics and the reading-level controls performed at comparable levels on the word measure but differed on the nonword measure (Bruck, 1990).

The Bruck words and nonwords were typed on recipe cards. Each card/word was presented to the participant separately. Both accuracy and response latencies were recorded. All testers practised the technique for presenting cards until there was some consistency between and within testers. Although it would have been desirable to use a computer with voice recognition capabilities to record response latencies, the limited resources for this project made this option cost prohibitive. This card "flipping" technique, however, has been used successfully in previous research (Lovett, Ransby & Barron, 1988).

c) Wide Range Achievement Test-Revised (Level II): Spelling Subtest

The spelling subtest of the WRAT-R Level II was administered to all participants. This subtest is a spelling-to-dictation test. Spelling skill is thought, by some investigators, to reflect the quality of orthographic representations in a readers' repertoire (e.g., Perfetti, 1992) and to distinguish between "compensated" dyslexics and normals (Lefly & Pennington, 1991).

d) Stanford Diagnostic Reading Test: Comprehension Subtest (SDRT Blue)

The Stanford Diagnostic Reading Test (Blue Level): Comprehension subtest (Karlsen, Madden & Gardener, 1984) was administered to all
participants. This test is designed for participants in grades 9-12 and community college and has two parallel forms. The readability levels of the passages appear to be in the grade 3-10 range. The test was specifically designed for students who are experiencing difficulty in reading. The Reading Comprehension subtest consists of several reading passages. The participant is required to answer multiple choice questions following silent reading. Reliability coefficients for internal consistency greater than .85 have been reported and there is evidence for good criterion related validity (Ysseldyke, 1985). The SDRT (Blue): Comprehension subtest was also used in the Bruck (1990) follow-up study. Adult dyslexics, in the Bruck sample, had slightly higher scores on this measure than the Grade 6 reading level controls but this difference did not reach significance. The results from the present study can thus be compared to Bruck's results.

e) Stanford Diagnostic Reading Test: Fast Reading Subtest

For the Fast Reading subtest of the SDRT (Blue), participants are given a three minute (180 seconds) time limit to read a one page short story about points of interest for sightseers visiting California. Interspersed throughout the story are 30 highlighted lines on which there are three words. Participants are to choose the word that makes the best sense at each of these 30 stages in the story. This subtest is a multiple choice, cloze (i.e., fill in the blanks) timed silent reading task. Although the participants in Bruck's (1990) study were required to do the SDRT comprehension subtest, they were not given the Fast Reading subtest.

f) Gray Oral Reading Test-Third Edition (GORT-3)

The Gray Oral Reading Test (GORT-3) (Wiederholdt & Bryant, 1992) was administered to all participants. This test is composed of several paragraphs that are ordered according to level of difficulty, with the easiest passages appearing first. According to the standardized procedures, participants do not read all passages, as they do in the SDRT (Blue):
Comprehension subtest. Instead, they begin reading at a level that is commensurate with their grade level. For this study, the starting paragraph was determined by the grade equivalent score earned on the WRAT-R II single word recognition test (Jastak & Wilkinson, 1984). Participants are required to read the passages out loud while the examiner records errors and the time taken to read the passage. After the passage has been read, participants are asked five multiple-choice comprehension questions. Although the examiner reads the questions aloud, the participant is given a written form of the questions and asked to follow along silently as the questions are spoken by the examiner. The standardized procedure requires participants to stop reading when the participants' performance drops to two out of a possible five correct responses for reading rate, reading accuracy, and comprehension.

Four scores were derived from this test: 1) a reading comprehension score; 2) a reading accuracy score; 3) a reading rate score; and 4) a passage reading score (the total of the rate and accuracy scores). The latter three scores are based upon the oral reading performance of the participants. Thus, three different aspects of connected discourse reading skills were measured with this test. The test differs from the SDRT (Blue) in a number of ways. The SDRT (Blue) is read silently, whereas the Gray Oral (GORT-3) is read orally. For the SDRT (Blue), participants read and answer all the questions, whereas for the Gray Oral (GORT-3), participants read only the passages between individually determined basal and ceiling levels. Finally, because the SDRT is read silently, and without interaction with the examiner, there is no opportunity to measure accuracy and rate directly. The SDRT (Blue) also allows participants to reread difficult sections or to vary their speed and tactics. The administration of the Gray Oral (GORT-3) is much more controlled. It was expected that for AD participants, the SDRT Comprehension subtest results would not be highly correlated with word recognition skill (Bruck, 1990). On the other hand, it
was expected that the Gray Oral accuracy and rate scores would be significantly correlated with word recognition (Lovett, 1987).

g) Print Exposure Tests

The Magazine Recognition Test (MRT) and The Author Recognition Test (ART) (Stanovich & West, 1989) were administered as "proxy measures" (Cunningham & Stanovich, 1990) of previous reading activity or print exposure. Participants were presented with a list of magazines and authors. Some of these were actual magazines and authors and some of them were foils. The participant is required to select the real ones. These testing procedures were developed so that participants could indicate their level of reading activity in a nonthreatening manner and so that the foils could detect those who were misrepresenting their reading activities and exposure to print. Thus, the problem of participants' tendencies to answer in a socially acceptable manner is overcome. The Newspaper Recognition Test was fashioned after the NRT developed by West and his colleagues (West, Stanovich & Mitchell, 1993). The procedures and rationale for the test are similar to the ART and MRT. I adapted the West et al. (1993) version of the test to accommodate a Canadian sample. The Ransby version of the NRT includes both American and Canadian newspapers. No attempt was made to include more Canadian items in the ART, MRT nor TRT tests since the publications on the Stanovich lists are widely circulated in Canada. A sample of the NRT (Adapted) test items and the instructions are given in Appendix 6. The Title Recognition Test (TRT) was also developed by Stanovich and colleagues (Cunningham & Stanovich, 1990). This test includes actual and fictional titles of children's books.

These three (ART, MRT, NRT) tests and the corresponding version for children (TRT) are, to my knowledge, the first instruments to have been developed to measure print exposure using this indirect approach. Therefore, it is difficult to assess their reliability and validity at this
stage. Cunningham et al. (1990), however, using an earlier version of the print exposure tests, found that reading comprehension (as measured by the Nelson-Denny Reading Comprehension test) and print exposure scores were moderately correlated ($r = .39$) and that print exposure accounted for 5.7% of unique variance in word recognition.

3. The Oral Language Battery
a) Listening Comprehension

A listening comprehension test was developed specifically for use in this study. Listening comprehension was measured with oral versions of the passages from the alternate form (Form B) of the GORT-3 (Wiederholt & Bryant, 1992). The format is an adaptation of a procedure used by Cunningham et al. (1990). Cunningham et al. (1990) found that there were significant differences between skilled and less skilled college student readers on a similar version of this procedure using passages from the Nelson-Denny Reading Test as a listening comprehension measure. The specific adaptations of the GORT-3 that were made for this study are presented in Appendix 7. Details concerning the development of this adaptation are presented below.

The following administrative and scoring procedures were developed specifically for this study. Individual participants were not required to listen to all passages but were required to complete a minimum of three passages. The first passage read to a participant was determined by the score on the Reading Comprehension portion of the GORT-3 (Form A). The first listening comprehension passage for an individual participant was at the level following the ceiling passage on the GORT-3 Reading Comprehension (Form A). The follow-up questions were adapted from the multiple-choice questions given in the standardized format for the reading test (Form B). Three open-ended questions, rather, than five multiple-choice questions were asked after each passage. This question format was adopted after it
became apparent, during pilot administrations, that the multiple-choice format for listening comprehension placed excessive demands on working memory.

Standard procedures for determining a basal (i.e., starting point) and ceiling (i.e., end point) were developed for the Listening Comprehension test. The basal was the first passage for which all three questions were answered correctly. The ceiling was the last passage for which two or more errors were recorded. If, however, the ceiling passage was the passage following the basal, a third passage was read to comply with the "read three passages" rule. Thus, each participant answered a minimum of nine questions after listening to at least three passages.

Since the questions were open-ended rather than multiple-choice, it was necessary to develop a scoring protocol for assessing the quality of participants' responses. A rating of 2 indicated a complete and correct answer. A rating of 1 indicated a partially correct response. A rating of 0 was given for incorrect answers. Sample answers for each category were developed during a preliminary scoring session that was attended by all three testers. The final scoring scheme was developed by consensus for which we eventually reached 100% agreement. The Listening Comprehension questions and scoring schemes are given in Appendix 7.

b) Vocabulary

Vocabulary skill was measured with the Peabody Picture Vocabulary Test-Revised (PPVT-R) (Dunn & Dunn, 1981), a test of receptive vocabulary. In this test, the examiner presents the participant with a small easel on which four pictures are displayed. A word is spoken by the examiner and the participant is required to select the picture that best tells the meaning of the word. The test is designed for children and adults between the ages of 2 and 40.
In the standardization phase of this version of the test, 200 adults between the ages of 19 and 24 were tested. The manual reported that, for the adult standardization sample, the median reliability coefficient for internal consistency for Form L was .82. This test of vocabulary was selected over others for a variety of reasons. First, it is psychometrically sound. Second, the test has been used in many studies that are relevant to the proposed study and against which results will be compared (e.g., Bruck, 1990; Cunningham et al., 1990). In both of the former studies, the PPVT-R scores were significantly different between the skilled and less skilled readers. Third, the test is normed for children, adolescents and young adults, all of whom were participants in the present study. Finally, this test is nonthreatening because minimal verbal or nonverbal responses are required.

c) **Rapid Naming**

Rapid naming was assessed with the Rapid Automatization Naming Test (R.A.N.) (Denckla & Rudel, 1976) using a continuous format. This is an experimental measure that has been used primarily in the neuropsychological literature (see Wolf, 1991 for a recent review). In this test, the examiner presents the participant with an array of 50 items (5 items presented 10 times in random order). The participant is required to name the items as quickly as possible in sequential order. Three sets of stimuli were presented: 1) Colours; 2) Numbers; and 3) Letters. Prior to the actual test, participants were asked to name the items so that correct labelling was ensured. Both speed (response latencies per set) and accuracy were recorded. The R.A.N. using the continuous format has distinguished between dyslexic and CA controls in previous studies of both children (Lovett, 1987) and adults (Felton et al., 1990).

d) **Speed and Accuracy of Lexical Access**

The Boston Naming Test (BNT) (Kaplan, Goodglass & Weintraub, 1983)
was administered as a measure of accuracy and speed of lexical access. The
stimuli in this test are semantically more complex than the R.A.N. stimuli.
It was expected, therefore, that this task would be more highly correlated
with reading comprehension (Wolf, 1991), whereas the R.A.N. rapid naming
tasks would be more highly correlated with word recognition (Lovett, 1987).

e) **Phonological Awareness**

To measure phonological awareness, two subtests from Bruck's (1992)
experimental battery were administered: (1) Phoneme Counting; and (2)
Phoneme Deletion. For the Phoneme Counting task five "Lego" blocks were
placed in front of the participant. The participant listened to a nonsense
word (e.g., *bash*) and then used the blocks to indicate how many phonemes
were in the word. For half the words, the number of phonemes corresponded
to the number of letters in the nonsense word (e.g., *tisk*) and for the
other half, diagraphs or diphthongs are used so that the number of phonemes
is less than the number of letters (e.g., *leem*). Both the accuracy and the
error patterns were recorded for this task. Participants who make
"overshoot errors" (Bruck, 1992) are those who say "four" when there are
four letters but only three phonemes. It has been argued that these
participants are using orthographic information more than phonological
information if this type of error is committed (Bruck, 1992; Tunmer &
Nesdale, 1982).

For the Phoneme Deletion task, a strip of paper was put before the
participant with "first" written at the participants' left side and "last"
written at the participants' right. After the tester pronounced a nonsense
word, the participant was asked to say the word with either the first or
last "sound"/phoneme missing. Bruck (1992) found that the adult dyslexics
had more difficulty than Grade three students on the Phoneme Deletion task
and that the former were more likely to make overshoot errors, thereby
suggesting that they made greater use of their orthographic knowledge.
f) Memory Skills

The memory battery consisted of: (1) the classic Daneman and Carpenter Listening Span task (1980) adapted by Swanson (1992); and (2) three subtests from the Swanson Working Memory Battery (1992) including Story Recall, Visual (Dot) Matrix and Semantic Association. For each of the working memory tasks, the participants are required to simultaneously store and process information. The typical format involves presenting the participant with stimuli to be remembered. Before the participant tells the examiner what he/she has recalled, a question or some other form of interference is interjected. Thus, in order to answer the question correctly and recall the stimuli, the participant must process and recall information simultaneously. Swanson (1992) reported internal reliability estimates that ranged from .80 to .96.

If working memory is a critical mechanism in the reading and comprehension of connected discourse, as Perfetti (1985) argues, then working memory measures should be correlated with the GORT-3 and the SDRT even when the effect of vocabulary knowledge is partialled out (Dixon, Lefevre & Twilley, 1988).

g) World/General Knowledge

General knowledge was measured with a recently developed and validated Canadian version of the Information subtest from the Wechsler Adult Intelligence Scale-Revised (Wechsler, 1981). Pugh and Boer (1991) administered 14 Canadian substitute items for those items thought to be easier for American participants than Canadian participants. Ten of these were recommended for Canadian use since their difficulty level more closely paralleled those of the original standardization data. Some examples of the Canadian items are: (1) "Name two houses in the Canadian parliament?"; (2) "What is the population of Canada?" and (3) "How far is it from Montreal to Vancouver?" It was predicted that, within the AD group, those
participants with better general information skills would be more likely to have better reading comprehension skills.

4. Nonverbal Reasoning

To measure nonverbal reasoning, the Raven's Progressive Matrices (Raven, Court & Raven, 1986) was administered. For this test, the participant is presented with a series of figural symbols with one symbol missing. The participant must identify the best figure to complete the series from a group of six to eight choices.

The Raven's also served as one estimate of IQ for the two control groups (CA and RL). It was also predicted that, within the AD sample, participants with better Raven's scores would also have better connected discourse reading scores. Bruck and Waters (1990) reported a similar pattern among less skilled elementary school age children.

5. Written Language Measures

Participants were asked to answer one question on the Information Form in writing.

"What type of career or job would you like to have over the next 5 to 10 years? Why does this job appeal to you? What skills do you think you will need to acquire in order to achieve your goals? Please write your response in pen."

The participants were given no more than five minutes to complete this question. They were unaware that the quality of the writing sample would be evaluated. The samples were coded for the total number of words written, the percentage of words spelled correctly, and the quality of the writing sample. The quality rating was a holistic impression. Two raters judged the samples independently. Results reported in Chapter Four are for the combined ratings. Participants were also asked to write the letters of the alphabet as quickly as possible. The time taken to do this exercise was
recorded. Berninger, Mizolawa & Bragg (1991) found that this task is often poorly executed by children with written language difficulties.

**E. THE CHILDHOOD TESTS AND MEASURES (1978 TO 1985): AD PARTICIPANTS ONLY**

The data for the childhood tests and measures were collected retrospectively. Therefore, there was less consistency among individual participants' batteries than would be ideal. In order to compare the results of the 22 participants with one another, some adjustments were necessary.


Since some of the AD participants had been given the 1978 version of the WRAT reading test and others had been given the 1984 version, it was difficult to compare the two samples. Although the items from the 1978 and 1984 versions do not differ, the norms do (Jastak & Wilkinson, 1984). Since the majority of the sample was tested in the 1983 to 1985 time frame, all of the WRAT (1978) scores were converted using the 1984 norms. Thus the results for the WRAT-R (1984) reported in Table 2 include results from some participants whose protocols were originally scored using the 1978 norms.

A total of 15 participants were given the same WRAT/WRAT-R items in childhood. This was the most commonly administered single word recognition test among the childhood records. Eleven of the 15 participants who received the WRAT/WRAT-R measures and several other AD participants, however, were also given the I.O.T.A. test of single word recognition. Using the scores from the I.O.T.A. and the WRAT-R with 1984 norms, I regressed I.O.T.A. scores on W.R.A.T. scores to acquire a prediction equation. The Minitab (Ryan, Joiner & Ryan, 1992) "regress" programme was the computational vehicle for these calculations. Thus, if a participant received a certain score on the I.O.T.A., I attempted to predict what the
score would have been on the WRAT-R if it had been hypothetically administered. In this way, I was able to derive "predicted" or "extrapolated" scores for the WRAT-R for an additional seven participants. This test equating procedure provided estimates of childhood word recognition skill that could allow some comparisons within the AD group. Table 2 includes results for 22 participants under the heading "WRAT-R (1984) Extrapolated". Included in this category are 15 participants who actually had WRAT/WRAT-R results and seven participants for whom the scores were predicted.


Five AD participants were given the 1959 version of the PPVT vocabulary test and 15 were given the 1981 version. Both the items and the norms changed from the 1959 to the 1981 version. The PPVT-R manual (Dunn & Dunn, 1981), however, includes a useful table (Table 3.2; page 50) derived from their 1979 psychometric research. This table presents corresponding standard score equivalents for converting the 1959 scores to 1981 scores. The manual indicates that children tend to score somewhat lower on the later version. The scores for the five AD participants with results from the 1959 version of the test were converted. Table 2 reports the group mean for childhood PPVT scores based on this conversion for 25% of the sample.

3. Other Childhood Tests

All other test scores are reported as they were in the childhood files of the AD participants. No other conversions were necessary. Table 2 presents results from the WISC-R intelligence test (Wechsler, 1974). Verbal IQ (VIQ), Performance IQ (PIQ), and Full Scale IQ (FSIQ) results are presented.
F. GENERAL RESEARCH QUESTIONS

The overriding questions posed in this follow-up study are: (1) How well do young adults with childhood diagnoses of developmental dyslexia read connected discourse? (2) What best accounts for individual and group differences in outcomes? and (3) To what extent do adult dyslexics use compensatory processing when reading connected discourse?

The results from the first question will provide descriptive information about the actual reading achievement levels of the Kenneth Gordon alumni relative to the two control groups. The second and third questions address the way in which the connected discourse reading outcomes are related to word recognition, oral language, and cognitive skills. When these relationships become apparent, inferences about processing will be made.

H. SPECIFIC RESEARCH QUESTIONS, HYPOTHESES AND METHODS FOR ANALYSES

1. Question Set One and Related Hypotheses and Analyses

a) Question Set One

What levels of skill do adult dyslexics (AD) achieve on various aspects of connected discourse reading in comparison with chronological age-matched (CA) and reading-level (RL) controls?

b) Hypotheses for Question Set One

It was hypothesized that the CA group would outperform the AD group on all the reading achievement measures (CA > AD). By design the AD group and the RL group were expected to have comparable scores on the WRAT-R II word recognition measure. It was hypothesized that the AD group would have nonword reading scores (Bruck nonwords) that were significantly lower than the RL group (AD < RL). It was hypothesized that the AD group and the RL group would have statistically comparable scores on the other reading

(Ransby, 1995)
measures (AD = RL).

c) Data Analyses for Question Set One

A series of multivariate analyses of variance (MANOVA's) were run to determine whether or not there was a significant group effect when the CA, RL, and AD group performances on reading measures were contrasted. If there were significant group effects, follow-up analyses with two planned comparisons, were undertaken. The groups were compared in pairs so that the AD group was contrasted with each of the control groups (AD vs. CA and AD vs. RL). T-tests, with Bonferroni corrections, were employed to determine the source of these group differences.

2. Question Set Two and Related Hypotheses and Analyses

a) Question Two

What levels of skill do adult dyslexics achieve on higher-order and lower-order language and cognitive measures in comparison with chronological age-matched (CA) and reading-level (RL) controls?

b) Hypothesis Two

It was hypothesized that the CA group would outperform the other two groups (CA > AD and CA > RL) on the lower-order language measures (i.e., rapid naming and phonological awareness). It was hypothesized that the RL group would outperform the AD group on the lower-order language measures (RL > AD). It was hypothesized that the AD group would perform better than the RL group on higher-order language measures (AD > RL) and that their performance would approach the performance of the CA group.

c) Data Analyses for Question Two

A series of multivariate analyses of variance (MANOVA's) were run to determine whether or not there was a significant group effect when the CA, RL, and AD group performances on oral language and cognitive measures were
contrasted. If there were significant group effects, follow-up analyses with two planned comparisons, were undertaken. The groups were compared in pairs so that the AD group was contrasted with each of the control groups (AD vs. CA and AD vs. RL). T-tests, with Bonferroni corrections, were employed to determine the source of these group differences.

3. Question Set Three and Related Hypotheses and Analyses

a) Question Set Three

What cognitive and oral language skills best account for individual differences in connected discourse reading outcomes among the adult dyslexics (AD)?

b) Hypotheses for Question Set Three

It was hypothesized that, within the AD group, those with the best connected discourse reading skills would be those with the best higher-order oral language and cognitive skills. It was hypothesized that those AD participants whose connected discourse reading scores were above the median would be those with the best childhood and adult oral language skills, and the best general information skills. That is, there would be significant differences between the AD High Group and the AD Low Group on higher-order oral language and general information in favour of the former subgroup (AD High > AD Low). It was also hypothesized that those with the best word recognition skills would have the best nonword reading and lower-order oral language skills.

c) Data Analyses for Question Set Three

Only the AD participants' data were analyzed for question three. A median split was performed on four different measures of reading skill. First, a median split was conducted on the SDRT: Blue Reading Comprehension Subtest. This exact analysis was undertaken in the Bruck (1990) study. This allowed comparisons between the results from the Bruck study and the
present study. The second median split was conducted on a reading composite variable (i.e., Reading Comprehension Composite). This composite was comprised of the SDRT Reading Comprehension subtest raw scores and the GORT-3 Reading Comprehension subtest raw scores. The third median split was undertaken on a second reading composite score (i.e., Reading Efficiency Composite). This composite was comprised of the two tests that demanded speed and precision in reading (i.e., GORT-3 Passage score and the SDRT Fast reading subtest). The final median split was conducted on the WRAT-R II word recognition test.

As a result of each median split there was a High AD and Low AD group. Those who were ranked High in one median split were not necessarily ranked High in the next median split. The resulting mean scores for High AD’s and Low AD’s were the data that were used for the subsequent t-test analyses for independent samples. The t-test results were then evaluated for significance using the Bonferroni criteria.

4. Question Set Four and Related Hypotheses and Analyses

a) Question Set Four

What is the nature of the relationship between oral language/cognitive skills and connected discourse reading outcomes among adult dyslexics (AD)? To what extent do these relationships resemble those found among the reading-level controls (RL)? What oral language and cognitive variables best predict connected discourse reading outcomes for the AD group as compared with the RL group? Is there any evidence for compensatory processing in the AD group?

b) Question Four: Models, Hypotheses and Predictions

Figure 1 depicts a set of relationships among the reading and oral language variables that were predicted to be associated with reading comprehension. The model is an adaptation of the Conners and Olson (1990)
model but includes more aspects of linguistic skill than the former model. The main structure of the Conners and Olson model (which is based on Hoover & Gough, 1989) is retained.

This structure reflects the independence of word recognition and reading comprehension skill that has been noted in previous empirical investigations of dyslexic children (Lovett, 1987), adolescents (Conners & Olson, 1990) and adults (Bruck, 1990). Lower-order language skills are most closely associated with word recognition skill whereas higher-order language and cognitive skills are associated with reading comprehension. The elements in this model are expected to be the same for both the AD and the RL groups but the extent to which each set of relationships contributes to reading comprehension outcomes is expected to vary.

It was hypothesized that word recognition skill would be significantly correlated with reading comprehension for RL participants. In contrast, it was hypothesized that this relationship would be weak and not significant for AD participants. It was hypothesized that the best predictor of reading comprehension for both AD and RL participants would be higher-order language skills. Finally, it was hypothesized that lower-order reading and oral language skills would be highly correlated with connected discourse outcomes for the AD group. Higher-order language and cognitive skills will be highly correlated with connected discourse outcomes for the RL group. It is expected, therefore, that the mean intercorrelation of the oral language/cognitive correlation matrix would be significantly different from the mean intercorrelation for the AD group.

c) Data Analyses for Question Four

Only the AD and RL data are considered in these analyses. First, the zero order correlations were compared on specific relationships. Significant differences between specific correlations were noted. Second, a
series of composite scores were assembled so that the subsequent analyses would be more easily interpreted and participant-to-variable ratios were reduced. Then the mean correlations for the AD matrix and the RL matrix were contrasted. Finally, a series of regression analyses were undertaken to determine what variables best predicted scores on the two connected discourse reading composites (i.e., Reading Comprehension Composite and Reading Efficiency Composite).

5. Evaluating Achievement and Processing Outcomes

a) Connected Discourse Achievement Outcomes

Four possible connected discourse reading achievement outcomes are anticipated for the adults with childhood diagnoses of dyslexia. They could have recovered from, or partially recovered from their early childhood deficits, they could be developmentally delayed, or they could be specifically impaired in connected discourse reading.

(1) **Recovered?** If the AD group and the CA group are comparable on reading accuracy and reading rate, they may be designated as 'recovered' dyslexics. This designation refers to their reading achievement outcomes and is similar to the Kinsbourne et al. (1991) concept of recovery.

(2) **Partially Recovered?** If the AD group and the CA group are comparable on reading accuracy but inferior on reading rate, then they would not have completely 'recovered'. In this instance, I will argue that their slower rate may be one source of evidence for compensatory processing. That is, the AD readers may adjust their speed downward to ensure an accurate performance. This potential outcome is similar to that of the 'compensated dyslexics' in the Lefly and Pennington study (1991). Their use of the word 'compensated' referred to accuracy achievement outcomes that were comparable to a CA group.
(3) Developmentally Delayed or Arrested? If the AD group is comparable to the RL group on reading achievement outcomes, then the AD participants' connected discourse reading skills would be considered appropriate for their level of word recognition skill. In this case, they could be referred to as developmentally delayed or arrested.

(4) Specific Deficit? If the AD group performs significantly less well than the RL group, then they will be referred to as having a specific reading comprehension deficit or connected discourse reading deficit.

b) Achievement Outcomes for Related Skills

The results of the related skills battery will be evaluated in the same manner as the connected discourse reading achievement battery.

(1) Associated Skills Comparable
If the AD group and the CA group are comparable on all measures in the associated skills battery, then there will be no evidence for compensatory processing.

(2) Associated Skills Developmentally Delayed or Arrested
If the AD group and the RL group are comparable on all measures in the associated skills battery, then one might infer that the AD participants' information processing is similar in quality to the younger children and adolescents at this developmentally lower achievement level.

(3) Associated Skills Show Strengths and Weaknesses
If the AD group is better than the RL group on one or more associated skills, they will have a strength/s in their profile. If they are significantly worse than the RL group on associated skills, they will have a weakness/es in their profile. If the AD group and the RL group are comparable on their achievement outcomes but have different strengths and
weaknesses on the associated skills battery, there will be evidence for compensatory processing. It will be inferred that they must have done some counterbalancing in information processing in order to achieve the same achievement levels as the RL controls. In other words, they would have arrived at the same destination or achievement level by a qualitatively different route or process.

c) Relationships Between Connected Discourse Reading and Related Skills

If the correlational patterns between connected discourse reading measures and associated measures are comparable for AD and RL, it may be inferred that their processing is comparable. If, however, there are significant differences between specific correlation matrices, then it may be inferred that there are qualitative differences in the groups' information processing.

6. Evaluating Individual Differences Within the AD Group

The Bruck compensation hypothesis will be evaluated by comparing relatively strong AD connected discourse readers with relatively weak AD connected discourse readers. If the AD high group and the AD low group are comparable on the associated skills battery there will be no support for the Bruck compensation hypothesis. On the other hand, if there are significant differences between the AD high group and the AD low group on oral language and general knowledge measures from childhood and/or follow-up assessments, there will be support for the Bruck compensation hypothesis.

7. Individual Case Presentations

When individual cases within the AD group are reviewed, those that appear to represent extremes in the sample will be identified. Individual cases who appear to have recovered, or who demonstrate compensatory processing are of special interest.
CHAPTER FOUR

RESULTS

A. DATA SCREENING

Prior to conducting the statistical analyses, the data were examined for patterns in the distributions that could potentially contribute to violations of the assumptions for the planned analyses.

1. Examination of the Data for Normality

All variables were examined both graphically (i.e., with histograms) and statistically to determine the extent to which they were normally distributed. This process was undertaken using data for 67 subjects (i.e., 22 CA'S, 23 RL'S, 22 AD'S). To identify potential outliers, the histograms were visually inspected and $z$ scores with values exceeding an absolute value of 3 were identified. During this process, one RL subject was eliminated because the case had high $z$ scores on almost every variable. Further examination of the raw data file suggested that this subject should be eliminated since the father's socioeconomic status (SES) was exceedingly high according to the Blishen scale (Blishen et al, 1987) (i.e., Physicians & Surgeons = 101.32). Furthermore, this subject had been enrolled in programmes for gifted students at various times during his school career. This subject's profile was inconsistent with the selection criteria, established $a$ priori, for the subjects in the reading-level control group (RL).
In addition to examining each variable for potential outliers, the distributions were examined for skewness. Variables with skewness scores exceeding an absolute value of 2 were noted (Dixon et al, 1990). Using this standard, the accuracy scores on the Bruck word recognition measure and the Bruck nonword reading test did not appear to be normally distributed. For the Bruck word recognition accuracy variable, this pattern appeared to be attributed to two cases that were extreme outliers in the low end of the distribution.

Thus, the scores for these two cases were adjusted in a trimming procedure so that they were brought closer to the next lowest score in the distribution that was not an outlier (Score X). The lowest outlier was assigned a score that was 2 below X (i.e., X - 2) and the next lowest outlier was assigned a score that was 1 below X (i.e., X - 1). For the nonword accuracy measure, there was one case that was an obvious outlier in the low end of the distribution. A similar trimming procedure was also implemented for this case. When these data were reanalysed, the skewness index indicated that the trimming procedure was successful in adjusting the distribution of scores to satisfy the normality requirement.

2. Examination of Skewed Variables for Homogeneity of Variance

To determine the extent to which the variables satisfied the homogeneity of variance assumption, results from Levene's test of equality of variability were examined. Two reading variables were found to violate this assumption: 1) the Bruck word recognition accuracy measure in its transformed and trimmed form; and 2) the response latency measure from the Bruck nonword reading test.
These variables were, therefore, candidates for transformations that may adjust the distributions so as to comply with the homogeneity of variance requirement. To determine what the appropriate transformations should be, the PLOT programme from BMDP7D 3 (Dixon et al, 1990) was requested. This programme uses a Box-Cox procedure by plotting the means versus the standard deviations for the variables of concern. A regression formula describing the relationships is subsequently derived. The slope from this regression is then applied to a table that indicates what would be the best transformation to alleviate the heterogeneity of variance problem. The resulting slopes (i.e., Bruck word recognition accuracy trimmed = -.44; Bruck nonword response latency = .49) were closest to the .5 mark on the table (Dixon et al, 1990; p. 202). Thus, a square root transformation was computed for each of these variables. When a one-way analysis of variance (ANOVA) was subsequently run on the transformed variables, the homogeneity of variance assumption was met for the Bruck nonword response latency measure (Levene’s p > .05), but not for the Bruck word recognition accuracy measure (Levene’s p < .007).

Because the Bruck word recognition measure could meet neither the homogeneity of variance nor the normality assumption, despite extreme adjustments including trimming and a square root transformation, a decision was made to eliminate this measure. Although the ANOVA procedure is thought to be relatively robust in the face of homogeneity of variance violations, particularly with equal n’s (Stevens, 1986; p. 201), the effect of both violations (i.e., nonnormality and heterogeneity of variance) is additive (Stevens, 1986). Since this additive effect could seriously compromise power, the Bruck word recognition accuracy variable was eliminated.

3 BMDP is a statistical software programme.  
7D is a subprogramme.
B. MATCHING VARIABLES

1. The Control Groups

Table 1 presents the results of tests and measures that were selected as matching variables for the samples according to the reading-level-match design outlined in Chapter Three. The first control group was matched to the adults with childhood diagnoses of dyslexia (AD) on chronological age (CA). The second control group was a reading-level-matched control (RL) and was matched to the AD group on scores on the Wider Range Achievement Test-Revised (Jastak & Wilkinson, 1984) (WRAT-II 11) word recognition subtest.

2. Chronological Age

The mean age for the CA group was 19.92 (SD = 1.94) and the mean age for the AD group was 19.74 (SD = 1.62). The RL group, as planned, was considerably younger than both the AD and the CA groups, in chronological age, with a mean of 12.66 (SD = 1.73) years. As expected, when chronological age was submitted to a one-way ANOVA, there was a significant group effect $F(2,63) = 120.17, p < .001$. A post-hoc analysis indicated that the RL group was significantly younger than the other two groups (i.e., CA = AD > RL) ($p < .0001$).

3. Reading Level for Word Recognition Skill

The second control group (RL) served as a reading-level-match control for the AD group. Their raw scores on the WRAT-II word recognition test were comparable ($p > .05$) to the raw scores of the AD group with means of 55.09 (SD = 8.55) and 55.18 (SD = 8.73), respectively. The CA group was significantly more skilled in single word recognition with a mean of 74.82 (SD = 6.91). Results from an ANOVA revealed a significant main effect of group $F(2,63) = 43.23, p < .0001$. A post-hoc analysis indicated that the CA group performance on the WRAT-II was significantly better than the other two groups (i.e., CA > AD = RL) ($p < .0001$).
4. *Socioeconomic Status*

Two separate measures of socioeconomic status (i.e., father’s occupation and mother’s highest grade level) were submitted to one-way ANOVA’s. Results from the ANOVA on father’s occupation revealed no significant group effect $F(2, 63) = .29, p < .74$. Similarly, the results from the ANOVA on mother’s education revealed no significant group effect $F(2, 63) = .43, p < .65$.

5. *Nonverbal Reasoning*

As mentioned earlier, according to the design that was formulated prior to sample selection, the samples were expected to be comparable on nonverbal intelligence, as measured by the Raven’s Progressive Matrices test. Summary statistics for the results of the Raven’s test are presented in Table 1.

When the groups were compared on the Raven’s raw scores, the CA group was found to outperform the other two groups ($M = 52.36, SD = 4.52$). The RL group mean ($M = 47.36, SD = 6.93$) and the AD group mean were in the same range ($M = 45.24, SD = 6.63$). A univariate ANOVA indicated that there was a significant effect of group $F(2, 62) = 7.75, p < .0001$. Follow-up $t$-tests indicated that the scores of the AD group differed significantly from the CA group ($p < .001$), but not the RL group ($p > .05$).

A slightly different pattern, however, emerged when percentile scores were submitted to the same analyses. Although all three groups achieved a mean score that was at least average, the AD group mean percentile score fell in the mid-average range ($M = 50.22, SD = 23.73$), while the CA ($M = 77.27, SD = 20.22$) and RL ($M = 69.77, SD = 28.76$) group mean percentile scores fell in the above average range. A univariate ANOVA indicated that there was a significant group effect $F(2, 63) = 7.15, p < .002$. Follow-up $t$-tests revealed that the performance of the AD group fell significantly
behind the performance of the other two groups (p’s < .05).

C. THE CHILDHOOD PROFILES OF THE ADULTS WITH CHILDHOOD DIAGNOSES

Table 2 presents the means, standard deviations and sample sizes for the test results and measures for the AD sample as children. Since these data were collected retrospectively, all cases do not have data for all measures. Thus, Table 2 indicates the cell sizes for each childhood measure.

Results in Table 2 indicate that the sample was diagnosed in childhood at a mean age of 9.7 (SD = 2.15). Mean verbal intelligence, as estimated by the Verbal Scale of the WISC-R (Wechsler, 1974) and the PPVT-R (Dunn & Dunn, 1959; Dunn & Dunn, 1981), fell in the mid-average range with mean standard scores of 97.15 (n = 20, SD = 8.51.) and 97.35 (n = 20, SD = 11.21), respectively. Mean performance IQ, as measured by the WISC-R Performance scale, and Full Scale IQ scores also fell in the mid-average range at 103.80 (n = 20, SD = 11.73) and 100.00 (n = 20, SD = 8.09), respectively.

In contrast, the mean scores on the WRAT-R (1984) single word recognition and spelling subtests fell approximately one and a half standard deviations below the mean levels of Verbal intelligence. For those who had been given a WRAT-R single word recognition reading test at the time of diagnosis, mean standard scores were 72.93 (n = 15, SD = 11.32). When predicted scores (See Chapter Three) on the WRAT-R single word recognition test were considered, the mean standard score for the AD group at the time of diagnosis was 72.59 (n = 22, SD = 9.76). Of the 22 AD subjects, 21 had estimated word recognition standard scores that were below 85 or one standard deviation below the mean.
One subject had a single word recognition standard score of 98. This subject, however, was included in the study because there were other sources of evidence for difficulties in learning how to read. This subject scored more than 1.5 grade levels below his placement on the Gilmore Oral Reading Test. Furthermore, the subject had a standard score of 81 on the WRAT-R spelling test. Anecdotal comments also indicated that he was having extreme difficulties reading novels and was upset because he was very slow when reading in context.

A mean standard score comparable to the WRAT-R II (1984) word recognition subtest was noted on the WRAT-R (1984) Spelling subtest ($M = 75.44, n = 18, SD = 6.92$).

D. RESULTS FROM THE READING BATTERY: WHAT LEVELS OF READING AND WRITTEN LANGUAGE SKILL DID THE AD GROUP ACHIEVE IN CONTRAST TO CONTROLS?

1. Reading Accuracy Using Raw Scores (Tables 3 & 4)

The following measures of reading accuracy were submitted to a multivariate analysis of variance (MANOVA): WRAT-R II raw scores, Stanford Diagnostic Reading Test (SDRT-Blue) Reading Comprehension subtest raw scores, Stanford Diagnostic Reading Test (SDRT-Blue) Fast Reading subtest scores, the transformed version of the Bruck nonword reading measure, the raw accuracy and comprehension scores from the Gray Oral Reading Test-3rd Edition (GORT-3). No attempt was made to convert scores to $z$ scores for this analysis nor subsequent MANOVA's because MANOVA has been found to be robust even when there are variations in scaling (McCall & Applebaum, 1973). When these measures of reading accuracy were submitted to a multivariate analysis of variance (MANOVA), there was a significant group effect $F(12, 116) = 9.40, p < .0001$.

Follow-up univariate ANOVA's and $t$-tests, using the critical values
for the Bonferroni post-hoc t-test for two comparisons (see Tables 3 and 4), indicated that the AD group was inferior to the CA group on every measure of reading accuracy (all \( p \)'s < .001), with the exception of the Gray Oral Reading Test-Third Edition (GORT-3) Comprehension subtest (\( p < .10 \)).

In contrast, the scores for the AD group were comparable to the RL group on all reading accuracy measures, except for nonword reading. For nonwords, whether the data were in the original or the transformed form, the AD group mean was significantly lower than the RL group mean (\( p < .05 \)).

2. Single Word Recognition Accuracy Using Standard Scores (Table 4)

When the WRAT-R (Level II) single word recognition standard scores were submitted to a univariate ANOVA, there was a significant group effect \( F(2,55) = 28.39, p < .0001 \). The AD group performance was significantly below both control groups. Since many of the RL subjects were too young to be eligible for the age adjusted scaled scores, according to the published norms, only 14 of the RL subjects are included in this analysis. For these subjects, however, mean standard scores for the CA and RL groups were statistically comparable (\( M = 112.50, SD = 8.86 \) vs. \( M = 108.50, SD = 12.91 \)), respectively (\( p > .05 \)), while the AD subjects performed significantly below both the control groups (\( M = 89.32, SD = 10.92 \)) (\( p < .001 \)).

3. Reading Rate Scores (Tables 5 and 6)

The following measures of reading rate were submitted to a multivariate analysis of variance (MANOVA): the median response latencies from the Bruck word recognition test, the median response latencies from the Bruck nonword reading test (the transformed version), and the reading rate raw scores from the GORT-3. The MANOVA results indicated that there was a significant group effect \( F(6,122) = 9.18, p < .0001 \). Follow-up univariate ANOVA’s and t-tests, using Bonferroni’s criteria for two
comparisons, indicated that the AD group was inferior to the CA group on all the measures of reading rate (all $p$'s < .01). The group differences between AD and RL, however, did not reach a conventional level of significance on the Bruck rate measure, nor the GORT-3 rate measure. In contrast to the AD group, the RL subjects performed faster on the Bruck nonword reading measure on both the transformed scores ($p < .06$) and the original scores ($p < .05$).

On the Fast Reading subtest of the SDRT, there was a significant group effect $F (2,63)=9.20$, $p < .0003$. The mean times for completion of the Fast SDRT passage were 159.91 seconds for the CA group, 174.14 seconds for the RL group, and 180.00 plus seconds for the AD group. Table 6 presents the means, standard deviations and ranges for the completion times on this task. Because the standardized time limit for this task is 180 seconds, the actual upper limit for those who did not complete the task is unknown. Table 6 also presents data indicating what percentage of each group completed the Fast SDRT task within the time limit of 180 seconds. Since 100% of the AD subjects did not complete the task, there was 0 variance in this group. Thus, follow-up $t$-test comparisons between groups could not be undertaken.

The groups were compared on the proportion of subjects who were unable to complete the Fast Reading subtest within the time limits. Forty-one percent of the CA's, 82% of the RL's and 100% of the AD's failed to complete the task within the time limit. The effect size differences between these proportions were calculated using Cohen's (1988) effect size difference of $h$. The arcsine transformations of proportions that are used in the effect size transformation are also presented in Table 6. When the AD group was contrasted with the CA group, there was a very large effect size difference ($d = 1.72$). When the AD group was contrasted with the RL group, there was a large effect size difference ($d = .90$).
4. Reading of Connected Discourse Composite Scores (Tables 7 and 8)

Two reading composite scores were computed. The first composite was the Reading Comprehension composite score that consisted of the \( z \) score from the SDRT silent reading comprehension measure and the \( z \) score for reading comprehension from the GORT-3. The second composite was the Reading Efficiency composite score that consisted of the \( z \) score from the SDRT Fast reading subtest and the \( z \) score for passage reading (accuracy and rate combined) from the GORT-3. All raw scores were converted to \( z \) scores based on the total sample (\( N = 66 \)). Then, the two \( z \) scores in each composite were added together and divided by 2. Thus, the formula for the reading comprehension composite was (SDRT silent reading \( z \) score + GORT-3 comprehension \( z \) score)/2. Similarly, the formula for the reading efficiency composite was (SDRT Fast \( z \) score + GORT-3 passage \( z \) score)/2.

Each of the discourse reading composite scores was submitted to a one way ANOVA procedure. For the reading comprehension composite, a significant group effect was noted \( F(2,63) = 11.81, p < .0001 \). Follow-up \( t \)-test analyses indicated that the AD group performed significantly below the CA group (\( p < .0001 \)), but was not significantly different from the RL group (\( p > .05 \)) (See Table 7). Effect size differences between the AD group and each of the control groups were computed using the respective control group standard deviation as the denominator in the calculation. The AD group fell 1.69 standard deviation units behind the CA group, but .21 standard deviation units ahead of the RL group on the reading comprehension composite. These results are presented in Table 8.

For the reading efficiency composite, a significant effect of group was also noted \( F(2,63) = 27.57, p < .0001 \). Follow-up \( t \)-tests indicated that the AD group performed significantly below the CA group (\( p < .0001 \)). Although the AD group performance mean (\( \bar{M} = -.635 \)) was below the RL group mean (\( \bar{M} = -.277 \)), the difference was not statistically significant.
The AD group fell 2.44 standard deviations behind the CA group and .54 standard deviation units behind the RL group on the reading efficiency composite (Table 8).

5. The Print Exposure Measures (Table 9)

The following measures of print exposure were submitted to a multivariate analysis of variance (MANOVA): (1) Author Recognition Test (ART); (2) Magazine Recognition Test (MRT); (3) the adapted Newspaper Recognition Test (NRT); and (4) Title Recognition Test (TRT). All scores were expressed as percentage correct. The MANOVA indicated that there was a significant effect of group $F(8,120) = 9.23, p < .0001$. Follow-up univariate ANOVA's and $t$-tests using Bonferroni critical values for two comparisons, indicated mixed results. There were no significant differences among the groups on the ART ($p$'s > .05). For the MRT, however, the AD group performed significantly less well than the CA group ($p < .001$), but had statistically comparable scores to the RL group ($p > .05$). On NRT, the AD and RL groups had comparable performances ($p > .05$). On the TRT, the AD group performance was significantly below both the RL ($p < .001$) and the CA group ($p < .05$).

6. The Written Language Measures (Table 10)

The following measures of written language were submitted to a multivariate analysis of variance: (1) WRAT-R (Level II) Spelling raw scores; (2) time taken to write all the letters of the alphabet in order; (3) the total number of words in the written language sample; and (4) the combined quality rating score consisting of the averaged ratings of both raters. When these measures of written language skill were submitted to a MANOVA, a significant group effect was noted $F(10,116) = 10.56, p < .0001$.

Follow-up univariate ANOVA's and $t$-tests, using Bonferroni's critical values for two comparisons, indicated that the AD group was significantly
below the CA group on spelling skill, letter writing speed, and the quantity and quality of written language. The AD group was comparable to the RL group on spelling skill, number of words in the written language sample, and the quality of the written language sample. The RL group, however, was significantly slower ($p < .05$) than the AD group on the time taken to write the letters of the alphabet in sequence. The RL group mean was 25.55 seconds in contrast to the AD group mean of 20.89 seconds. It should be noted, however, that there was a significant violation of the homogeneity of variance assumption on this variable, according to Levene's test $F(2,62) = 13.32$, $p < .0001$. The greatest variability was noted in the RL group with a standard deviation of 8.66, whereas the least amount of variability was noted in the CA group with a standard deviation of 3.12. The standard deviation for the AD group was 5.09.

When the standard scores, rather than the raw scores, for the Spelling subtest of the WRAT-R were considered, the AD group fell significantly below both groups ($p$'s < .001). The mean standard scores and their respective standard deviations for the CA, RL and AD groups are as follows: $(\bar{M} = 108.23, SD = 7.96)$; $(\bar{M} = 101.86, SD = 8.54)$; and $(\bar{M} = 84.00, SD = 13.58)$.

7. The Reading Measures, with the Raven's Progressive Matrices as Covariate

Since the groups were not homogeneous in nonverbal reasoning ability, according to the Raven's, an attempt was made to approach homogeneity by using the Raven's percentile scores as a covariate. Using the reading accuracy variables as dependent variables and the Raven's percentile scores as a covariate, a multiple analysis of covariance (MANCOVA) analysis was performed. The results indicated that the Raven's did not make any significant contribution to group differences. Furthermore, since the homogeneity of slopes assumption was violated, no further analyses were conducted with the Raven's as a covariate.
8. Summary of Results from Reading and Written Language Battery

The AD group scored significantly below the CA group on every raw score measure of reading accuracy, rate, print exposure and written language with a few minor exceptions. Although the AD group had lower scores than the CA group on the GORT-3 reading comprehension measure, the differences were not statistically significant. Two measures of print exposure (i.e., the Newspaper Recognition Test and the Author Recognition Test) failed to discriminate among the groups.

In contrast, the AD group performance was comparable to the RL group performance on every raw score measure of reading accuracy, reading rate, print exposure, and written language with a few exceptions. The RL group performed significantly better than the AD group on the accuracy and speed of nonword reading and on the children's book Title Recognition Test.

Although grade equivalent estimates were not used in any analyses, they are presented in the tables for descriptive purposes. Overall, according to grade equivalent estimates, the CA group performed in the post secondary school range (grade 12+) in reading skill, whereas the AD and RL groups performed in the junior high school range (grade 7 to grade 9). The only exception to this pattern was a grade equivalent estimate at the grade 11 level for the AD group on the GORT-3 reading comprehension measure.

E. RESULTS FROM THE ORAL LANGUAGE BATTERY: WHAT LEVEL OF ORAL LANGUAGE SKILL DID THE AD GROUP ACHIEVE IN CONTRAST TO THE CONTROL GROUPS?

1. Higher-Order Language and General Information Skills (Table 11)

The following measures of higher-order language and general information were submitted to a multivariate analysis of variance (MANOVA): PPVT-R raw scores (PPVT-R), Boston Naming accuracy raw scores, Boston Naming response latencies, Listening Comprehension raw scores, the raw
scores for the Canadian version of the Information subtest of the WAIS-R. When these measures of higher-order language and information were submitted to a MANOVA, a significant effect of group was noted $F(10,118) = 3.91$, $p < .0001$.

Results from the univariate ANOVA's revealed that there was no significant group effect for the speed of naming individual words on the Boston Naming Test ($p > .05$). There were, however, significant group effects for Listening Comprehension $F(2,63) = 10.64$, $p < .0001$, PPVT-R raw scores $F(2,63) = 18.92$, $p < .0001$, Boston Naming Accuracy $F(2,63) = 10.25$, $p < .0001$, and WAIS-R Information $F(2,63) = 16.11$, $p < .0001$.

According to the post-hoc Bonferroni $t$-test analyses, the AD group performed significantly less well than the CA group on Listening Comprehension ($p < .01$) and on Information ($p < .001$). On the Boston Naming Accuracy measure, however, the AD group did not differ significantly from the CA group ($p$'s $> .05$). When contrasted with the RL group, the AD group means on Listening Comprehension and Information were not significantly different ($p > .05$). The AD group demonstrated a significant advantage over the RL group on two measures of vocabulary (i.e., PPVT-R raw scores and Boston Naming Accuracy raw scores). According to Levene's test, the Listening Comprehension variable had violated the homogeneity of variance assumption $F(2,62) = 4.73$, $p < .01$. The following standard deviations were noted for the groups: CA = 7.28; RL = 10.68; AD = 11.34. Since the source of the significant difference in variability appeared to be between the CA group and the other two groups, and since this variable was normally distributed, no transformations were undertaken.

2. Memory Measures (Table 12)

The following measures of Story Recall and Working Memory were submitted to a multivariate analysis of variance (MANOVA): (1) the Daneman
and Carpenter working memory listening span measure; (2) the Story Recall; (3) Dotboxes subtests; and (4) the Semantic Association measure. When these memory measures were submitted to a MANOVA, a significant effect of group was noted $F(8,120) = 2.18, p < .03$. Follow-up univariate ANOVA and $t$-tests, using Bonferroni critical values for two comparisons, indicated that there was a significant group effect for the Daneman and Carpenter working memory measure $F(2,63) = 7.21, p < .001$. The AD group mean of 2.32 ($SD = .72$) was significantly lower than the CA group mean of 3.14 ($SD = .94$) but statistically comparable to the RL group mean of 2.14 ($SD = .66$). On all the other measures of memory, there were no significant group effects (all $p$'s > .05).

3. Lower-Order Oral Language Skills (Table 13)

The following measures of lower-order language were submitted to a multivariate analysis of variance (MANOVA): (1) the Rapid Automatized Naming (R.A.N.) measures including the median response latencies for Colour Naming, Letter Naming and Number Naming; and (2) the Phonological Awareness measures including Phoneme Counting error scores and Phoneme Deletion error scores. When these measures were submitted to a MANOVA, a significant effect of group was noted $F(10,116) = 6.73, p < .000)$. Follow-up univariate ANOVA's and $t$-tests using Bonferroni's critical values for two comparisons, indicated that there was an uneven pattern of results.

The AD group performed more slowly on all the R.A.N. tasks than the CA group (all $p$'s < .01). When the AD group was contrasted with the RL group, there were no significant differences between the groups on the speed of letter naming, and the speed of number naming ($p$'s > .05). The AD group, however, was significantly faster than the RL group on the rapid naming of colours ($p < .001$).

Results from the phonological awareness tasks indicated that the AD
group had the least number of errors on Phoneme Counting with a mean error score of 3.77 (SD = 2.9). This error score was significantly less than the mean RL error score of 7.41 (SD = 4.0). Although the AD group mean error score (3.77) was numerically lower than the CA error score (5.00), this did not represent a significant difference (p > .05). On Phoneme Deletion, however, a different pattern of results emerged with the AD group scoring more errors (M = 4.27, SD = 3.5) than the other two groups. When the AD group mean of 4.27 (SD = 3.5) was compared with the CA group mean of 1.73 (SD = 2.3), there was a significant difference (p < .01). When the AD group mean was compared with the RL group mean of 3.63 (SD = 2.7), however, there was not a significant difference (p > .05).

4. Summary of Results from the Oral Language and Information Measures

The results from the oral language and general information battery indicated that the AD group performance, relative to the control groups, was uneven across tasks. The performances of the AD group and the CA group were significantly different on several measures, but not all.

The CA group performed significantly better than the AD group on three measures of higher-order language: (1) Listening Comprehension; (2) WAIS-R Canadian Information; (3) the Daneman and Carpenter working memory measure; and (4) one measure of lower-order language processing (i.e., Phoneme Deletion). There were no significant differences in group performance between the AD group and the CA group on Boston Naming Accuracy, Boston Naming Speed, and Phoneme Counting. Three of the memory measures failed to distinguish among the groups. These were the Story Recall, the Dot Boxes and the Semantic Association from the Swanson working memory battery.
The AD group had a significant advantage over the RL group on two measures of vocabulary (i.e., the Boston Naming Accuracy and the PPVT-R), on the speed of Colour Naming and on Phoneme Counting. On all other measures of higher-order and lower-order language processing, the AD group and RL group performances were not significantly different. Finally, it should be noted that the RL group did not have any significant advantages over the AD group on any measure of higher-order or lower-order language.

**F. INDIVIDUAL DIFFERENCES WITHIN THE AD GROUP: WHAT ORAL LANGUAGE AND COGNITIVE SKILLS ARE ASSOCIATED WITH THE BEST READING OUTCOMES FOR AD SUBJECTS?**

1. **Median Split Procedures and Resulting Groups**

   In order to divide the AD group into relatively high and low performers, four separate median splits were undertaken on four adult reading variables: (1) the silent Reading Comprehension subtest from the SDRT (Blue); (2) the connected discourse Reading Comprehension composite variable that was composed of the SDRT reading comprehension $z$ score and the GORT-3 reading comprehension $z$ score; (3) the connected discourse Reading Efficiency composite score that consisted of the $z$ score from the Fast silent reading passage from the SDRT (Blue) and the $z$ passage reading score (a combination of oral reading accuracy and rate) from the GORT-3; and (4) the WRAT-R (Level II) single word recognition test. As a result of each these median splits, there were 11 subjects in the Low AD group and 11 subjects in the High AD group. The groups were then compared on several variables using $t$-tests for independent samples. The assumption of homogeneity of variance was met for all variables that were compared in the set. According to Levene’s tests, all $p$’s were > .05. The resulting $t$ values were then assessed for significance using the Bonferroni $t$-test critical values for two comparisons.
2. Median Split on the SDRT Silent Reading Comprehension (Table 14)

Table 14 presents means and standard deviations for the Low AD’s and the High AD’s on the SDRT standard scores on the silent reading comprehension measure. The results from independent t-test comparisons between the Low AD’s and High AD’s are also presented. Table 14 presents the results in eight categories: (1) childhood test scores; (2) child and family demographics; (3) adult higher-order language skills; (4) adult memory; (5) adult lower-order language skills; 6) adult decoding and spelling skills; (7) adult nonverbal reasoning skills; and (8) a composite of child and adult print exposure.

a) Childhood Variables (SDRT Median Split)

There were no significant differences on any of the following childhood variables: age at time of diagnosis, WRAT-R Reading word recognition predicted and standard scores, WRAT-R Spelling standard scores, Verbal IQ, and Performance IQ. The mean childhood PPVT standard score for Low AD’s was 92.27, whereas the mean childhood PPVT score for High AD’s was 103.55. This difference of 12.90 standard score points was significant (p < .05). The effect size difference between these two scores was large (Cohen’s d = 1.25). Although the differences between the Low AD’s and the High AD’s on Verbal IQ was not statistically significant, the effect size difference was also large (Cohen’s d = .80). This stands in contrast to a small effect size difference (Cohen’s d = .25) for Performance IQ.

b) Demographic Variables (SDRT Median Split)

There were no significant differences between Low AD’s and High AD’s on any of the following demographic variables: Father’s SES, Mother’s highest level of education, family history of developmental dyslexia, gender, number of years spent at the Kenneth Gordon/Fraser Academy, nor age at adult follow-up (all p’s > .05).
c) **Adult Nonverbal Reasoning (SDRT Median Split)**

There were no significant differences between the Low AD's and the High AD's on the Raven's Progressive Matrices test using percentile scores.

d) **Adult Decoding/Spelling (SDRT Median Split)**

There were no significant differences on adult single word recognition WRAT-R II standard scores, nonword reading accuracy raw scores, nor WRAT-R II Spelling accuracy scores.

e) **Lower-Order Language (SDRT Median Split)**

There were no significant differences between the Low AD's and the High AD's on the Rapid Automatized Naming composite z-scores, nor on either of the phonological awareness measures (i.e., Phoneme Counting errors and Phoneme Deletion errors).

f) **Higher-Order Language and General Information (SDRT Median Split)**

The Low AD's had a mean z-score on the higher-order language composite of -4.27, whereas the High AD's had a mean z-score of .098. This represented a significant difference (p < .05). When the Low AD and High AD scores on specific higher-order language measures were compared, it became apparent that the High AD's mean scores were numerically superior on every measure in the higher-order language cluster. These differences were statistically significant for Listening Comprehension (p < .01) and for adult PPVT-R vocabulary standard scores (p < .01), but were not significant for the Boston Naming accuracy measure (p > .05). No significant differences between Low AD's and High AD's emerged on the Canadian WAIS-R Information subtest (p > .05).

g) **Adult Memory Tests (SDRT Median Split)**

There were no significant differences between the Low AD's and the High AD's on any measure of recall nor working memory.
h) **Print Exposure (SDRT Median Split)**

The Low AD's had a mean z score of -.583 on the print exposure composite, whereas the High AD's had a mean z score of -.120. This difference did not reach a conventional level of significance.

3. **Results from Median Split on the Connected Discourse**

**Reading Comprehension Composite Score (Table 15)**

Table 15 presents means and standard deviations for the Low AD's and the High AD's on the connected discourse Reading Comprehension composite. The results from independent t-test comparisons between the Low AD's and High AD's are also presented.

a) **Childhood Variables (Reading Comprehension Median Split)**

There were no statistically significant differences on any of the childhood variables. The mean childhood Verbal IQ score of the High AD's (M = 100.10) was numerically higher than the mean Verbal IQ score for the Low AD's (M = 93.55). Although the High AD advantage was not statistically significant (p > .05), the effect size difference was large (d = .82), according to Cohen's standards (Cohen, 1988).

b) **Demographic Variables (Reading Comprehension Median Split)**

There were no significant differences between Low AD's and High AD's on any of the following demographic variables: Dad's SES, Mother's highest level of education, family history of developmental dyslexia, gender, years at Kenneth Gordon/Fraser Academy, nor age at adult follow-up.

c) **Adult Higher-Order Language and General Information (Reading Comprehension Median Split)**

When the Low AD and High AD scores on the higher-order language measures were compared, it became apparent that the High AD's mean scores
were superior on every measure of higher-order language. These differences were statistically significant for Listening Comprehension (p < .05) and for adult PPVT-R vocabulary standard scores (p < .01). Although the High AD's performed better than the Low AD's on the WAIS-R Information and the Boston Naming measure, these advantages were not statistically significant (p's > .05).

d) Adult Memory (Reading Comprehension Median Split)

There were no significant differences between the Low AD's and the High AD's on any measure of recall or working memory.

e) Adult Lower-Order Language (Reading Comprehension Median Split)

There were no significant differences between the Low AD's and the High AD's on Rapid Automatized Naming z-scores, nor on either of the phonological awareness measures (i.e., Phoneme Counting errors and Phoneme Deletion errors).

f) Adult Decoding/Spelling (Reading Comprehension Median Split)

There were no significant differences on single word recognition WRAT-R II standard scores, nonword reading accuracy raw scores, nor WRAT-R II Spelling accuracy scores.

g) Adult Nonverbal Reasoning (Reading Comprehension Median Split)

There were no significant differences between the Low AD's and the High AD's on the Raven's Progressive Matrices test using percentile scores.

h) Print Exposure (Reading Comprehension Median Split)

The Low AD's had a mean z score of -.599 on the Print Exposure composite whereas the High AD's had a mean z score of -.105. This represented a significant difference (p < .05).
4. Results from Median Split on the Connected Discourse Reading Efficiency Composite (Table 16)

Table 16 presents means and standard deviations for the Low AD's and the High AD's on the connected discourse Reading Efficiency composite score. The results from independent t-tests for Low AD and High AD comparisons follow.

a) Childhood Variables (Reading Efficiency Median Split)

There were no significant differences on any of the childhood variables.

b) Demographic Variables (Reading Efficiency Median Split)

There were no significant differences between Low AD's and High AD's on any of the following demographic variables: Mother's highest level of education, family history of developmental dyslexia, gender, nor age at adult follow-up. The subjects who were in the Low AD group, however, had fathers with lower SES scores (M = 46.55) than the subjects in the High AD group (M = 59.82). This represented a significant difference (p < .05).

c) Higher-Order Language, General Information and Memory (Reading Efficiency Median Split)

There were no significant differences between the Low AD's and the High AD's on any measure of higher order language, general information nor memory.

d) Lower-Order Language (Reading Efficiency Median Split)

There were no significant differences between the Low AD's and the High AD's on either of the phonological awareness measures (i.e., Phoneme Counting errors and Phoneme Deletion errors). The Low AD's, however, were slower on Rapid Automatized Naming tasks than the High AD's with mean z scores on the R.A.N. composite of -.60 and -.18 respectively. This
represented a significant difference ($p < .05$).

e) Decoding/Spelling (Reading Efficiency Median Split)

The mean score for the Low AD's was lower than the High AD's on every measure in this category. The Low AD's mean standard score on WRAT-R II reading was 82.45 compared with the High AD's score of 96.18. This difference was significant ($p < .01$). Low AD's had a mean standard score of 78.00 on the WRAT-R II Spelling subtest, whereas the High AD's had a mean standard score of 90.00. This represented a marginally significant difference ($p < .06$). The differences between High AD's and Low AD's reached significance on the Bruck nonword reading measure ($p < .05$).

f) Nonverbal Reasoning (Reading Efficiency Median Split)

There were no significant differences between the Low AD's and the High AD's on the Raven's Progressive Matrices test using percentile scores.

g) Print Exposure (Reading Efficiency Median Split)

There were no significant differences between the Low AD's and the High AD's on the print exposure composite ($p > .05$).

5. Results from Median Split on the WRAT-R II Word Recognition Test (Table 17)

Table 17 presents means and standard deviations for the Low AD's and the High AD's when a median split was performed on the WRAT-R II single word recognition raw scores. The results from independent t-tests are also presented in table 17.

a) Childhood Variables (WRAT-R II Median Split)

There were no significant differences between the Low AD group and the High AD group on any of the childhood measures.
b) **Demographic Variables (WRAT-R II Median Split)**

There were no significant differences between the Low AD's and the High AD's on any of the demographic measures (all p's > .05).

c) **Higher-Order Language and Memory (WRAT-R II Median Split)**

There were no significant differences between the Low AD's and the High AD's on any of the higher-order language or memory measures (all p's > .05).

d) **Lower-Order Language (WRAT-R II Median Split)**

The High AD's had better scores than the Low AD's on all measures of lower-order language. Two out of three of these differences were statistically significant. The High AD's performance on the rapid automatized naming (R.A.N.) composite (M = -.19) was significantly faster \( t(20) = 2.59, p < .05 \) than the Low AD's performance (M = .61). The High AD's also had significantly fewer errors on the Phoneme Deletion task (M = 2.63) than the Low AD's (M = 5.91), \( t(20) = 3.69, p < .05 \).

e) **Nonwords (WRAT-R II Median Split)**

The High AD's performed significantly better than the Low AD's on both accuracy \( t(20) = -2.83, p < .05 \) and speed on the Bruck nonword reading task \( t(20) = 3.69, p < .001 \).

f) **Nonverbal Reasoning (WRAT-R II Median Split)**

There were no significant differences between the Low AD's and the High AD's on the Raven's Progressive Matrices (p > .05).

g) **Print Exposure (WRAT-R II Median Split)**

There were no significant differences between the Low AD's and the High AD's on the Print Exposure composite measure (p > .05).
6. Summary of Results from Median Splits on Adult Reading Measures for the AD Subjects

When the Low AD's and the High AD's were contrasted on the SDRT reading comprehension measure, the High AD's performed best on several higher-order language measures in both childhood and at follow-up. The High AD’s performed best on childhood PPVT scores, adult Listening Comprehension, adult PPVT-R vocabulary, Boston Naming vocabulary, and Print Exposure. A similar pattern of results was observed when the median split was conducted on the connected discourse Reading Comprehension composite. The High AD’s performed best on adult Listening Comprehension and adult PPVT-R.

A very different pattern of results emerged, however, when the median split was conducted on the connected discourse Reading Efficiency composite. The High AD’s were best on Rapid Automatized Naming speed and WRAT-R II Reading and Spelling. Furthermore, the fathers of the High AD’s had significantly higher SES ratings.

When the median split was conducted on the WRAT-R II single word recognition raw scores, the High AD’s performed significantly better on childhood PPVT, rapid automatized naming (R.A.N.), Phoneme Deletion, and Bruck nonword reading accuracy and speed.

G. Data Reduction Using Composite Scores

1. The Composition of the Composite Scores

Using the results from Pearson r correlation matrices and theoretical considerations, a series of composite measures were formed for use in subsequent analyses. In all cases each component of the composite was weighted equally and expressed as a z score.
a) **Childhood Composites**

The Child Reading and Spelling composite consisted of the predicted WRAT-R scores for single word recognition and the WRAT-R spelling scores that were achieved by the AD group at the time of diagnosis. The Child Language composite consisted of the child Verbal IQ score and the child PPVT score. Each component was expressed as a standard score and then converted to a z score.

b) **Demographic Composite**

The Parent's SES composite consisted of the fathers' occupational status, using the Blishen scale, and the mothers' highest level of completed education.

c) **Language Composites**

The Higher-Order Language composite consisted of two vocabulary measures (i.e., PPVT-R and the Boston Naming Accuracy measure), listening comprehension and the Canadian version of the WAIS-R Information subtest. The Memory measure consisted of the Daneman and Carpenter Listening Span working memory measure, the Story Recall task, the Semantic Association working memory measure and the Dot Matrix working memory measure. The Rapid Naming composite consisted of the response latencies from the Rapid Automatized Naming tasks for Colours, Letters and Numbers. The Phonological Awareness composite measure consisted of the Phoneme Counting measure and the Phoneme Deletion measure. All of the language composites were expressed as z scores derived from raw scores.

d) **Decoding/Spelling Composites**

The Word Recognition/Spelling composite consisted of the WRAT-R II word recognition reading scores and the WRAT-R II spelling scores. The Nonword Accuracy and Speed composite consisted of the nonword reading accuracy measure and the nonword response latencies measures.
e) **Print Exposure Composite**

The **Print Exposure** composite consisted of the Author Recognition Test, the Magazine Recognition Test, the Newspaper Recognition Test and the Children’s Title Recognition Test. All were expressed as percentages derived from raw scores and then converted to $z$ scores.

**H. GROUP COMPARISONS ON COMPOSITE SCORES (Tables 18 and 19)**

Since subsequent regression analyses were conducted on composite scores, ANOVA results are presented in this section. Table 18 presents the means, standard deviations and $t$-test results for the composite scores. Table 19 presents the effect size differences between the AD group and the control groups on the composite variables. On the SES and memory composites there was no significant effect of group ($p$‘s > .05). For all of the other composites there was a significant group effect (all $p$‘s < .05).

On the Higher-order Language composite, there was a significant group effect $F(2,63) = 18.63, p < .001$. The mean $z$ scores indicated that the CA group had the best performance ($M = .722, SD = .66$), the AD group had the next best performance ($M = -.154, SD = .85$) and the RL group had the weakest performance ($M = -.566, SD = .61$). Follow-up $t$ tests indicated that the difference between the AD group and the CA group was significant. The difference between the AD and RL group was not statistically significant when the Bonferroni standards were applied. There was, however, a medium effect size advantage for the AD group (Cohen’s $d = .48$).

On the Vocabulary composite, there was a significant group effect $F(2,63)=17.02, p <.05)$. The mean $z$ scores indicated that the CA group had the best performance ($M = .685, SD = .67$), the AD group the next best performance ($M = -.030, SD = .59$) and the RL group had the weakest performance ($M = -.654, SD = .97$). Follow-up $t$-tests indicated that there was a significant difference between the AD group and the CA group...
(p < .01) and there was a significant difference between the AD group and the RL group (p < .05).

On the Rapid Automatized Naming composite, there was a significant group effect \( F(2,63) = 15.63, p < .001 \). A better performance on this measure is represented by a lower score since this test was measured in response latencies. Thus, a faster time has a lower value. The CA group performance was fastest (M = -.730, SD = .50), the AD group performance was next fastest (M = .207, SD = .82) and the RL performance was slowest (M = .523, SD = .92). Follow-up t-tests indicated that there was a significant difference between the AD and CA group (p < .001) but the difference between the AD group and the RL group did not reach significance (p > .05).

On the Phonological Awareness composite there was a significant effect of group \( F(2,63) = 3.79, p < .02 \). The best score was achieved by the RL group (M = .347, SD = .85), followed by the AD group (M = -.49, SD = .79) with the lowest score recorded for the CA group (M = -.296, SD = .68). Follow-up t-tests indicated that the AD group did not differ significantly from the other two groups on this measure (p's > .05).

On the Word Recognition/Spelling composite, there was a significant group effect \( F(2,63) = 45.77, p < .0001 \). The mean z scores indicate that the CA group had a superior performance (M = 2.04; SD = 1.13), while the RL group (M = -.97, SD = 1.23) and the AD group had lower scores (M = -1.06, SD = 1.28). Follow-up t-tests indicated that the difference between the AD group and the CA group was significant (p < .001). There was no significant difference between the AD group and the RL group (p > .05).
On the Nonword Accuracy and Speed composite, there was a significant group effect $F(2,63) = 18.37$, $p < .0001$. On this measure, the CA group had the best performance ($M = .626$, $SD = .47$), the RL group had the next best performance ($M = -.008$, $SD = .59$) and the AD group had the poorest performance ($M = -.619$, $SD = .81$). Follow-up $t$-tests indicated that the difference between the AD group performance and the CA group performance was significant ($p < .001$). Furthermore, the difference between the AD group performance and the CA group performance was also significant ($p < .05$).

On the Print Exposure composite there was a significant group effect $F(2,63) = 14.63$, $p < .001$. The group mean $z$ scores indicated that the CA group had the highest score ($M = .523$, $SD = .64$), the RL group had the next best score ($M = -.171$, $SD = .52$) and the AD group had the poorest score ($M = -.352$, $SD = .52$). Follow-up $t$-tests indicated that there was a significant difference between the AD group and the CA group ($p < .001$) but there was not a significant difference between the AD group and the RL group ($p > .05$).

I. COMPARISONS OF THE AD AND RL GROUPS ON CORRELATIONAL PATTERNS:
TO WHAT EXTENT ARE CONNECTED DISCOURSE READING SKILLS RELATED TO WORD RECOGNITION, ORAL LANGUAGE AND COGNITIVE SKILLS IN EACH GROUP?

1. Correlations Among Reading Variables (Tables 20 and 21)

Tables 20 and 21 present Pearson $r$ correlation tables for reading variables for the AD and RL groups, respectively. In the RL group, all of the connected reading discourse measures were significantly intercorrelated (all $p$'s < .01). Correlations ranged from .60 to .84. For the AD group, 5 out of 6 pairs of connected discourse reading measures were significantly intercorrelated (all $p$'s < .05). The significant correlations ranged from
The correlation between the GORT-3 passage score (GORTPASS) and the GORT-3 reading comprehension (GORTCOMP) measure for the AD group, however, appeared to be virtually orthogonal with a Pearson $r$ of .04.

Although most of the intercorrelations among connected discourse reading measures were significantly correlated in both the AD and the RL groups, there appeared to be some differences in the magnitude of the correlations with the RL group correlations falling in a higher range. For instance, the correlations between SDRT and GORT-3 Comprehension were .43 for the AD group and .84 for the RL group.

The relationships between word recognition and connected discourse reading measures varied considerably both within and between groups. The correlation between SDRT silent reading comprehension and WRAT-R (Level II) single word reading was significant for the AD ($r = .42$) group, but not the RL group ($r = .29$). A similar pattern was observed between the SDRT Fast reading measure and the WRAT-R with correlations of .64 and .34 respectively. Correlations between the GORT-3 Comprehension and the WRAT-R were not significant for either group (AD = .17, RL = .36) but varied in magnitude. The correlations between the GORT-3 passage score and the WRAT-R were significant for both the AD ($r = .72$) and the RL group ($r = .66$).

When correlations between nonword accuracy scores and connected discourse reading measures were contrasted, it became apparent that the AD pattern differed from the RL pattern. In the AD group, nonword reading was significantly correlated with the SDRT ($r = .43$) and the GORT-3 passage reading ($r = .78$). In contrast, correlations between nonword reading and connected discourse reading measures approached 0, in 3 out of 4 measures (i.e., SDRT ($r = -.05$), GORT-3 Comprehension ($r = -.04$), Fast SDRT ($r = -.11$) for the RL group. The correlation between nonword reading and GORT-3 passage reading was also not significant.
2. Correlations Among Reading Comprehension Measures, Language and Cognitive Measures (Tables 22 and 23)

Tables 22 and 23 present Pearson $r$ correlations for the relationships between the connected discourse reading variables that comprise the Reading Comprehension composite (i.e., SDRT silent reading comprehension and GORT-3 comprehension) and language and cognitive variables. For both the AD and the RL groups, all of the language and cognitive variables were positively correlated with the two reading comprehension measures, with the exception of the Rapid Automatized Naming (R.A.N.) measure, for which lower response latencies represent a faster/better performance.

For the RL group, both reading comprehension variables were significantly correlated with Listening Comprehension, PPVT-R vocabulary, Boston Naming Accuracy, Daneman and Carpenter working memory, WAIS-R Information and the R.A.N. measures. Correlation coefficients ranged from .51 to .84. In the RL group, the Raven's Progressive Matrices was not significantly correlated with either of the reading comprehension measures.

A more variable pattern emerged among the AD subjects. Although the Listening Comprehension and PPVT-R measures were significantly correlated with the reading comprehension measures, the Boston Naming test, the Daneman and Carpenter working memory measure, and the WAIS-R Information subtest were not. The SDRT was not significantly correlated with the Raven's ($r = .28$) while the correlation with the GORT-3 Comprehension was significant ($r = .43$). R.A.N. scores were associated with better scores on the SDRT measure ($r = -.57$) whereas the correlation between the GORT-3 Comprehension and R.A.N. was not significant ($r = -.17$).
3. Correlations Among Connected Discourse Reading Efficiency Measures, Language and Cognitive Variables (Tables 24 and 25)

Tables 24 and 25 present Pearson $r$ correlation coefficients for the relationships between the connected discourse reading variables that comprise the Reading Efficiency composite (i.e., Fast reading from the SDRT and the GORT-3 Reading Comprehension score) and selected language and cognitive variables. These patterns of intercorrelation appeared to differ by group. For the AD group, only two out of seven variables were significantly correlated with the Fast reading measure (i.e., PPVT-R $r = .45$ and R.A.N. $r = -.57$). For the GORT-3 passage reading measure, there were no significant correlations with any of the language or cognitive variables ($r$’s range from $-.13$ to $-.18$) for the AD group (See Table 24, column 2).

For the RL group, a very different pattern of intercorrelations emerged. The Fast reading measure was significantly correlated with all of the language and general information variables ($r$’s range from $.53$ to $.79$) but was not significantly correlated with the Raven’s. Similarly, the GORT-3 passage score was significantly correlated with all of the language and information variables ($r$’s range from $.53$ to $.79$) with one marginal exception on the Boston Naming ($r = .41$). The GORT-3 passage score was not significantly correlated with the Raven’s ($r = .21$).

4. Differences in Correlational Patterns on Reading Efficiency for AD and RL (Table 26)

Table 26 presents the correlations between the two connected discourse reading composite measures and 12 other variables: (1) Number of years spent at the Kenneth Gordon School and/or the Fraser Academy; (2) the Child Reading/Spelling composite; (3) the Child Language composite; (4) Parents’ SES; (5) Higher-Order Language composite; (6) the Memory composite; (7) the Rapid Naming composite; (8) the Phonological Awareness
composite; (9) the Word Recognition/Spelling composite; (10) the Nonword Accuracy and Speed composite; (11) the Print Exposure Composite; and (12) the Raven's Progressive Matrices.

An examination of the correlational patterns revealed that the correlations between the Reading Comprehension composite with each of the 12 variables in Table 26 were comparable between the AD and RL groups. Several correlations between the Reading Efficiency composite and the 12 variables, however, appeared to be discrepant. For instance, the correlations between SES and connected discourse Reading Efficiency were -.15 for the RL group but .60 for the AD group. The correlations between Nonword skills and connected discourse Reading Efficiency were .01 for the RL group and .67 for the AD group. The correlations between the higher-order language composite and Reading Efficiency were .77 for the RL group and .29 for the AD group. The correlations between Phonological Awareness and Reading Efficiency were -.21 for the RL group and .45 for the AD group.

These numerical differences among correlations in the AD group were then formally tested for statistical significance. The Pearson r's were converted to z scores and a Fisher z score test was conducted. The results of these tests indicated that the magnitudes of these correlations varied significantly by group for the following correlations: (1) Nonword reading and Reading Efficiency ($z = 2.51; p < .01$); (2) Higher-order Language and Reading Efficiency ($z = 2.28; p < .05$); (3) SES and Reading Efficiency ($z = 2.63; p < .004$); and (4) Phonological Awareness and Reading Efficiency ($z = 2.18; p < .01$).

5. Comparison of Mean Intercorrelations Between AD Matrix and RL Matrix

Since there appeared to be differences in magnitude between the correlations in the AD matrix versus the RL matrix, a formal test of this hypothesis was undertaken using Kaiser's procedure for calculating mean
intercorrelations (Kaiser, 1968). The null hypothesis was that the AD correlation matrix was equal to the RL correlation matrix. First, the matrices were condensed by using the composite scores. The composite scores included the Higher-order Language composite, the SES composite, the Rapid Automatized Naming composite, the Word Recognition/Spelling composite, the Print Exposure composite, the Raven's, the Nonwords composite, the Phonological Awareness composite and the Memory composite. According to the Kaiser procedure, the mean intercorrelation for the AD matrix was .255 and for the RL matrix it was .203. These coefficients were then converted to $z$ scores and compared using a Fisher $z$ test. According to the Fisher $z$ test, there was not a significant difference between the AD and RL correlation matrices ($z = .165; p > .05$).

6. **Summary of Correlational Patterns in the AD and RL Groups**

In both groups, the reading measures were highly correlated with each other. However, when the relationships between connected discourse reading variables and language, cognitive and word recognition variables were considered, the patterns varied by group. Although the overall matrices were not significantly different, significant differences were observed in specific correlations. The correlations between Reading Efficiency and the following composite variables were significantly different when the AD and RL groups were contrasted: (1) Nonword Accuracy and Speed; (2) Higher-order Language; (3) Phonological Awareness; and (4) SES. The correlations between the Reading Comprehension composite and other composite variables were statistically comparable in the AD and RL groups.

**WHAT LANGUAGE AND COGNITIVE VARIABLES BEST PREDICT CONNECTED DISCOURSE READING OUTCOMES FOR THE AD AND RL GROUPS?**

1. **Regression Procedures and Tests of Assumptions**

Since some of the patterns of intercorrelations in the AD group and the RL varied significantly, a series of regression analyses were
undertaken to determine what language, cognitive and decoding variables best predict scores on the connected discourse reading measures for the AD and RL groups.

For each of the regression analyses that follow, the following procedures were undertaken. First, a stepwise regression procedure using BMDP2R (Dixon et al, 1990) was used in all cases. In this procedure, variables compete with one another statistically to determine which variable accounts for the greatest amount of variance in the dependent variable. The results were identical, irrespective of the order of entry of the variables of interest.

To accommodate potential difficulties with subject-to-variable ratios (Stevens, 1986), composite scores were used to reduce the number of variables. The independent variables were selected with the following criteria in mind. First, the same set of variables for each group (AD and RL) were entered into the models. Using the correlational tables as guidelines, variables that were the most highly correlated with the dependent variable were selected first. Finally, the assumptions for regression analyses (i.e., linearity and homoscedasticity) were considered by examining subjects' residual scores (i.e., the difference between their predicted scores and their actual scores) and plots of residuals by group. Cases that were outliers were eliminated and then the regression analyses were rerun without these cases. Since the sample sizes for the regression analyses were relatively small (i.e., 20-22), all "variance accounted for" results refer to the R-squared adjusted figure rather than R-squared. The R-squared adjusted figure is a more conservative estimate of variance accounted for because it takes the small sample size into account.
2. **What Best Predicts Reading Comprehension?**

For the first set of stepwise regression analyses, the dependent variable was the Reading Comprehension composite. For both AD and RL groups, the following variables were entered as the independent variables in the following order: (1) Age; (2) the Higher-order Language composite; (3) the Word Recognition/Spelling composite; (4) the Rapid Automatized Naming composite; and (5) the Print Exposure composite. Age was selected because of the significant difference between the chronological age of the AD and the RL groups ($p < .0001$). All the other variables were chosen because they were significantly and highly correlated with reading comprehension in one or both of the AD and RL groups.

a) **The AD Group (Reading Comprehension)**

When the stepwise regression analysis was run on the AD group data, one subject had a residual that exceeded 2 standard deviations from the mean. This subject had performed worse than expected. This subject was thus eliminated from the group and the analysis was rerun. With this outlier removed, another subject exceeded 2 standard deviations and was also removed. This subject had performed better than expected. Finally, the analysis was rerun with the data from 20 AD subjects. Under these circumstances, all the required assumptions were met.

The results of this stepwise regression are presented in Table 27. Two variables made significant contributions to the prediction of the Reading Comprehension composite. For the AD group, the best predictor of the Reading Comprehension composite was Higher-order Language. This variable accounted for 72% of the variance in the AD group. The Rapid Automatized Naming variable also made a significant contribution to the Reading Comprehension composite and added an additional 8% of the variance. In total, these two variables uniquely accounted for 80% of the variance in the Reading Comprehension composite.
b) The RL Group (Reading Comprehension)

When the stepwise regression was run on the RL group, one subject had a residual score that exceeded 2 standard deviations from the mean. This subject was, therefore, eliminated and the analysis was rerun with the data for 21 RL subjects. Under these circumstances, all the required assumptions were met. The results of this stepwise regression are presented in Table 29. Only one variable made a significant contribution to the prediction of the Reading Comprehension composite. For the RL group, the Higher-order Language variable uniquely accounted for 75% of the variance in the Reading Comprehension composite.

3. What Best Predicts Reading Efficiency?

For the second set of stepwise regression analyses, the dependent variable was the Reading Efficiency composite. For both the AD and RL groups, these variables were entered as the independent variables in the following order: (1) Age; (2) the Word Recognition/Spelling composite; (3) the Rapid Automatized Naming composite; (4) the Higher-order Language composite; and (5) the SES composite. Age was selected because of the significant difference between the AD and RL groups (p < .0001). The other variables were selected because they were significantly and highly correlated with the dependent variable in at least one of the AD and RL groups.

a) The AD Group (Reading Efficiency)

When the stepwise regression analysis was run on the AD group data, there were no significant residual scores and the residual plots indicated that the assumptions had been met. The results of this analysis are presented in Table 28. Three variables made significant contributions to the prediction of Reading Efficiency in the AD group. The Word Recognition/Spelling composite accounted for 67% of the variance in the AD group. The Rapid Automatized Naming composite added an additional 12%,
while the Higher-order Language composite accounted for an additional 4%. In total, these three variables uniquely accounted for 83% of the variance in reading efficiency in the AD group. Although the SES composite was highly correlated with Reading Efficiency (r = .60), it did not make a unique contribution to the outcome in this regression analysis. This can likely be explained by its high correlation with the Word Recognition/Spelling composite (r = .45).

b) The RL Group (Reading Efficiency)

When the stepwise regression was run on the RL group data, no significant outliers were noted and the assumptions were met. The results of this analysis are presented in Table 30. Only one variable made a significant and unique contribution to the prediction of Reading Efficiency for the RL group. The Higher-order Language variable uniquely accounted for 58% of the variance in Reading Efficiency in this group. Even though three other variables were highly correlated with the Reading Efficiency composite, these variables were also highly correlated with each other. For instance, the correlations between Reading Efficiency and these variables were as follows: (1) the Rapid Naming Composite (r = .72); (2) the Word Recognition/Spelling composite (r = .62); and (3) the Print Exposure composite (r = .59).

G. SUMMARY OF RESULTS

1. What Levels of Reading Skill Do AD Subjects Achieve Relative to RL and CA?

The reading skills of the AD group fall, on average, in the junior high school range (grade 7 to 9). Both their word recognition skills and their connected discourse reading skills are significantly below the CA controls. The AD group has achieved reading skill levels that are comparable to the RL group. Thus, their reading skills, on average, are comparable to those of twelve year old children. There was, however, one
exception to this pattern. The AD group's ability to read nonwords accurately and quickly is significantly below the RL controls.

2. What Levels of Skill Do AD Subjects Achieve in Language and Cognitive Domains Relative to RL and CA?

The oral language and cognitive skills of the AD group, relative to the other two groups, were more variable than their reading skills. The AD group was comparable to the CA group on Boston Naming Accuracy and Speed, Phoneme Counting, and three memory measures. The AD group performed significantly below the CA group on most measures of Higher-order Language including Listening Comprehension, Information, Daneman and Carpenter working memory and PPVT-R vocabulary. The AD group was significantly better than the RL group on two measures of vocabulary, on R.A.N. Colour Naming times, and on Phoneme Counting. On all other measures, the AD group was comparable to the RL group.

3. What Predicts Connected Discourse Reading Outcomes within the AD Group?

AD subjects who scored best on the SDRT-Blue reading comprehension measure and the Reading Comprehension composite, had the best Listening Comprehension and Vocabulary scores in the adult years and the best Verbal IQ and PPVT (on the SDRT-Comprehension median split only) scores in childhood. Furthermore, they had better scores on Print Exposure. AD subjects who scored best on the Reading Efficiency measure were those who had better scores on Rapid Naming, Word Recognition and Spelling. AD subjects who scored best on the WRAT-R (Level II) single word reading test were those who had better scores on specific lower-order language skills, including Rapid Naming and Phoneme Deletion. They also had better scores on the Bruck Nonword measures for both speed and accuracy.
4. Are There Any Differences in the Pattern of Relationship between Reading Skills and Cognitive/Language Skills When the AD and RL Groups are Compared?

Although there were no significant differences between the AD and RL groups when the mean correlations of the matrices were contrasted, there were specific differences in some subsets of the matrices. Correlations between Reading Efficiency and SES, and Reading Efficiency and Nonword reading skill, were significantly different by group. While high SES and high Nonword reading skills were associated with a good outcome on Reading Efficiency for AD subjects, they were not highly correlated with outcome for RL subjects. A similar pattern was noted with Phonological Awareness. There were also significant differences in the correlations between the Reading Efficiency composite and Higher-order Language skill. Higher-order Language skill was highly correlated with Reading Efficiency for RL subjects but not AD subjects. Otherwise, the correlational patterns across groups appeared to be statistically comparable.

5. What Cognitive and Language Skills Best Predict Connected Discourse Reading Skill Among AD and RL Subjects?

For RL subjects, Higher-order Language skill uniquely accounted for 75% of the variance on the Reading Comprehension composite and 58% of the variance on the Reading Efficiency Composite. For AD subjects, Higher-order Language skill accounted for 72% of the variance in the Reading Comprehension composite with Rapid Naming contributing an additional 8%. On the other hand, for the AD group Word Recognition/Spelling skill uniquely accounted for 67% of the variance in the Reading Efficiency composite with Rapid Naming, and Higher-order Language contributing an additional 12% and 4% respectively.
K. INDIVIDUAL CASE STUDIES AND CLINICAL PATTERNS AMONG AD SUBJECTS

1. Distribution of AD Reading Scores According to Grade Equivalent Estimates

Table 31 presents results for AD subjects on the reading measures. Subjects were classified in one of four categories according to achievement levels in reading at follow-up. Since the reading tests were measured with a variety of scales, the classifications are presented with a common scale across measures that is clinically understandable. Grade equivalent scores were used to classify reading achievement at four levels: (1) low elementary (i.e., K to grade 4); (2) middle school level (i.e., grade 5 to grade 8); (3) high school level (i.e., grade 9 to grade 12); and (4) post secondary school level (i.e., grade 12 and beyond).

Results in Table 31 indicate that the majority of AD subjects scored at the grade 5 level or above on connected discourse reading measures. On the GORT-3 reading comprehension measure, the GORT-3 passage (accuracy and rate) and the SDRT-Blue Fast reading measure, over 91% of the sample scored at the grade 5 level or above. On the SDRT-Blue reading comprehension measure, 86% of the sample scored above the grade 5 level. All AD subjects had a minimum grade equivalent score of grade 5 on word recognition accuracy on the WRAT-R 11.

The proportions of subjects scoring above the high school level, however, were relatively low for the GORT-3 passage reading accuracy and speed measure (9%), for the SDRT-Blue Fast reading measure (9%) and for the SDRT-Blue reading comprehension measure (9%). In contrast, 41% of AD subjects scored above the grade 12 level on the GORT-3 reading comprehension measure.
2. Unusual Individual Cases

When the cases that were in the lowest category (i.e., K to grade 4) and the highest category (i.e., Beyond grade 12) were identified, two cases emerged as consistently extreme performers. Case A’s scores were consistently low. This result is consistent with the observation that several scores for Case A were either eliminated or adjusted in previous analyses (i.e., ANOVA’s and Regressions) because of extreme z scores. Case B was a consistently high performer. Case C was identified as unusual because he was classified as a very high performer (i.e., Beyond grade 12) on some tests and a very low performer on others (i.e., Below grade 5). Detailed profiles of Cases A, B and Case C are presented in Tables 32, 33 and 34 since these individual differences data may not have been adequately captured in the analyses of group data.

3. A Comparison of Childhood/Demographic Variables for Cases A, B, and C

Table 32 presents data for childhood and demographic variables for Cases A, B, and C. All of these AD subjects are males with a family history of developmental dyslexia. Cases A (Low) and B (High), however, differ considerably on every other variable.

Case A (Low) was older at diagnosis (age 12 vs. age 6) and at follow-up (age 23 vs. 19) and spent less time at the Kenneth Gordon School (3 vs. 5 years). Both SES indices suggest that Case A(Low) had some environmental disadvantages when compared to Case B(High). His father’s occupation was ranked lower (37.66 vs. 56.83) and his mother had fewer years of education (12 vs. 17).

Case A’s (Low) standard score on childhood single word recognition was .78 of one standard deviation below the AD group mean while Case B’s (High) standard score was more than one SD (+1.27) above the mean. Case A (Low) also scored more than one SD (-1.21) below the mean on childhood
spelling whereas Case B (High) scored close to the group AD mean. Case A (Low) had a childhood Verbal IQ score that was 23 points below that of Case B (High) and a childhood PPVT receptive vocabulary standard score that was 19 points below Case B (High). The only exception to this pattern of Case A (Low) scoring lower than Case B (High) was on the childhood Performance IQ. Case A (Low) scored very close to the AD group mean whereas Case B (High) scored more than one SD below the AD group mean.

Case C’s (Mixed) family background was similar to Case B (High) on mother’s years of education (both at 17 years) but differed on father’s occupational SES index. This SES index was similar to Case A (Low) (33.30 vs. 37.66). Case C (Mixed) was diagnosed at 10 years of age and spent three years at the Kenneth Gordon School. This pattern is comparable to the AD group mean. Although his childhood academic scores (i.e., word recognition and spelling) were more than one SD below the AD group mean and were similar to those of Case A (Low), his scores on the childhood higher-order language measures were approximately one SD above the mean and close to Case B (High).

4. Reading Scores for Cases A, B, & C at Follow-up

Table 33 presents grade equivalent estimates, raw scores, standard scores and z scores for the reading measures at follow-up. The table of z scores confirms that the cases do represent extremes in the AD sample. Reading test scores for Case A (Low) were consistently below the mean for the AD group. Z scores were all negative and ranged from -0.16 to -3.02. In contrast, reading test scores for Case B (High) were consistently above the mean for the AD group. Z scores were all positive and ranged from +1.02 to +1.92. Z scores for Case C (Mixed) were above the AD mean on the reading comprehension measures (i.e., GORT-3 = +1.40 and SDRT-Comp = +0.61) but were below the mean on all other reading measures. The negative z scores for Case C (Mixed) ranged from -0.73 to -1.50. The lowest z score for Case C
was for GORT-3 passage reading (accuracy and rate) while the highest $z$
score for Case C was for GORT-3 reading comprehension.

5. Language Test Results for Cases A, B, & C at Follow-up

For lower-order language tests, Case A’s performance was consistently
below the AD group mean with $z$ scores ranging from +0.16 to +1.92. Although
the sign for these $z$ scores is positive, these scores indicate that he was
slower than the AD mean on rapid automatized naming (R.A.N.) tasks and made
more errors on phonological awareness tasks. $z$ scores for Case B (High)
were consistently better than the AD group mean on all lower-order language
tests. For Case C (Mixed), the $z$ scores were both positive and negative but
the magnitudes were never more than one standard deviation from the mean.

For higher-order language, Case B (High) consistently scored above
the mean on all measures with a range from +.87 to +1.48. Case C (Mixed)
also placed above the AD mean on all but one higher-order language measure
(i.e., Daneman and Carpenter working memory). Case C’s $z$ scores on
listening comprehension, PPVT-R vocabulary, and Boston Naming were as
follows: +1.22, +1.29 and +1.77.

6. Comments About Reading Strategies from Case C

When Case C was undergoing the GORT-3 reading comprehension test, he
spontaneously offered some insights into his own connected discourse
reading strategies. The following comments were transcribed from the audio-
tape of Case C reading the grade 9 GORT-3 passage.

Case C... "You know the key to reading a paragraph is picking
out the essential information and disregarding the
mindless babble. Do you understand what I mean?... and I’ve learned to do that. That’s how I got through
the other test [SDRT-Blue Comprehension]. I skimming
through it. I know you’re ‘spose to read it but for
me it’s frustrating to sit there and ponder through
a bunch of meaningless words. You look for key
sentences-key words-names.... and dates. And that’s
how you get through those tests. ....Cheating."
Examiner... "It's not cheating. It's being strategic."

Case C... "Well it's almost discouraging to read it out loud. Well, I can read it and then answer the questions without having to read it out loud. I don't have to read every single word to get the understanding. It's hard[er] for me to read out loud than it is to myself because I can sound out the words that give me a hard time."

7. **Summary of Results for Cases A, B, & C**

Language test scores and reading test scores both in childhood and at follow-up were closely related for Cases A (Low) and B (High). Scores for Case B (High) were consistently high for reading and for language. Scores for Case A were consistently low, with a few exceptions. Case A scored close to the mean on GORT-3 reading comprehension ($z = -0.16$) and listening comprehension ($z = +0.08$) and scored more than one SD above the mean on Boston Naming. For Case C (Mixed), those tests that comprised the reading comprehension composite were above the AD mean while those that comprised the reading efficiency composite were below the AD mean. Case C (Mixed) fell more than one SD below the AD mean on single word recognition and GORT-3 passage reading at follow-up. Higher-order language skills, with the exception of working memory, also were more than one SD above the AD mean at follow-up. Case C (Mixed) also presented with relatively strong verbal skills in childhood (VIQ $z = +.93$; PPVT $z = +1.13$). Case C (Mixed) offered some unsolicited comments about the way in which he approached the connected discourse reading tasks.
CHAPTER FIVE

DISCUSSION

The purpose of this follow-up study was to extend our knowledge of the connected discourse reading skills of adults with childhood diagnoses of developmental dyslexia. Questions concerning the extent to which adult dyslexics recover from, or compensate for, their childhood reading deficits were posed. Also of interest was the extent to which adult dyslexics with childhood diagnoses of dyslexia show evidence of compensatory processing while reading connected discourse. Thus, in this follow-up study, both achievement outcomes and processing outcomes were investigated.

The connected discourse reading skills of a sample of young adults, who were alumni of a private elementary school that specializes in the treatment of developmental dyslexia, were assessed. Using a reading-level and chronological age-matched design, their reading skills were evaluated to determine the extent to which they were appropriate for their age and for their level of word recognition skill. In addition, several oral language and cognitive skills that are thought to be associated with reading skill were also assessed to determine the way in which adult dyslexics process information while reading connected discourse.

A. ACHIEVEMENT OUTCOMES: READING SKILLS

1. No Evidence for Complete Recovery

The participants in this study were evaluated on several different types of reading measures. Five subtests were selected to measure various aspects of
connected discourse reading skill and two subtests were selected to measure single word reading. Four measures of print exposure were also included in the battery. As a group, the AD participants fell significantly behind their chronological peers on the majority of the reading measures. Thus, when the group data were considered, it was clearly apparent that they had not recovered from their documented early reading deficits.

A review of individual case outcomes revealed that only one AD subject’s reading skills were age appropriate. Although this subject (i.e., Case B) scored as well as his chronological peers on the rate of oral reading on the GORT-3, he may not be as fluent as his peers under pressure. This subject, along with all the other AD participants, did not complete the Fast reading subtest of the SDRT in the required time of three minutes. Thus, this subject appears to resemble the compensated dyslexics in Lefly and Pennington’s (1991) sample in which the accuracy scores were consistently age appropriate but the rate scores were not. Therefore, at best, only five percent of this sample of adults with documented childhood diagnoses of dyslexia appears to have recovered, or partially recovered, from early reading deficits.

Since multiple measures of reading skill were administered in this study, there was actually a bias against identifying recovered dyslexics. If the GORT-3 Reading Comprehension subtest were the only test of connected discourse reading skill to have been administered, as it was in the Kinsbourne et al. (1991) study, then a large proportion of the AD participants might have been inappropriately labelled recovered. On the other hand, if the only reading comprehension measure to be administered were the SDRT, then fewer individuals would have been considered to have recovered since only 9% of the AD sample scored beyond the high school level on this test.
2. How Does This Sample Compare with Other Samples?

Unfortunately, direct comparisons with the Kinsbourne et al. (1991) sample are not possible because of several differences in psychometrics on the Gray Oral Reading Test (GORT). First, Kinsbourne et al. (1991) used an earlier version of the test. Second, they reported the results for the total score rather than for separate subtest scores in oral reading accuracy, rate, and comprehension. Furthermore, they reported their results in standard scores, for which there was no comparison in the present sample since the oldest age group in the GORT-3 standardization sample was 18.

This sample of AD participants appears to be comparable to the Bruck (1990) adult dyslexic sample on the reading skills that were measured with the same instruments and the same norms. The mean standard scores on the Stanford Diagnostic silent reading comprehension test for the Bruck dyslexic college sample and the present sample were 696 and 685, respectively. The word recognition scores were also comparable with a grade equivalent estimate of grade 10 for the Bruck sample and grade 9 for this sample. The mean percentile scores for the WRAT-R II single word recognition test were 32 for the Bruck sample and 23 for this sample. Expressed as standard scores, the results would be 93 and 89, respectively. The Bruck sample was somewhat less accurate and slower on the Bruck experimental nonword reading measure. The mean raw scores for nonword accuracy were 25.4 and 29.0 respectively. The Bruck mean score for response latencies for nonwords was 2.01 seconds in contrast to 1.60 seconds for this sample. Whether or not these differences between samples would be significant is difficult to determine. Nevertheless, both samples were inferior to their respective reading-level (mean age 12 years) controls on both accuracy and speed of nonword reading.

Although the standard scores on the SDRT appeared to be comparable, the grade equivalent scores did not. For instance, on the SDRT, the mean grade equivalent scores were 11.5 for the Bruck sample and 7.3 for this sample. The
lowest grade equivalent scores were grade 6.1 and grade 2.2 respectively. Whether or not the SDRT Reading Comprehension grade equivalent scores are actually discrepant may depend on the norms that were used to derive the grade equivalent scores. In this study, I used the norms for the Spring of Grade 12. This decision was somewhat arbitrary, however, because most of the AD participants were not grade 12 students at the time of assessment. This test does not have norms for students at the post-secondary level. Since Bruck does not indicate how the grade equivalent scores were derived for the Montreal sample, accurate comparisons between samples, using grade equivalent scores, are not possible. For comparisons across studies, the standard scores appear to be the best metric.

Although the skill levels of the Bruck sample (1990) and the present sample appeared to be comparable, the Bruck sample may have an advantage over the longer term since all of the Montreal participants were enrolled in university. In contrast, none of the present sample had been accepted to, or were enrolled in, university even though their fathers' SES and their mothers' highest level in school (i.e., approximately second year university level) would suggest that many could expect a university education. In an earlier study, Bruck (1985) concluded that reading skills continue to improve when young adults are exposed to reading challenges in occupational or educational settings.

3. The Implications of the Print Exposure Results

The finding that the AD participants scored less well than the CA participants on the magazine and newspaper print exposure measures was not unexpected. The finding that there were no significant differences between the AD group and the CA group on the Author Recognition Test is interpreted, not so much as a relative strength for the AD participants, but rather as a relative weakness for the CA participants. Both groups performed so poorly on this measure that floor effects may have influenced this outcome. The finding
that the CA group outperformed the AD group on the print exposure measure of children's book titles was also not surprising since this would be predicted by the Matthew effects theory (Stanovich, 1986). The finding that is very interesting, however, was that the CA group and the RL group did not differ significantly on their exposure to children's literature. This finding is inconsistent with the hypothesis that the TRT scores were poor for the AD group because the titles were not contemporary. In fact, most of the children's book titles were for books that have been in print for two decades or longer.

4. Developmentally Delayed Reading Skills?

Although the AD group and the RL group had comparable scores on most of the reading measures, there were some dramatic exceptions. The finding that the AD group's scores on nonword reading accuracy and speed were significantly behind the RL group's scores is consistent with findings from other laboratories (Bruck, 1990; 1992). The finding that the AD participants were slow to complete the SDRT Fast Reading subtest, within the allotted time limit, is not unexpected and is also consistent with other studies (Mosberg & Johns, 1994; Runyan, 1991) in which reading disabled adults were contrasted with normal controls. The more interesting finding is that absolutely none of the AD participants completed the FAST reading task on time. Unfortunately, because the upper limits of their time to completion were not measured in the standard procedure for the SDRT Fast, these data were not available for inclusion in the Reading Efficiency composite. If these data had been captured in the Reading Efficiency composite, I suspect that there would have been statistically significant differences between the AD and RL groups on the reading efficiency composite.

Nevertheless, the overall pattern of results from the reading achievement battery indicates that the adult dyslexics are functioning no better than the average twelve year old. Thus, one might conclude, that with
respect to achievement outcomes, they are developmentally delayed. What remains unclear, however, is whether this represents the end point of their growth in connected discourse reading skills or whether they will continue to develop better skills over time.

Overall, the results from the reading achievement test battery were not unexpected and were consistent with the findings of previous investigators. There were, however, some results from this study that make a unique contribution to our knowledge. Because a variety of tests were administered, it became apparent the GORT-3 Comprehension subtest tended to overestimate recovery, whereas the other measures were more conservative (e.g., SDRT Reading Comprehension). The results from this study may also have implications for the reading-level-match design. One of the implicit assumptions of the reading-level matching procedure is that the groups will be matched, not only on word recognition skill but, also on exposure to print. In this study, the younger children and adolescents appeared to have a print exposure advantage. The results from this study, therefore, suggest that word recognition skill matched groups are not necessarily matched for print exposure.

5. Individual versus Group Differences

The results also suggest that both individual and group performances should be evaluated in order to provide clinically useful information. There was a great deal of heterogeneity in this sample. Two or three cases had scores that were consistent outliers when compared with the rest of the sample (e.g., Case A and Case B). The assumptions and conventions associated with ANOVA's and regression analyses may actually mask some clinically important information. When data are trimmed, transformed, or eliminated because the homogeneity of variance assumptions or normality assumptions have not been met, the outliers or exceptional cases are affected. Their influence is either dismissed or their effect on the distribution is diluted. As a result, the group data may be misleading when one considers the implications of the
performance outcomes for long term prognoses and clinical interventions. The individual case results illustrate the heterogeneity of this population. The lowest scoring AD participant appears to be barely literate, whereas the highest functioning AD participant appears to be functioning as well as Bruck's (1990) normally achieving college students.

6. The Reading Composite Scores

The results from this study also suggest that the distinction between reading comprehension and reading efficiency may be important when evaluating long term connected discourse reading achievement and processing outcomes. Originally, the decision to form composites was motivated by the need for some data reduction, so that the subjects-to-variables ratio was lower for regression analyses. It was also argued that by combining the measures reliability would be enhanced. Although the rationale for assigning particular tests to composites was formulated post-hoc, the decisions were systematically made on both theoretical and empirical grounds. When the data were not dramatic, theoretical considerations superseded.

The empirical rationale for the composites was motivated by the relationships between word recognition skill and the various measures of connected discourse reading skill. It was expected that there would be a dissociation between word recognition skill and reading comprehension measures (Bruck, 1990). In contrast, it had been anticipated that oral reading of connected discourse would be highly correlated with word recognition (Lovett, 1987).

Consistent with predictions, there was a continuum in the magnitudes of the correlation coefficients between word recognition skill and connected discourse reading skill, for AD participants. The coefficients ranged from .17, for the GORT-3 comprehension measure, to .72 for the GORT-3 oral reading measure. These results are not surprising since the GORT-3 comprehension
measure, for which questions were read orally by the examiner, appeared to place the least demands on word recognition skill. On the other hand, the GORT-3 oral reading task placed the greatest demands on word recognition skill. Thus, these two measures appeared to represent extremes on the continuum so their inclusion in their respective composites appeared to be both empirically and theoretically justified.

Decisions about the allocation of the SDRT silent reading measure and the SDRT FAST reading measure to composites were more difficult to make. The SDRT was assigned to the Reading Comprehension composite because the correlations with word recognition were lower for both the AD group and the RL group than they were for the FAST reading subtest, but these differences were minimal. At this decision point, the conceptual argument was given more weight. It was argued that the time constraints associated with the FAST reading subtest would place greater demands on local processes, including word recognition. Therefore, the FAST reading subtest was assigned to the Reading Efficiency composite. An alternative choice would have been to assign three measures to a Reading Comprehension composite and let the GORT-3 oral reading measure stand alone. This option, however, was rejected when it was noted that the FAST reading subtest was highly and significantly correlated with word recognition, for the AD group ($r = .64$), and moderately, but not significantly correlated for the RL group ($r = .34$). Thus, for the AD group, word recognition accounted for over 40% of the variance in FAST reading whereas, for the RL group, it accounted for less than 12%. Thus, it appeared as if there were group differences in the association between word recognition and these measures of connected discourse reading.

The results from subsequent analyses suggest that the Reading Comprehension and Reading Efficiency composites measure different aspects of connected discourse reading skill. This interpretation is offered in light of the group differences when effect sizes and correlation coefficients are
considered. The AD group fell more than one and a half standard deviations behind the CA group on the Reading Comprehension Composite and almost two and a half standard deviations behind on the Reading Efficiency Composite. The AD group was only slightly better than the RL group on the Reading Comprehension Composite ($d = .21$) but their scores on the Reading Efficiency measure fell approximately one half of a standard deviation below the AD group ($d = -.54$). Furthermore, although the difference between the AD group and the RL group on the Reading Efficiency Composite was not statistically significant, the medium effect size difference stands in contrast to the low effect size difference for the Reading Comprehension Composite.

Another group contrast, that offers support for the validity of the Reading Efficiency composite, is the relationship between Reading Efficiency and four important variables. According to the Fisher $z$ tests, there were significant differences between the AD and the RL groups in the magnitudes of the correlations on each of these variables. For the AD group, the following variables were significantly and strongly related to Reading Efficiency: (1) SES; (2) nonword reading; and (3) phonological awareness. In contrast, higher-order language was significantly and strongly related to Reading Efficiency for the RL group. Thus, for the adults with childhood diagnoses of dyslexia, achievement success on the connected discourse reading measures, that comprised the Reading Efficiency composite measures, was strongly related to better performance on phonological coding and phonological awareness skills. These skills are relative weaknesses in this sample and are thought to be the "core" (Stanovich, 1988) deficits in dyslexic populations.

Ideally, the composite scores would have been empirically derived from the results of factor analyses. In this research, however, factor analyses were contra-indicated because of the small subjects-to-variables ratio. Thus, the procedures that were followed were implemented as the best alternative for a small-sample clinical study. In light of the findings presented above, it is
argued that the Reading Efficiency and Reading Comprehension composites represent different aspects of connected discourse reading skill and are valid constructs for this research. In future clinical research, however, there may be some value in selecting connected discourse reading measures and composites that have fewer overlapping features so that differences in task demands across measures are more distinct.

B. ACHIEVEMENT OUTCOMES: ORAL LANGUAGE AND COGNITIVE SKILLS

1. The Significance of this Battery

The results from the oral language and cognitive skills battery are particularly interesting for a variety of reasons. First, few researchers have assessed these skills in a comprehensive fashion in previous studies. Second, these data provide a springboard from which to make inferences about the way in which information is processed when adult dyslexics read connected discourse. Furthermore, although the literature suggested that strengths and weaknesses in oral language and cognitive skills would be associated with reading performance outcomes, it was difficult to predict how well this sample would perform on this battery. Researchers, who had studied the oral language and cognitive skills of children with deficient reading skills, implicitly made contradictory predictions about the oral language outcomes for young adults with a history of reading problems. There were some indications that subtle oral language deficits could be expected in the young adult years (e.g., Felton et al, 1990; Lovett, 1987), but other indications that higher-order oral language skills could be a relative strength in this population (e.g., Bruck & Waters, 1990; Bruck, 1990; Conners & Olson, 1990).

Although it was difficult to offer precise hypotheses about the oral language outcomes for this sample, some predictions were formulated. It was predicted that the AD group would have relative strengths in higher-order language skills that would be better than the RL group and would approach the skill levels of their chronological age mates. It was also predicted that the
AD group would have lower-level language skills that were significantly poorer than the RL group. The results were generally consistent with these predictions.

2. **Adult Dyslexics Present with a Mixed Profile**

Although the oral language and cognitive skills of the AD participants were not as well developed as their chronological age mates, they were more advanced than the reading-level controls on some measures. The AD participants performed significantly better than the RL controls on two measures of vocabulary, on colour naming speed, and on phoneme counting. On several higher-order language measures, their performance was statistically comparable to the RL group. The AD and RL groups were comparable on the following higher-order language skills: (1) listening comprehension; (2) working memory listening span; and (3) general information. They were also comparable to the RL group on several lower-order language skills including the rapid automatized naming of numbers, the rapid naming of letters, and phoneme deletion. Contrary to expectations, the Swanson working memory measures failed to distinguish among the three groups.

The results also suggest that there are several lower level and higher level language skills that may best be developed in a print enriched environment. All correlations between print exposure and connected discourse reading tests were significant among the RL group. The results from the TRT, however, indicated that the AD group’s knowledge of children’s literature was impoverished, in contrast to both of the controls. The finding that the AD participants were better than the RL participants on the R.A.N. Colours, as opposed to the R.A.N. numbers and letters, might also be explained by their limited print exposure. Thus, the age advantage of the adults with childhood diagnoses may have been diluted by the print exposure disadvantage. It is also possible that some of their developmentally delayed language skills could be attributed to subtle oral language skill deficits that were actually
Contrary to expectations, the AD participants outperformed the RL group on phoneme counting, one of the measures of phonological awareness. Why the AD participants were better able to undertake phoneme counting is not clear. One possibility, however, is that this was a skill that was promoted while the Kenneth Gordon alumni were involved in the Orton-Gillingham reading interventions during their elementary school years. Another possibility is that this skill is not as critical for the normally achieving children and adolescents because they are less reliant on phonological information when reading. Evidence to support this possibility was provided by the response latency data for nonword reading. The AD group was significantly slower when decoding nonwords, an analogue for unknown real words. This result suggests that they may rely more heavily on a phonological coding procedure as opposed to an orthographic analogy approach (Goswami, 1986) when reading nonwords.

Working memory tests were included in the test battery because of the central role of memory resources in Perfetti’s (1985; 1988) verbal efficiency theory. The results from the working memory tests, however, are difficult to interpret because there was no consistent pattern in group differences. Consistent with predictions, the CA group outperformed both of the other two groups on the Daneman and Carpenter listening span measure. The adult dyslexics and the reading level controls performed at comparable levels. Contrary to predictions, the subtests of the Swanson working memory battery failed to distinguish among groups.

Why did the Swanson battery fail to distinguish among groups? One possibility is that the Swanson measures are related more to general executive processing skills than to reading skills (Swanson, 1992), whereas the Daneman and Carpenter task is a better analogue for reading (Daneman & Carpenter,
1980). It is also possible that there are ceiling effects on the Swanson measures so that potential growth in the CA group could not be detected. This hypothesis is offered since the mean scores achieved by all the groups were comparable to the mean for recently published standardized norms (Swanson, 1995).

C. RELATIONSHIPS BETWEEN READING SKILLS AND ORAL LANGUAGE/COGNITIVE SKILLS

Since both the empirical and theoretical literature had suggested that oral language and cognitive skills would be related to connected discourse reading outcomes, two questions regarding this relationship were posed. The first question regarding this relationship concerned relative strengths and weaknesses within the AD group. What cognitive and oral language skills best account for individual differences in connected discourse among adult dyslexics? The Bruck (1990) compensation hypothesis motivated this question. Bruck had hypothesized that adults with childhood diagnoses of dyslexia with the best reading comprehension scores would be those with the best oral language and world knowledge. The second question regarding the nature of the relationship between oral language/cognitive skills and connected discourse reading focused on processing outcomes. To answer this question, the patterns of relationships between and among skills, for the AD and the RL groups, were contrasted.

1. Individual Differences Among AD Participants

When a median split was performed on the SDRT: Blue Reading Comprehension subtest, the results were very similar to the Bruck (1990) results. In both studies, it was found that those who performed best on this measure had relatively strong receptive vocabulary scores, as measured by the PPVT, both in childhood and at follow-up. In addition, there were no significant differences between the High AD’s and Low AD’s on any aspect of decoding including word recognition and nonword reading.
Since the associated skills battery was more comprehensive in the present study, some findings were reported that are unique to this study. Consistent with Bruck’s predictions, the High AD’s were superior on listening comprehension. The finding that there were no differences between the groups on general information was inconsistent with Bruck’s (1990) notion that better comprehenders would have better world knowledge. The finding that the High AD’s had better print exposure scores is unique to this study. When the median split was conducted on the Reading Comprehension Composite score, a similar pattern emerged, with one exception. Although the High AD’s had better childhood PPVT scores than the Low AD’s, this difference was not significant.

These results provide partial support for Bruck’s compensation hypothesis. There was no support for Bruck’s notion that relatively good reading comprehenders would have better world knowledge. In this study, world or general knowledge was measured with a Canadian adaptation of the WAIS-R Information subtest. It is possible that this measure is not sensitive to subtle individual differences in general information. It is also possible that good general knowledge was not critical for understanding the connected discourse reading passages in this battery. Instead specific knowledge, that was related to the expository texts in the connected discourse reading battery, may have been more critical for understanding. On the other hand, Information subtest scores were highly and significantly correlated with reading comprehension outcomes for the RL group. For the AD group, the correlations were low and insignificant. Since the RL group and the AD group had comparable general information raw scores, these results suggest that there may be group differences in their reliance on these skills.

When the median split was conducted on the Reading Efficiency Composite score, a very different set of tests distinguished between the High AD’s and the Low AD’s. The High AD’s had better scores on single word recognition, nonword accuracy, spelling, rapid automatized naming, and father’s SES. When
the median split was conducted on the WRAT-R II word recognition test, the results indicated that the High AD's were superior on two aspects of lower-order language (i.e., rapid naming and phoneme deletion) and on nonword reading accuracy and speed.

The results from the median splits indicated that although relatively strong word recognition and lower-order language skills are not necessarily associated with better performances on reading comprehension, they are associated with better performances on reading efficiency and word recognition. If there were continuity between childhood performances and adult performances, one might also have expected that better childhood word recognition skill would have been associated with better performances on the Reading Efficiency composite and the adult WRAT-R II. There were, however, no significant differences between the groups. This result could be attributed to several factors.

It is possible that the measurement errors, which were an inevitable consequence of the test equating process, were not random across groups. It is also possible that the groups actually did not differ on childhood word recognition scores, but various aspects of schooling, motivation, or family circumstances were more favourable for the High AD's. Support for the latter possibility is provided by the better SES scores for the High AD's on the Reading Efficiency median split. It is also possible that there was a restriction of range in the childhood word recognition scores, making it difficult to detect individual differences. A more likely possibility is that information about subtle individual differences in a small clinical sample cannot be adequately captured by the median split procedure because it converts continuous data to a categorical form. Had the AD sample been larger, and the childhood battery more complete, the best childhood predictors of connected discourse reading achievement outcomes would have been determined using a multiple regression technique.
The results from the median split indicated that adult dyslexics who performed best on reading comprehension had relatively stronger higher-order language skills and more exposure to print, irrespective of word recognition skill levels. In contrast, those who performed best on Reading Efficiency measures of connected discourse reading, and those who performed best on word recognition, had superior lower-order language skills and better phonological coding (nonword reading) skills.

Overall, these results suggest that the prognosis for connected discourse reading outcomes will vary by task. It may be possible for a dyslexic child to eventually achieve age appropriate reading comprehension skills as a young adult, without acquiring superior word recognition skill, provided the individual has relatively strong higher-order language skills, both in childhood and at follow-up. These higher-order language skills may be developed, in part, by extensive exposure to print. Results from Case A provides support for Bruck's suggestion that a certain level of minimal word recognition skill may be a necessary condition before the higher-order oral language skill advantage can be effective in facilitating reading comprehension outcomes. On the other hand, the dyslexic child will not likely achieve efficient connected discourse reading skills if he/she suffers from severe phonological coding and/or rapid naming deficits that result in weak word recognition skills.

Because word recognition skills appeared to be more influential in determining reading efficiency outcomes, I suspect that a higher minimum level of word recognition skill is necessary for facile reading of connected discourse under time constraints. In other words, a higher threshold for word recognition skill may be necessary, when reading under stressful conditions, before any higher-order oral language skill advantage becomes influential. These conclusions, however, are tentative and based upon the within group analyses.
2. Comparisons Between AD and RL Participants

a) The Correlational Data

The correlational data for the AD and RL groups provide additional support for the tentative conclusions that were derived from the median split analyses within the AD group. As expected, all the connected discourse reading measures were positively and significantly intercorrelated. One exception to this pattern, however, was a virtually orthogonal relationship between the GORT-3 Passage score and the GORT-3 Comprehension score ($r = .04$) for the AD group. This finding indicates that some AD's with relatively poor oral reading accuracy and speed could have scored well on the reading comprehension questions from the same passage. This discrepancy suggests that, for some participants, relatively good reading comprehension outcomes on this measure were independent of accurate and fluent word recognition skills. Thus, success on this measure may have been related, at least in part, to the vocabulary advantage of the AD participants since the correlations between the GORT-3 comprehension and the PPVT-R receptive vocabulary scores were significant.

The results from the Case C profile, presented in Chapter Four, illustrate this dissociation between oral reading skill and reading comprehension. Case C scored beyond the high school level on the GORT-3 reading comprehension measure despite an oral passage reading score that was at the grade four level and a WRAT-R II word recognition score at the grade seven level. This represents a major discrepancy between the expected outcome, for level of word recognition skill, and the actual outcome. Since this subject had oral language skills that were above average, according to the standardized test norms, both in childhood and at follow-up, compensatory processing with favourable achievement outcomes is inferred. This subject also scored beyond the grade 12 level on the SDRT Reading Comprehension test but was more impaired on the tests that comprise the Reading Efficiency composite. This subject's score on the Fast Read measure was commensurate with his word recognition skills and was estimated to be at a grade six level.
b) **Best Predictors of Connected Discourse Reading Outcomes**

The regression analyses confirmed what the correlational patterns had foreshadowed. For both AD and RL participants, the best predictor of Reading Comprehension was higher-order language skill. For both groups, this variable accounted for at least 72% of unique variance. For the AD group, rapid automatized naming contributed an additional 8%. These findings are consistent with Bruck’s hypothesis that adult dyslexics who are the best reading comprehenders will have the best higher-order language skills, relative to their dyslexic peers. In contrast, the best predictors for Reading Efficiency varied by group. For the AD participants, the best predictors were lower level skills. Word recognition and spelling accounted for 69% of the variance and rapid automatized naming skills added an additional 12%. Although higher-order language skills also predicted outcome, they entered the equation after the lower level skills and uniquely accounted for an additional 4% of the variance. In contrast, for the RL participants, the best predictor of Reading Efficiency was higher-order language skills.

The finding that Reading Comprehension and Reading Efficiency outcomes are predicted by different associated skills is very interesting and has a number of implications. First, when researchers and clinicians are evaluating the skills of young adults with childhood diagnoses of dyslexia, the way in which higher-order and lower-order information is processed will vary depending upon what aspects of connected discourse reading skill are measured. Second, even though adult dyslexics appear to have connected discourse reading achievement levels that are appropriate for their levels of word recognition skill, when the task demands escalate, their processing begins to change.

It appears as if the potential for, or the effect of, drawing on relative strengths in oral language to compensate for poor phonological coding is diminished as the speed and accuracy requirements become more stringent. When the connected discourse reading tasks are more challenging, the adult
Dyslexics must become more reliant on a process that is weak (i.e., phonological coding). Therefore, they appear to perform an information processing counterbalancing act that is different from normal children and adolescents. This information processing counterbalancing act appears to be an effort to take advantage of their relative strengths in some higher-order skills. However, when reading efficiency is demanded, the achievement outcomes appear to be more constrained by, and determined by, the lower-order skills.

D. COMPENSATORY PROCESSING: IS THERE ANY EVIDENCE?

Three criteria were established a priori for evaluating the extent to which the adult dyslexics with childhood diagnoses of dyslexia were using compensatory processing. It was determined that they must differ from the reading-level control group on at least one of the following: (1) reading rate; (2) the strengths and weaknesses in their profile of associated skills and; (3) the magnitude of the relationships between connected discourse reading skills and the associated skills battery. If there were no significant differences between the AD group and the RL group on any of these criteria, it could be argued that they were using comparable information processing. But if there were differences between the AD group and the RL group, it could be argued that the adult dyslexics were employing qualitatively different information processing that is associated with factors other than developmentally delayed or arrested (Bruck, 1990) word recognition skill.

The adult dyslexics were comparable to the reading-level controls on the speed of single word reading and the speed of oral reading of connected discourse. They fell significantly below the reading-level controls on nonword reading and failed to complete one connected discourse reading measure for which there was a time limit. At a minimum, these results suggest that their performance is constrained by their level of word recognition skill. It also suggests that when faced with the pressure of time limits in connected discourse reading, they may be adjusting their speed to compensate for other
weaknesses. If one considers poor nonword reading as an analogue for the ability to decode new or unfamiliar real words, then it is possible that an adjustment in speed is made to accommodate this weakness.

For the most part, the oral language and cognitive skills of the adult dyslexics and the reading-level controls were comparable. There were, however, some significant differences in their profiles that reflected relative strengths and weaknesses. On the one hand, it appeared as if these two groups had comparable general knowledge as reflected by the scores on the Canadian WAIS-R Information subtest. On the other hand, the reading-level controls appeared to have had more print exposure to children's literature, despite their younger age. Thus, it is possible that they had a broader knowledge base than the adult dyslexics. The adult dyslexics also had poor nonword reading skills but relative strengths in vocabulary. So although the adult dyslexics and the reading level controls had comparable accuracy scores on all aspects of connected discourse reading, these results suggest that they may have achieved these results by qualitatively different information processing. They appear to be relying more heavily on their relative strengths in vocabulary to compensate for their relative weaknesses in phonological coding. They may also be using their better vocabulary to compensate for knowledge deficiencies that may be consequences of limited exposure to children's literature.

The finding that the adult dyslexics and the reading-level controls have comparable relationships between reading comprehension test scores and the associated skills test scores suggests that, for these reading comprehension tasks, both groups arrived at their achievement outcomes by using similar information processing. In contrast, the finding that the adult dyslexics and the reading-level controls have some significantly different relationships between reading efficiency and the associated skills suggests that, for the reading efficiency tasks in this battery, they were using qualitatively different information processing.
Thus, in conclusion, there were differences between the adult dyslexics and the reading-level controls on some aspect of all three of the \textit{a priori} criteria for evaluating compensatory processing. Furthermore, it is argued that there is evidence for compensatory processing that is above and beyond that which would be expected for their level of word recognition skill. That is, the adult dyslexics with childhood diagnoses of developmental dyslexia have a specific pattern of information processing when undertaking challenging connected discourse reading tasks.

\textbf{E. IMPLICATIONS OF THE RESULTS}

\textbf{1. Theoretical Implications}

The hypotheses for the present study were formulated with one theory and two models as points of reference. Perfetti's verbal efficiency theory offered a model for the way in which information processing operates for normally developing readers. This theory, however, was not designed to explain reading in dyslexic populations nor did it include a compensatory component. The theory did, however, emphasize the importance of accurate and fluent lower level skills, including word recognition skill, for efficient reading. Although Stanovich's interactive-compensatory model was designed to explain information processing at the word level, his notion of compensatory processing was adopted as a potentially useful construct for explaining the reading of connected discourse. Conners and Olson's (1990) model, based on data from an adolescent sample, suggested that the relationships between and among associated component skills would be different for dyslexics compared with younger controls matched for word recognition skill level.

The results for the achievement outcomes in this study provide support for some aspects of Perfetti's (1985; 1988) verbal efficiency theory. For instance, Perfetti argues that fluent lower-level or local processes are necessary for efficient reading. In the present study, the CA group was
distinguished from the AD and RL groups by their superior level of word recognition skill. Furthermore, the level of word recognition skill determined the approximate level of connected discourse reading achievement outcomes. The young adults with no history of reading disability (CA) and age appropriate word recognition skill performed best on all aspects of connected discourse reading skill whereas the young adults with childhood diagnoses of dyslexia performed no better than the average twelve year old. In other words, as a group, the connected discourse reading achievement levels of the AD group were constrained by the word recognition skill levels. Thus, these results provide support for Perfetti’s (1985; 1988) contention that fluent local processes are important for determining achievement outcomes.

Perfetti’s theory also emphasizes the importance of good working memory resources for efficient reading. The results from this study provide only partial support for the working memory hypothesis. Although the CA group outperformed the other two groups on the Daneman and Carpenter measure, there were no significant differences among groups on the Swanson working memory battery. In an earlier section of this chapter, I hypothesized that the content and psychometric properties of the Daneman and Carpenter measure may be more sensitive to group differences in reading. On the other hand, the groups may have achieved a ceiling on working memory skill as suggested by the results from the Swanson battery. In this case, it is possible that all three groups had achieved a threshold of working memory capacity that was sufficient for processing these particular connected discourse reading tasks.

Perfetti’s theory is less well equipped to explain the processing outcomes that were noted in the present study. The results, however, suggest that Stanovich’s interactive-compensatory theory might be expanded to include not only single word reading but also connected discourse reading. The evidence from the associated skills battery demonstrates that this sample had an uneven profile of strengths and weaknesses in oral language and nonword
reading skill, relative to reading level controls. The fact that they had similar achievement levels as the reading level controls, but different associated skills profiles, suggests that they relied on their relative strengths to compensate for relative weaknesses. Thus, these data suggest that a model of dyslexic reading should include an interactive-compensatory component.

The results also provide support for Connor’s and Olson’s notion that even when component skill levels are comparable to reading level controls, specific skills are more critical to a successful performance than others. To what extent do the data support the model presented in Figure 1? The model was developed to show the relationships between and among skills when adult dyslexics undertake reading comprehension tasks such as the SDRT silent reading task.

In the model, word recognition and higher-order language are presented as independent components that both contribute to reading comprehension outcomes. This representation is generally supported by the data. A precise model, however, would show some overlap between word recognition and reading comprehension since the correlations between word recognition and reading comprehension measures ranged from .17 to .42, for the AD group, and .29 to .36, for the RL group. Thus, shared variance would range from approximately two percent to 17 percent. The data support the associations of pseudowords, rapid naming, and phonological awareness with word recognition. The data also support the association of listening comprehension, vocabulary, and speed of lexical access with higher-order language. The data indicate that working memory has a weak association with higher-order language, with the Swanson data included. In the model, print exposure was not assigned to either category because it was difficult to predict how it would be related. The data, however, indicate that it is more closely associated with higher-order language. The data also indicate that, for reading comprehension outcomes, the
components of the model are appropriate for both the AD and the RL groups. The magnitudes of the relationships, however, are within the same range.

Although the model adapted from Connor’s and Olson (1990) was generally supported by the data, it was designed only for reading comprehension outcomes. If the construct of reading efficiency were adopted, however, the model would not be adequate. The results from this study suggest that the magnitudes of the relationships between the components in the model need to be adjusted as the dependent or outcome variable changes. That is, the information processing system of the dyslexic young adult appears to change as task demands change. Furthermore, qualitative processing differences between dyslexic adults and normally achieving adolescents become more exaggerated as the task demands escalate. Thus, a more precise model would best be conceptualized and drawn in three dimensions including: (1) the sample; (2) the magnitudes of the relationships between and among components; and (3) the outcome variable. A more precise model of adult dyslexic reading would be dynamic in nature so that as one of these dimensions change, there would be a corresponding change in each of the other dimensions.

The results from this study also provide support for the specificity hypothesis. Although the connected discourse reading achievement levels of the adult dyslexics appeared to be simply developmentally delayed or perhaps "arrested" (Bruck, 1990), their information processing appeared to be qualitatively different. The nature of this processing difference appeared to be a counterbalancing act that took advantage of relatively good vocabulary skills to compensate for poor phonological coding, the "core" deficit in dyslexic readers (Stanovich, 1988). Rather than being "deviant" as Prior (1989) would suggest, I argue that this counterbalancing act is adaptive, since it appears to vary as task demands change. Nevertheless, whether adaptive or deviant, this information processing juggling act appears to be a distinguishing and specific feature of the dyslexic readers in this sample.
2. **Implications for Assessment**

The results from this study have a number of implications for clinicians vested with the responsibility for the assessment of children and adults with complaints of reading difficulties.

First, in childhood, it is recommended that a good reading assessment battery include not only measures of reading but also measures of higher-order and lower-order language and other associated skills. This will allow the clinician to present parents and teachers with a profile of strengths and weaknesses that can form the basis of an instructional plan. Such a profile, if comprehensive, may also offer parents some general direction regarding a prognosis. Students with the best prognosis for connected discourse reading outcomes will likely be those with the best higher-order language skills. Of particular importance, for connected discourse reading outcomes, is vocabulary knowledge and listening comprehension. At all ages, tests that attempt to measure knowledge of the phonological code should be included. Measures of phonological awareness and phonological coding (nonword reading) are essential. An evaluation of print exposure would also be worthwhile.

Second, at all ages it is suggested that the reading assessment battery include tests that measure a variety of aspects of reading skill. If a single reading test is employed, the clinician risks either underestimating or overestimating achievement levels. Dimensions such as time (i.e., timed vs. untimed), mode of reading (i.e., oral or silent), and length (i.e., sentences vs. paragraphs) should be varied and perhaps manipulated to ensure a better understanding of the reader's skills. It is also suggested that question formats also be systematically varied and should include, at a minimum, multiple choice and open-ended types.

Caution is advised when using grade equivalent estimates to report results. Standard scores or percentiles are the preferred method of reporting,
particularly for younger and older extremes in the age ranges. The measures that were selected for this research are particularly problematic for grade equivalent scores because the upper age limits are in the high school range. If the standardization sample was selected from a different age cohort, then the grade equivalent estimates must be employed very cautiously, if at all.

Finally, as in all forms of assessment, the battery must be determined by the purpose of the assessment. If the purpose of the assessment is to develop an instructional plan, then skill inventories may be the most useful. On the other hand, if legal or medical assessments are being undertaken, then it is essential that measures be selected for which the standardization sample resembles the student/patient/client in question. This requirement, however, presents the clinician, vested with the responsibility of assessing an adult with practical difficulties. Few, if any measures of connected discourse have a range of passages at varying levels of difficulty. The ideal connected discourse reading achievement measure would include passages with readability ratings ranging from grade one to university level. There would also be several subtests so that the student’s response to a variety of formats and time requirements could be evaluated in comparison with one another relative to the standardization sample in the same age cohort and/or the same word recognition level cohort.

3. Implications for Instruction and Remediation for Children

The results from this follow-up study indicate that achievement outcomes of adults with childhood diagnoses of developmental dyslexia are related to several reading and nonreading skills. Although there appear to be some limitations to the upper limits to which some of these related skills develop, it should be the instructional goal of treatment, school, and remedial programmes to help each student develop both reading and nonreading skills to his/her potential.
The skill that most constrained the progress of the adult dyslexics as a group was word recognition skill. On average, their word recognition skills fell in the same range as the average Vancouver twelve year old. Furthermore, higher-order oral language skills were associated with relatively good reading comprehension outcomes. Irrespective of word recognition skill level, word recognition/spelling skill was the best predictor of reading efficiency.

Thus, one might conclude that one of the most important instructional goals for any programme for dyslexic learners is to help them acquire accurate and fluent word recognition skills. Furthermore, one might conclude that programmes that also work toward enhancing phonological awareness, sound-symbol correspondences, and blending techniques are essential, particularly at the beginning stages of learning to read. Recent treatment outcome research has indicated that programmes with these elements have been successful in helping dyslexic children acquire word recognition skills (Lovett, Ransby & Barron, 1988; Lovett, Ransby, Hardwick, Johns & Donaldson, 1989; Lovett, 1993; Lovett, Borden, DeLuca, Lacerenza, Benson & Brackstone, 1994).

The participants in the present sample did have the benefit of an intensive Orton-Gillingham programme that places an emphasis on acquiring word recognition skills. To some extent, this programme appears to have had some positive benefits since, by the young adult years, the majority of the sample scored in the early high school range on both word recognition and connected discourse measures. None of the sample, however, were enrolled in nor accepted for university attendance. Therefore, the programme may have been introduced too late and/or was not sustained for long enough. The young people in this sample were diagnosed with reading difficulties at a relatively older age, on average at age nine, and remained in the programme for, on average, three years. Case (B), who was the best performer in the sample, however, was diagnosed at age six and was enrolled in the programme for five years.
The finding that the AD group had been exposed to children's literature much less than both of the control groups is not surprising since, as Stanovich points out in his discussion of Matthew effects (1986), students who have difficulty learning to read face a cascade of obstacles to success. Because they do not have the skills to read well, they are exposed to printed material with less volume and less quality than their chronological peers. In the present sample, however, AD participants with the best print exposure had the best scores on the reading comprehension composite. This result suggests that parents and schools should attempt to expose dyslexic children to as much literature as possible at a level that is commensurate with their age, as often as possible, so that the knowledge and oral language skills that are thought to be uniquely derived from literature are accessible to them.

The finding that the AD group had less exposure to children's literature than their chronological age mates has prompted my colleague and me to develop a series of studies to evaluate a literature programme for dyslexic children. We developed a treatment outcome study designed to expose dyslexic children to good literature using audio-tape technology (Ransby & Melonari, 1995).

In the first phase, we conducted a pilot study with a sample of young dyslexic adolescents who were selected from the present cohort of students at the Kenneth Gordon school. Using a within-group-cross-over design, we evaluated two independent homework activities for students. Students were exposed to several novels that were age appropriate. In the first condition, the novels were presented by audio-tape on "Walkman" style cassette machines. In the second condition, novels were presented with the audio-tape and the corresponding book so that students listened to the tapes and followed along with the print simultaneously. Since this was a within-subjects design, we used novels, rather than subjects, in an alternative treatment, as controls. Participants were exposed to several novels during the six week treatment. They were assessed, however, not only on content from these novels, but also
on content from a second set of novels to which they had not been exposed. The unexposed novel set consisted of novels by the same authors as the exposed set. Thus, they were written in the same genre and at the same level of difficulty.

The results from this pilot study were encouraging. The young adolescents, with childhood diagnoses of developmental dyslexia, performed significantly better on measures of instructed content, as opposed to uninstructed content, on the following skills: (1) word recognition; (2) passage reading accuracy and rate; (3) specific information from the stories; and (4) vocabulary. These results have prompted us to consider continuing this line of research.

The print exposure results also suggest that parents and teachers can play an important role by ensuring that dyslexic students have many opportunities to listen to good literature being read aloud. With increased print exposure, students may be less likely to suffer Matthew effects (Stanovich, 1986) in oral language and general knowledge skill development. Other programmes and strategies that are designed to expand vocabulary may also be helpful.

The data from this long-term follow-up study suggest that children with the best prognosis for connected discourse reading outcomes are those with the best word recognition/spelling skills and the best oral language skills. Therefore, remedial and treatment programmes will likely be most successful when they are specifically tailored to address these areas. In order to devote attention to these areas, some compromises may have to be made in the curriculum so that time and energy may be concentrated in these domains.
4. Instructional Implications for Adults

The instructional implications for adults with childhood diagnoses of dyslexia are less obvious than they are for children. Several theoretical and practical concerns, however, may determine instructional design.

Of theoretical interest is the extent to which various nonreading skills develop in young adults. Bruck (1992), for instance, has suggested that phonological awareness skills actually stop developing at a certain point and hence are "arrested". If in fact there is a ceiling on development in phonological skills, then an instructional programme that attempts to address these skills might be fruitless. On the other hand, there may be skills such as vocabulary, that continue to develop well into the middle adult years, provided occupational or educational opportunities are pursued (Bruck, 1985).

Some practical considerations that may influence instructional design are the following: (1) student motivation; (2) amount and distribution of time available for instruction; and (3) level of adult skill. Assuming that students are motivated and available for instruction, the results from this study suggest that instruction that is designed to expand word recognition and oral vocabulary skills would likely be the most worthwhile. Additional print exposure may also help to promote higher-order language skills that would facilitate connected discourse reading. The specific content for each of these domains may need to be determined by the student's occupational and/or personal preferences. In the adult years, instruction that focuses on a specific content area may be the most efficient. If time management issues arise, it is recommended that professional teacher time be primarily devoted to instruction designed to promote word recognition. Audio-tape techniques, with periodic teacher discussion and/or monitoring, might also promote better vocabulary and listening comprehension skills for young adults.
5. Implications for Future Research

The present study represents one of the first comprehensive attempts to examine the connected discourse reading skills of adults with documented childhood diagnoses of developmental dyslexia. The data were collected on a wide range of reading and nonreading skills on the same sample of adults. Thus, the relationships between and among skills could be explored and discussed and compensatory hypotheses could be tested. Since a variety of discourse reading measures were included in the assessment battery, it became apparent that the extent to which adult dyslexics use compensatory processing varies with task demands. Thus, it is suggested that in future investigations, hypotheses concerning processing outcomes take this dynamic relationship into account.

Productive research for the future will, in my opinion, fall into three main categories: (1) treatment outcome and training studies with children; (2) prospective longitudinal studies; and (3) treatment and training programmes for adults. As mentioned earlier, the results from this study may offer some suggestions about the skills that need to be the focus of training studies (e.g., Ransby & Melonari, 1995). The results of prospective longitudinal studies will also be important so that reading and nonreading skills can be measured at regular intervals. In this way, more information can be gathered about the way in which the relationships between reading and nonreading skills change over time. This type of data will have implications for possibly preventing or diluting the effects of reading failure. If children with developmental dyslexia can develop their oral language and cognitive skills to their full potential, then their reading opportunities and skills may be maximized despite persistent, and possibly treatment resistant, deficits in phonological coding and word recognition skill.
F. SUMMARY AND CONCLUSIONS

The results from this study suggest that the average young adult with a childhood diagnosis of developmental dyslexia performs a complex juggling act when encountering connected discourse reading tasks. His juggling performance does not appear to be as skilful as the other jugglers his age. Although his overall performance resembles some of the younger jugglers in the ring, his style is clearly unique. Some of the balls he must toss are heavy while others are very light, so as his rhythm changes to compensate for the unequal weights, he drops some of the balls but keeps others in the air. Then, when the crowd demands that he toss the balls more quickly and accurately, his rhythm is completely disrupted and his performance begins to deteriorate. Whether or not his juggling will continue to improve, or whether he will acquire some better balls, will only become apparent to close observers at the juggling demonstrations of the next decade.
### TABLE 1

MEANS AND STANDARD DEVIATIONS FOR MATCHING VARIABLES

<table>
<thead>
<tr>
<th></th>
<th>CA</th>
<th>RL</th>
<th>AD</th>
<th>CA-RL</th>
<th>CA-AD</th>
<th>RL-AD</th>
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<td>1.62</td>
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<td>WRAT-R</td>
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<td>55.09</td>
<td>55.18</td>
<td>8.07</td>
<td>8.03</td>
<td>-0.04</td>
</tr>
<tr>
<td>(Raw)</td>
<td>6.91</td>
<td>8.55</td>
<td>8.73</td>
<td></td>
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<tr>
<td>DAD'S SES</td>
<td>55.60</td>
<td>55.91</td>
<td>53.19</td>
<td>-.08</td>
<td>.62</td>
<td>.70</td>
</tr>
<tr>
<td>(Raw)</td>
<td>14.5</td>
<td>11.1</td>
<td>12.9</td>
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<tr>
<td>MOM'S ED</td>
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<td>14.86</td>
<td>14.09</td>
<td>-.44</td>
<td>.49</td>
<td>.93</td>
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<td>(Raw)</td>
<td>3.3</td>
<td>2.3</td>
<td>2.4</td>
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<td>RAVEN</td>
<td>52.36</td>
<td>47.36</td>
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<td>(Raw)</td>
<td>4.5</td>
<td>6.9</td>
<td>6.6</td>
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<td>RAVEN</td>
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<td>50.22</td>
<td>1.02</td>
<td>3.66</td>
<td>2.63</td>
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<tr>
<td>(%iles)</td>
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<td>28.76</td>
<td>23.73</td>
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</tbody>
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Note: Standard deviations are in brackets

CA = Chronological Age Match  
RL = Reading Level Match  
AD = Adult with Childhood Diagnosis of Dyslexia

t values are reported for 62-63 Degrees of Freedom

Bonferroni t-test critical values for 2 comparisons

* $p < .05$  
** $p < .01$  
*** $p < .001$
TABLE 2

SUMMARY STATISTICS FOR CHILDHOOD VARIABLES FOR AD SUBJECTS

<table>
<thead>
<tr>
<th></th>
<th>n</th>
<th>Range</th>
<th>M</th>
<th>SD</th>
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</thead>
<tbody>
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<td><strong>A. Demographic Variables</strong></td>
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<td></td>
<td></td>
<td></td>
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<tr>
<td>1. Age at diagnosis</td>
<td>22</td>
<td>6-14</td>
<td>9.70</td>
<td>2.15</td>
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<tr>
<td>2. Years at K.G./F.</td>
<td>22</td>
<td>2-8</td>
<td>3.27</td>
<td>1.77</td>
</tr>
<tr>
<td>Special Schools</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>3. % with Family</td>
<td>22</td>
<td>----</td>
<td>63%</td>
<td></td>
</tr>
<tr>
<td>History of Dyslexia</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>4. % Males</td>
<td>22</td>
<td>----</td>
<td>63%</td>
<td></td>
</tr>
<tr>
<td><strong>B. Test Scores</strong></td>
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<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>1. Verbal IQ</td>
<td>20</td>
<td>86-114</td>
<td>97.15</td>
<td>8.51</td>
</tr>
<tr>
<td>2. Performance IQ</td>
<td>20</td>
<td>86-131</td>
<td>103.80</td>
<td>11.73</td>
</tr>
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<td>3. Full Scale IQ</td>
<td>20</td>
<td>87-117</td>
<td>100.00</td>
<td>8.09</td>
</tr>
<tr>
<td>4. PPVT (1981) SS</td>
<td>20</td>
<td>64-112</td>
<td>97.35</td>
<td>11.21</td>
</tr>
<tr>
<td>+++</td>
<td></td>
<td></td>
<td></td>
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<tr>
<td>5. Word Recognition</td>
<td>15</td>
<td>58-98</td>
<td>72.93</td>
<td>11.32</td>
</tr>
<tr>
<td>(WRAT-R, 1984 Norms)</td>
<td></td>
<td></td>
<td></td>
<td></td>
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<tr>
<td>Standard Scores</td>
<td></td>
<td></td>
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<td></td>
</tr>
<tr>
<td>+++</td>
<td></td>
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<tr>
<td>(WRAT-R, 1984 Norms)</td>
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<tr>
<td>Extrapolated SS</td>
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<tr>
<td>+++</td>
<td></td>
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<tr>
<td>7. Spelling</td>
<td>18</td>
<td>66-88</td>
<td>75.44</td>
<td>6.92</td>
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<tr>
<td>(WRAT-R, 1984 Norms)</td>
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<tr>
<td>Standard Scores</td>
<td></td>
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</tbody>
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Note: K.G./F. = Kenneth Gordon School or Fraser Academy
++ 1984 norms were used
+++ Predicted scores are included (See Chapter 3)
++++ 1984 norms are used


<table>
<thead>
<tr>
<th></th>
<th>CA</th>
<th>RL</th>
<th>AD</th>
<th><strong>GROUP BY GROUP COMPARISONS</strong></th>
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<tbody>
<tr>
<td></td>
<td></td>
<td></td>
<td></td>
<td>CA-RL</td>
</tr>
<tr>
<td>SDRT Comp</td>
<td>54.68</td>
<td>41.95</td>
<td>43.18</td>
<td>***</td>
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<tr>
<td>(Raw)</td>
<td>(4.09)</td>
<td>(8.64)</td>
<td>(9.58)</td>
<td></td>
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<tr>
<td>++ SDRT Comp</td>
<td>12+</td>
<td>7.0</td>
<td>7.3</td>
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<td>(Grade Eq)</td>
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<tr>
<td>SDRT Comp</td>
<td>780.77</td>
<td>679.14</td>
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<td>(Standard)</td>
<td>(58.91)</td>
<td>(45.42)</td>
<td>(48.69)</td>
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<td>SDRT Fast</td>
<td>25.63</td>
<td>19.13</td>
<td>16.86</td>
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<td>(5.27)</td>
<td>(6.47)</td>
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<td>815.32</td>
<td>712.23</td>
<td>673.50</td>
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<td>(85.37)</td>
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<td>SDRT Fast</td>
<td>12+</td>
<td>12.2</td>
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<tr>
<td>(Grade Eq)</td>
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<td>GORT-ACC</td>
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<td>(Raw)</td>
<td>(9.10)</td>
<td>(9.44)</td>
<td>(11.77)</td>
<td></td>
</tr>
<tr>
<td>GORT-ACC</td>
<td>12.2+</td>
<td>8.1</td>
<td>6.9</td>
<td>-</td>
</tr>
<tr>
<td>(Grade Eq)</td>
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<td></td>
</tr>
<tr>
<td>GORT-COMP</td>
<td>48.77</td>
<td>39.91</td>
<td>42.68</td>
<td>2.90</td>
</tr>
<tr>
<td>(Raw)</td>
<td>(8.23)</td>
<td>(11.70)</td>
<td>(10.22)</td>
<td></td>
</tr>
<tr>
<td>GORT-COMP</td>
<td>12.2+</td>
<td>9.8</td>
<td>11.2</td>
<td>-</td>
</tr>
<tr>
<td>(Grade Eq)</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

*Note: ++ The grade equivalent estimates were taken from the spring of grade 12 table (Karlsen & Gardner, 1985). SDRT=Stanford Diagnostic Reading Test. GORT=Gray Oral Reading Test-3rd Edition.

t values are reported for 63 degrees of Freedom. Standard deviations are in brackets. Probabilities for Bonferroni t-test critical values for 2 comparisons

a

| p < .10 |
|<.05 |
|<.01 |
|<.001 |

The table shows summary statistics for connected discourse reading accuracy grouped by CA, RL, and AD groups. The comparisons are made between CA-RL, CA-AD, and RL-AD groups.
## TABLE 4

**SUMMARY STATISTICS FOR PERFORMANCE ON WORD RECOGNITION ACCURACY**

<table>
<thead>
<tr>
<th></th>
<th>CA</th>
<th>RL</th>
<th>AD</th>
<th>CA-RL</th>
<th>CA-AD</th>
<th>RL-AD</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td></td>
<td></td>
<td></td>
<td>***</td>
<td></td>
<td></td>
</tr>
<tr>
<td>WRAT-R 11</td>
<td>74.82</td>
<td>55.09</td>
<td>55.18</td>
<td>8.07</td>
<td>8.03</td>
<td>-.04</td>
</tr>
<tr>
<td>(Raw)</td>
<td>(6.91)</td>
<td>(8.55)</td>
<td>(8.74)</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>WRAT-R 11</td>
<td>12+</td>
<td>9E</td>
<td>9E</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>(Grade Eq)</td>
<td></td>
<td></td>
<td></td>
<td>***</td>
<td></td>
<td></td>
</tr>
<tr>
<td>WRAT-R 11</td>
<td>112.50</td>
<td>108.50</td>
<td>89.32</td>
<td>1.09</td>
<td>7.17</td>
<td>5.23</td>
</tr>
<tr>
<td>(Standard)</td>
<td>(8.86)</td>
<td>(12.91)</td>
<td>(10.92)</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Nonwords</td>
<td>36.73</td>
<td>32.22</td>
<td>29.09</td>
<td>3.29</td>
<td>5.59</td>
<td>2.30</td>
</tr>
<tr>
<td>(Trimmed)</td>
<td>(3.45)</td>
<td>(4.52)</td>
<td>(5.40)</td>
<td>**</td>
<td>***</td>
<td>*</td>
</tr>
<tr>
<td>Nonwords</td>
<td>36.73</td>
<td>32.22</td>
<td>28.55</td>
<td>2.92</td>
<td>5.30</td>
<td>2.39</td>
</tr>
<tr>
<td>(Raw)</td>
<td>(3.45)</td>
<td>(4.52)</td>
<td>(6.80)</td>
<td>**</td>
<td>***</td>
<td>*</td>
</tr>
</tbody>
</table>

Note: *t* values are reported for 63 degrees of freedom. Standard deviations are in brackets.

Probabilities using Bonferroni *t*-test critical values for 2 comparisons

* *p < .05
** **p < .01
*** ***p < .001
## TABLE 5

### SUMMARY STATISTICS FOR PERFORMANCE ON READING RATE MEASURES

<table>
<thead>
<tr>
<th></th>
<th>CA</th>
<th>RL</th>
<th>AD</th>
<th>GROUP BY GROUP COMPARISONS</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>CA-RL</td>
<td>CA-AD</td>
<td>RL-AD</td>
<td></td>
</tr>
<tr>
<td><strong>Bruck RL</strong></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>(Medians)</td>
<td>1.22</td>
<td>1.44</td>
<td>1.60</td>
<td><strong>-2.18</strong></td>
</tr>
<tr>
<td></td>
<td>(.31)</td>
<td>(.29)</td>
<td>(.42)</td>
<td><strong>-3.17</strong></td>
</tr>
<tr>
<td></td>
<td></td>
<td></td>
<td></td>
<td><strong>-1.53</strong></td>
</tr>
<tr>
<td><strong>Nonwords RL</strong></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>(Transform)</td>
<td>38.46</td>
<td>41.99</td>
<td>46.12</td>
<td><strong>-1.95</strong></td>
</tr>
<tr>
<td></td>
<td>(4.73)</td>
<td>(5.20)</td>
<td>(7.71)</td>
<td><strong>-4.22</strong></td>
</tr>
<tr>
<td></td>
<td></td>
<td></td>
<td></td>
<td><strong>-2.27</strong></td>
</tr>
<tr>
<td><strong>Nonwords RL</strong></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>(Medians)</td>
<td>1.50</td>
<td>1.79</td>
<td>2.18</td>
<td><strong>-1.84</strong></td>
</tr>
<tr>
<td></td>
<td>(.34)</td>
<td>(.42)</td>
<td>(.72)</td>
<td><strong>-4.35</strong></td>
</tr>
<tr>
<td></td>
<td></td>
<td></td>
<td></td>
<td><strong>-2.51</strong></td>
</tr>
<tr>
<td><strong>GORT-Rate</strong></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>(Raw)</td>
<td>58.50</td>
<td>40.22</td>
<td>35.86</td>
<td><strong>5.92</strong></td>
</tr>
<tr>
<td></td>
<td>(6.92)</td>
<td>(11.39)</td>
<td>(11.70)</td>
<td><strong>7.33</strong></td>
</tr>
<tr>
<td></td>
<td></td>
<td></td>
<td></td>
<td><strong>1.41</strong></td>
</tr>
<tr>
<td><strong>GORT-Rate</strong></td>
<td>12.2+</td>
<td>9.2</td>
<td>7.8</td>
<td></td>
</tr>
<tr>
<td>(Grade Eq)</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

Note: Standard deviations are in brackets.

t values are reported for 63 degrees of freedom

Probabilities using Bonferroni t-test critical values for 2 comparisons

- a < .10
- b < .05
- **b < .01
- ***b < .001
| 1. Mean number of seconds to complete | 159.91 | 174.14 | 180.00+ |
| 2. Standard deviation for time to complete | (22.25) | (16.46) | (0.00) |
| 3. Minimum time to completion | 105.00 | 108.00 | 180.00+ |
| 4. Number of subjects not completing on time | 9.00 | 18.00 | 22.00 |
| 5. Proportion not completing on time | 41.00 | 82.00 | 100.00 |
| 6. Arcsine tranformation on proportions | 1.39 | 2.24 | 3.14 |
TABLE 7

SUMMARY STATISTICS FOR PERFORMANCE ON DISCOURSE READING COMPOSITES

<table>
<thead>
<tr>
<th></th>
<th>CA</th>
<th>RL</th>
<th>AD</th>
<th>CA-RL</th>
<th>CA-AD</th>
<th>RL-AD</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>.654</td>
<td>-.423</td>
<td>-.229</td>
<td>4.56</td>
<td>3.74</td>
<td>-.82</td>
</tr>
<tr>
<td>(z-scores)</td>
<td>(.52)</td>
<td>(.95)</td>
<td>(.81)</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td></td>
<td>.883</td>
<td>-.277</td>
<td>-.606</td>
<td>5.51</td>
<td>7.07</td>
<td>1.56</td>
</tr>
<tr>
<td>(z-scores)</td>
<td>(.61)</td>
<td>(.78)</td>
<td>(.70)</td>
<td></td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

Note: Degrees of Freedom (2,63)

* p < .05  
** p < .01  
*** p < .001
### TABLE 8

**SUMMARY STATISTICS AND EFFECT SIZE DIFFERENCES BETWEEN THE AD'S AND CONTROL GROUPS ON DISCOURSE READING COMPOSITES**

<table>
<thead>
<tr>
<th></th>
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<th>AD vs CA</th>
<th>AD vs RL</th>
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<td><strong>Means and Standard Deviations</strong></td>
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<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>COMPREHENSION (z-scores)</td>
<td>.654 (.52)</td>
<td>-.423 (.95)</td>
<td>-.229 (.81)</td>
<td>-1.69</td>
<td>.21</td>
</tr>
<tr>
<td>EFFICIENCY (z-scores)</td>
<td>.883 (.61)</td>
<td>-.277 (.78)</td>
<td>-.606 (.70)</td>
<td>-2.44</td>
<td>-.54</td>
</tr>
</tbody>
</table>
### TABLE 9

**SUMMARY STATISTICS FOR PERFORMANCE ON PRINT EXPOSURE MEASURES**

<table>
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<th>CA-AD</th>
<th>RL-AD</th>
</tr>
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<tr>
<td><strong>Authors</strong></td>
<td>.255</td>
<td>.132</td>
<td>.127</td>
<td>2.13</td>
<td>2.23</td>
<td>.10</td>
</tr>
<tr>
<td></td>
<td>(.24)</td>
<td>(.13)</td>
<td>(.18)</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td><strong>Magazines</strong></td>
<td>.410</td>
<td>.171</td>
<td>.232</td>
<td>7.48</td>
<td>5.57</td>
<td>-1.91</td>
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<tr>
<td></td>
<td>(.11)</td>
<td>(.10)</td>
<td>(.10)</td>
<td></td>
<td></td>
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<tr>
<td><strong>Newspapers</strong></td>
<td>.613</td>
<td>.420</td>
<td>.420</td>
<td>3.42</td>
<td>3.42</td>
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<td></td>
<td>(.18)</td>
<td>(.20)</td>
<td>(.18)</td>
<td></td>
<td></td>
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<tr>
<td><strong>Child Titles</strong></td>
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<td>.406</td>
<td>.216</td>
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<td>2.55</td>
<td>4.10</td>
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<td></td>
<td>(.16)</td>
<td>(.17)</td>
<td>(.12)</td>
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</tr>
</tbody>
</table>

Note: t values reported for 63 degrees of freedom

Probabilities using Bonferroni t-test critical values for 2 comparisons

*P < .05
**P < .01
***P < .001
**TABLE 10**

**SUMMARY STATISTICS FOR PERFORMANCE ON WRITTEN LANGUAGE MEASURES**

<table>
<thead>
<tr>
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<th>CA</th>
<th>RL</th>
<th>AD</th>
<th>GROUP BY GROUP COMPARISONS</th>
<th>CA-RL</th>
<th>CA-AD</th>
<th>RL-AD</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td></td>
<td></td>
<td></td>
<td>CA-RL</td>
<td>***</td>
<td>***</td>
<td>.46</td>
</tr>
<tr>
<td>Spelling (Raw)</td>
<td>39.59</td>
<td>25.18</td>
<td>24.14</td>
<td></td>
<td>6.32</td>
<td>6.72</td>
<td></td>
</tr>
<tr>
<td></td>
<td>(8.52)</td>
<td>(6.49)</td>
<td>(7.52)</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Spelling (Grade Eq)</td>
<td>12(B)</td>
<td>7(E)</td>
<td>7(B)</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Spelling (Standard)</td>
<td>108.23</td>
<td>101.86</td>
<td>84.00</td>
<td></td>
<td>1.76</td>
<td>7.60</td>
<td>4.94</td>
</tr>
<tr>
<td></td>
<td>(7.96)</td>
<td>(8.54)</td>
<td>(13.58)</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Alphabet (Seconds)</td>
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<td>25.55</td>
<td>20.89</td>
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<td>2.54</td>
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<tr>
<td></td>
<td>(3.12)</td>
<td>(8.66)</td>
<td>(5.09)</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>N of Words (Raw)</td>
<td>113.22</td>
<td>81.23</td>
<td>81.52</td>
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<td>3.09</td>
<td>3.02</td>
<td>-.04</td>
</tr>
<tr>
<td></td>
<td>(28.14)</td>
<td>(43.27)</td>
<td>(29.58)</td>
<td></td>
<td></td>
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<td></td>
</tr>
<tr>
<td>Quality (Raw)</td>
<td>4.23</td>
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<td>2.71</td>
<td></td>
<td>9.02</td>
<td>6.90</td>
<td>-2.01</td>
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<td></td>
<td>(.61)</td>
<td>(.88)</td>
<td>(.62)</td>
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</tbody>
</table>

Note: t values are reported for 63 degrees of freedom

Probabilities using Bonferroni t-test critical values for 2 comparisons

* p < .05
** p < .01
*** p < .001
TABLE 11

SUMMARY STATISTICS FOR PERFORMANCE ON HIGHER-ORDER LANGUAGE SKILLS

<table>
<thead>
<tr>
<th></th>
<th>CA</th>
<th>RL</th>
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<th>CA-RL</th>
<th>CA-AD</th>
<th>RL-AD</th>
</tr>
</thead>
<tbody>
<tr>
<td>PPVT-R</td>
<td>157.59 (10.76)</td>
<td>136.50 (13.12)</td>
<td>144.68 (10.32)</td>
<td>6.10 ***</td>
<td>3.73 ***</td>
<td>-2.37 *</td>
</tr>
<tr>
<td>(Raw)</td>
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<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>PPVT-R</td>
<td>108.36 (13.07)</td>
<td>114.18 (9.25)</td>
<td>93.41 (9.83)</td>
<td>-1.78 ***</td>
<td>4.57 ***</td>
<td>6.35 ***</td>
</tr>
<tr>
<td>(Standard)</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>BNT ACC</td>
<td>55.18 (3.73)</td>
<td>48.95 (5.93)</td>
<td>52.46 (3.70)</td>
<td>4.52 ***</td>
<td>1.98 ***</td>
<td>-2.54 *</td>
</tr>
<tr>
<td>(Raw)</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>BNT RL</td>
<td>1.154 (.22)</td>
<td>1.257 (.19)</td>
<td>1.180 (.19)</td>
<td>-1.71 ***</td>
<td>-0.43 ***</td>
<td>1.28</td>
</tr>
<tr>
<td>(Medians)</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>LIST COMP</td>
<td>68.55 (7.28)</td>
<td>55.50 (10.68)</td>
<td>58.09 (11.34)</td>
<td>4.36 ***</td>
<td>3.49 ***</td>
<td>-.87</td>
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<tr>
<td>(Raw)</td>
<td></td>
<td></td>
<td></td>
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<td></td>
<td></td>
</tr>
<tr>
<td>WAIS INFO</td>
<td>20.45 (5.47)</td>
<td>12.00 (5.27)</td>
<td>14.36 (4.49)</td>
<td>5.50 ***</td>
<td>3.96 ***</td>
<td>-1.54</td>
</tr>
<tr>
<td>(Raw)</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

Note: PPVT-R=Peabody Picture Vocabulary Test-Revised
BNT-ACC=Boston Naming Test (Accuracy Score)
BNT-RL=Boston Naming Test (Median Response Latencies)
LIST COMP=Listening Comprehension
WAIS-INFO=Wechsler Adult Intelligence Scale-Information Subtest (Canadian)

Degrees of Freedom (2,63)
Probabilities using Bonferroni t-test critical values for 2 comparisons

* P < .05
** P < .01
*** P < .001
### TABLE 12

**SUMMARY STATISTICS FOR PERFORMANCE ON WORKING MEMORY AND RECALL**

<table>
<thead>
<tr>
<th></th>
<th>CA</th>
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<th>CA-RL</th>
<th>CA-AD</th>
<th>RL-AD</th>
</tr>
</thead>
<tbody>
<tr>
<td>DC WKMEM</td>
<td>3.14</td>
<td>2.14</td>
<td>2.32</td>
<td>3.08</td>
<td>3.46</td>
<td>.38</td>
</tr>
<tr>
<td>(Raw)</td>
<td>(.94)</td>
<td>(.66)</td>
<td>(.72)</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>STORY REC</td>
<td>8.55</td>
<td>8.46</td>
<td>7.91</td>
<td>.16</td>
<td>1.10</td>
<td>.95</td>
</tr>
<tr>
<td>(Raw)</td>
<td>(1.60)</td>
<td>(1.73)</td>
<td>(2.33)</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>DOT WKMEM</td>
<td>5.09</td>
<td>4.91</td>
<td>4.68</td>
<td>.59</td>
<td>1.32</td>
<td>.73</td>
</tr>
<tr>
<td>(Raw)</td>
<td>(1.06)</td>
<td>(1.02)</td>
<td>(.99)</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>SA-WKMEM</td>
<td>2.00</td>
<td>1.50</td>
<td>1.82</td>
<td>1.56</td>
<td>.57</td>
<td>-1.00</td>
</tr>
<tr>
<td>(Raw)</td>
<td>(1.11)</td>
<td>(1.10)</td>
<td>(.96)</td>
<td></td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

Note: DC WKMEM=Daneman & Carpenter Listening Span Working Memory
STORY REC=Story Recall (Swanson Battery)
DOT WKMEM=Visual (Dot) Matrix (Swanson Working Memory Battery)
SA WKMEM=Semantic Association (Swanson Working Memory)

Degrees of Freedom (2,63)
Probabilities using Bonferroni critical values for 2 comparisons

* *p < .05
** B < .01
***P < .001
### TABLE 13

**SUMMARY STATISTICS FOR PERFORMANCE ON LOWER-ORDER LANGUAGE MEASURES**

<table>
<thead>
<tr>
<th></th>
<th>CA</th>
<th>RL</th>
<th>AD</th>
<th>CA-RL</th>
<th>CA-AD</th>
<th>RL-AD</th>
</tr>
</thead>
<tbody>
<tr>
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Note: Degrees of Freedom (2,63)
Probabilities using Bonferroni t-test critical values for 2 comparisons

* * p < .05
** * p < .01
*** * p < .001
TABLE 14

COMPARISON OF HIGH AND LOW AD's ON SILENT READING COMP (SDRT)

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TABLE 15

COMPARISONS OF HIGH AND LOW AD’s ON READING COMPREHENSION COMPOSITE

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### TABLE 16

**COMPARISONS OF HIGH AND LOW AD's ON DISCOURSE READING EFFICIENCY**

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TABLE 17

COMPARISON OF HIGH AND LOW AD’s ON ADULT WORD RECOGNITION (WRAT-R)

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**SUMMARY STATISTICS FOR COMPOSITE VARIABLES**

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Notes:
- CA=Chronological Age Match
- RL=Reading Level Match
- AD=Adult with Childhood Diagnosis of Dyslexia
- SES=Socioeconomic status (Father’s Occupation and Mother’s Highest Grade)
- HIGH LANG=Higher Order Language (Vocabulary, Listening Comprehension, Information)
- MEMORY=Working Memory and Story Recall
- VOCAB=Vocabulary (PPVT-R and Boston Naming Accuracy)
- R.A.N.=Rapid Automated Naming (Colours, Numbers, Letters) Response Latencies
- PHONOLOG=Phonological Awareness (Phoneme Counting and Phoneme Deletion)
- WORD REC/SPELLING=Word Recognition Accuracy and Spelling (WRAT-R)
- NONWORD=Accuracy and Speed for Nonwords
- PRINT EXP=Print Exposure (Authors, Magazines, Newspapers, Children’s Titles)

`t` values are reported for 63 Degrees of Freedom
- **Bonferroni t-test critical values for 2 comparisons**
  - *p < .05
  - **p < .01
  - ***p < .001
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<th>RL-AD</th>
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<td>(.73)</td>
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NOTE: +Indicates AD>control; -Indicates AD<control
CA=Chronological Age Match
RL=Reading Level Match
AD=Adult with Childhood Diagnosis of Dyslexia
SES=Socioeconomic status (Father's Occupation and Mother's Highest Grade)
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*p values are reported for 63 Degrees of Freedom
  Bonferroni *-test critical values for 2 comparisons
  *p < .05
  **p < .01
  ***p < .001

(Ransby, 1995)
### TABLE 20

**CORRELATIONS AMONG READING MEASURES FOR THE AD GROUP**

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### TABLE 21

**CORRELATIONS AMONG READING MEASURES FOR THE RL GROUP**

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**Note:**
- SDRT=Stanford Diagnostic Reading Test-Comprehension Subtest
- GCOMP=Gray Oral Reading Test-3rd Edition-Comprehension Score
- FAST=Stanford Diagnostic Reading Test-Fast Reading Subtest
- GPASS=Gray Oral Reading Test-3rd Edition-Passage Score
- WRATR=Wide Range Achievement Test-Revised-Single Word Recognition Subtest
- NONAC=Bruck Nonword Reading Test-Accuracy Score
- PRINTEXP=Print Exposure

**Degrees of freedom = 20**

**Significance levels for r**
- If $r > .42$, $p < .05$
- If $r > .49$, $p < .02$
- If $r > .53$, $p < .01$
- If $r > .65$, $p < .001$
### TABLE 22

CORRELATIONS AMONG READING COMPREHENSION, LANGUAGE & COGNITIVE MEASURES FOR THE AD GROUP

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<th>GCOMP</th>
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Notes: Degrees of Freedom = 20
Significance levels for r
If r > .42 p < .05
If r > .49 p < .02
If r > .53 p < .01
If r > .65 P < .001

### TABLE 23

CORRELATIONS AMONG READING COMPREHENSION, LANGUAGE & COGNITIVE MEASURES FOR THE RL GROUP

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<th></th>
<th>SDRT</th>
<th>GCOMP</th>
<th>LCOMP</th>
<th>PPVTR</th>
<th>BNTAC</th>
<th>DCWKM</th>
<th>INFO</th>
<th>RAVEN</th>
</tr>
</thead>
<tbody>
<tr>
<td>GORTCOMP</td>
<td></td>
<td>.84</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>LCOMP</td>
<td></td>
<td>.72</td>
<td>.71</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
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<tr>
<td>PPVTR</td>
<td></td>
<td>.80</td>
<td>.84</td>
<td>.80</td>
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<td></td>
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</tr>
<tr>
<td>BNTAC</td>
<td>.58</td>
<td>.60</td>
<td>.48</td>
<td>.76</td>
<td></td>
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<td></td>
<td></td>
</tr>
<tr>
<td>DCWKM</td>
<td>.51</td>
<td>.53</td>
<td>-.31</td>
<td>.35</td>
<td>.05</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>INFO</td>
<td>.77</td>
<td>.75</td>
<td>.84</td>
<td>.78</td>
<td>.71</td>
<td>.27</td>
<td></td>
<td></td>
</tr>
<tr>
<td>RAVEN</td>
<td>.28</td>
<td>.15</td>
<td>.25</td>
<td>.21</td>
<td>.22</td>
<td>.31</td>
<td>.34</td>
<td></td>
</tr>
<tr>
<td>RAN</td>
<td>-.63</td>
<td>-.53</td>
<td>-.63</td>
<td>-.74</td>
<td>-.64</td>
<td>-.25</td>
<td>-.63</td>
<td>-.17</td>
</tr>
</tbody>
</table>

Notes: Degrees of Freedom = 20
Significance levels for r
If r > .42 p < .05
If r > .49 p < .02
If r > .53 p < .01
If r > .65 P < .001
### TABLE 24

**CORRELATIONS AMONG CONNECTED DISCOURSE READING EFFICIENCY, LANGUAGE & COGNITIVE MEASURES FOR THE AD GROUP**

<table>
<thead>
<tr>
<th></th>
<th>FASTS</th>
<th>GORTP</th>
<th>LCOMP</th>
<th>PPVTR</th>
<th>BNTAC</th>
<th>DCWKM</th>
<th>INFO</th>
<th>RAVEN</th>
<th>RAN</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>GORTPASS</strong></td>
<td>.50</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td><strong>LCOMP</strong></td>
<td>.40</td>
<td>.13</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td><strong>PPVTR</strong></td>
<td>.45</td>
<td>.12</td>
<td>.63</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td><strong>BNTAC</strong></td>
<td>.06</td>
<td>.09</td>
<td>.46</td>
<td>.35</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td><strong>DCWKM</strong></td>
<td>.17</td>
<td>-.08</td>
<td>-.20</td>
<td>.04</td>
<td>-.18</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td><strong>INFO</strong></td>
<td>.29</td>
<td>.06</td>
<td>.21</td>
<td>.55</td>
<td>.17</td>
<td>-.03</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td><strong>RAVEN</strong></td>
<td>.16</td>
<td>-.18</td>
<td>.28</td>
<td>.68</td>
<td>.17</td>
<td>.34</td>
<td>.49</td>
<td></td>
<td></td>
</tr>
<tr>
<td><strong>RAN</strong></td>
<td>-.57</td>
<td>-.17</td>
<td>-.18</td>
<td>-.15</td>
<td>-.20</td>
<td>-.06</td>
<td>-.09</td>
<td>.04</td>
<td></td>
</tr>
</tbody>
</table>

Notes: Degrees of Freedom = 20

Significance levels for $r$
- If $r > .42$ $p < .05$
- If $r > .49$ $p < .02$
- If $r > .53$ $p < .01$
- If $r > .65$ $p < .001$

### TABLE 25

**CORRELATIONS AMONG CONNECTED DISCOURSE READING EFFICIENCY, LANGUAGE & COGNITIVE MEASURES FOR THE RL GROUP**

<table>
<thead>
<tr>
<th></th>
<th>FASTS</th>
<th>GORTP</th>
<th>LCOMP</th>
<th>PPVTR</th>
<th>BNTAC</th>
<th>DCWKM</th>
<th>INFO</th>
<th>RAVEN</th>
<th>RAN</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>GORTPASS</strong></td>
<td>.78</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td><strong>LCOMP</strong></td>
<td>.79</td>
<td>.65</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td><strong>PPVTR</strong></td>
<td>.67</td>
<td>.65</td>
<td>.80</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td><strong>BNTAC</strong></td>
<td>.39</td>
<td>.41</td>
<td>.48</td>
<td>.76</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td><strong>DCWKM</strong></td>
<td>.53</td>
<td>.43</td>
<td>-.31</td>
<td>.35</td>
<td>.05</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td><strong>INFO</strong></td>
<td>.75</td>
<td>.65</td>
<td>.84</td>
<td>.78</td>
<td>.71</td>
<td>.27</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td><strong>RAVEN</strong></td>
<td>.17</td>
<td>.21</td>
<td>.25</td>
<td>.21</td>
<td>.22</td>
<td>.31</td>
<td>.34</td>
<td></td>
<td></td>
</tr>
<tr>
<td><strong>RAN</strong></td>
<td>-.60</td>
<td>-.77</td>
<td>-.63</td>
<td>-.74</td>
<td>-.64</td>
<td>-.25</td>
<td>-.63</td>
<td>-.17</td>
<td></td>
</tr>
</tbody>
</table>

Notes: Degrees of Freedom = 20

Significance levels for $r$
- If $r > .42$ $p < .05$
- If $r > .49$ $p < .02$
- If $r > .53$ $p < .01$
- If $r > .65$ $p < .001$
### Table 26

**Correlations Between Discourse Reading Composite Measures and Cognitive/Language Measures for the AD and RL Groups**

<table>
<thead>
<tr>
<th></th>
<th>Reading Efficiency</th>
<th></th>
<th>Reading Comprehension</th>
<th></th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>AD</td>
<td>RL</td>
<td>AD</td>
<td>RL</td>
</tr>
<tr>
<td>1. Years at K.G./F.</td>
<td>.18</td>
<td>-</td>
<td>.11</td>
<td>-</td>
</tr>
<tr>
<td>2. Child Reading/Spell</td>
<td>.17</td>
<td>-</td>
<td>.12</td>
<td>-</td>
</tr>
<tr>
<td>3. Child Language</td>
<td>.29</td>
<td>-</td>
<td>.63</td>
<td>-</td>
</tr>
<tr>
<td>4. Parent's SES</td>
<td>.60</td>
<td>-.15</td>
<td>.20</td>
<td>-.08</td>
</tr>
<tr>
<td>5. Higher-Order Language</td>
<td>.29</td>
<td>.77</td>
<td>.71</td>
<td>.86</td>
</tr>
<tr>
<td>6. Memory</td>
<td>.10</td>
<td>.46</td>
<td>.39</td>
<td>.52</td>
</tr>
<tr>
<td>7. Rapid Naming</td>
<td>.75</td>
<td>.72</td>
<td>.46</td>
<td>.64</td>
</tr>
<tr>
<td>8. Phonological Awareness</td>
<td>.45</td>
<td>-.21</td>
<td>.17</td>
<td>-.12</td>
</tr>
<tr>
<td>9. Word Recognition/Spelling</td>
<td>.83</td>
<td>.62</td>
<td>.28</td>
<td>.41</td>
</tr>
<tr>
<td>10. Nonword Accuracy &amp; Speed</td>
<td>.67</td>
<td>.01</td>
<td>.19</td>
<td>-.23</td>
</tr>
<tr>
<td>11. Print Exposure</td>
<td>.33</td>
<td>.59</td>
<td>.44</td>
<td>.63</td>
</tr>
<tr>
<td>12. Raven's</td>
<td>.04</td>
<td>-.13</td>
<td>.42</td>
<td>.25</td>
</tr>
</tbody>
</table>
### TABLE 27

**STEPWISE REGRESSION ANALYSIS FOR THE AD GROUP WITH READING COMPREHENSION COMPOSITE AS DEPENDENT VARIABLE**

<table>
<thead>
<tr>
<th>STEP</th>
<th>PREDICTOR VARIABLES</th>
<th>B</th>
<th>R</th>
<th>RSQ</th>
<th>CHANGE IN RSQ</th>
<th>F TO ENTER</th>
</tr>
</thead>
<tbody>
<tr>
<td>1</td>
<td>Higher-Order Language</td>
<td>1.07</td>
<td>.86</td>
<td>.72</td>
<td>.72</td>
<td>50.75</td>
</tr>
<tr>
<td>2</td>
<td>Rapid Naming</td>
<td>-0.26</td>
<td>.90</td>
<td>.80</td>
<td>.08</td>
<td>7.36</td>
</tr>
</tbody>
</table>

Note: * This is the adjusted r-square.

### TABLE 28

**STEPWISE REGRESSION ANALYSIS FOR THE AD GROUP WITH READING EFFICIENCY COMPOSITE AS DEPENDENT VARIABLE**

<table>
<thead>
<tr>
<th>STEP</th>
<th>PREDICTOR VARIABLES</th>
<th>B</th>
<th>R</th>
<th>RSQ</th>
<th>CHANGE IN RSQ</th>
<th>F TO ENTER</th>
</tr>
</thead>
<tbody>
<tr>
<td>1</td>
<td>Word Recognition and Spelling</td>
<td>.45</td>
<td>.83</td>
<td>.67</td>
<td>.67</td>
<td>44.18</td>
</tr>
<tr>
<td>2</td>
<td>Rapid Naming</td>
<td>.35</td>
<td>.90</td>
<td>.79</td>
<td>.12</td>
<td>12.26</td>
</tr>
<tr>
<td>3</td>
<td>Higher-Order Language</td>
<td>.25</td>
<td>.92</td>
<td>.83</td>
<td>.04</td>
<td>5.50</td>
</tr>
</tbody>
</table>

Note: * This is the adjusted r-square.
**TABLE 29**

**STEPWISE REGRESSION ANALYSIS FOR THE RL GROUP WITH READING COMPREHENSION COMPOSITE AS THE DEPENDENT VARIABLE**

<table>
<thead>
<tr>
<th>STEP</th>
<th>PREDICTOR</th>
<th>B</th>
<th>R</th>
<th>RSQ</th>
<th>CHANGE IN RSQ</th>
<th>F TO ENTER</th>
</tr>
</thead>
<tbody>
<tr>
<td>1</td>
<td>HIGHER-ORDER LANGUAGE</td>
<td>.91</td>
<td>.87</td>
<td>.75</td>
<td>.75</td>
<td>60.77</td>
</tr>
</tbody>
</table>

Note: * This is the adjusted r-square.

**TABLE 30**

**STEPWISE REGRESSION ANALYSIS FOR THE RL GROUP WITH READING EFFICIENCY COMPOSITE AS THE DEPENDENT VARIABLE**

<table>
<thead>
<tr>
<th>STEP</th>
<th>PREDICTOR</th>
<th>B</th>
<th>R</th>
<th>RSQ</th>
<th>CHANGE IN RSQ</th>
<th>F TO ENTER</th>
</tr>
</thead>
<tbody>
<tr>
<td>1</td>
<td>HIGHER ORDER LANGUAGE</td>
<td>.71</td>
<td>.77</td>
<td>.58</td>
<td>.58</td>
<td>29.59</td>
</tr>
</tbody>
</table>

Note: * This is the adjusted r-square.
<table>
<thead>
<tr>
<th></th>
<th>Grade K to 4</th>
<th>Grade 5 to 8</th>
<th>Grade 9 to 12</th>
<th>Beyond Grade 12</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>GORT-3 COMPREHENSION</strong></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>n</td>
<td>1</td>
<td>5</td>
<td>7</td>
<td>9</td>
</tr>
<tr>
<td>%</td>
<td>&lt; 1</td>
<td>23</td>
<td>32</td>
<td>41</td>
</tr>
<tr>
<td>Range</td>
<td>2.2</td>
<td></td>
<td></td>
<td>12.9+</td>
</tr>
<tr>
<td><strong>GORT-3 PASSAGE SCORE</strong></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>n</td>
<td>2</td>
<td>14</td>
<td>4</td>
<td>2</td>
</tr>
<tr>
<td>%</td>
<td>9</td>
<td>64</td>
<td>18</td>
<td>9</td>
</tr>
<tr>
<td>Range</td>
<td>3.8</td>
<td></td>
<td></td>
<td>12.9+</td>
</tr>
<tr>
<td><strong>SDRT READING COMPREHENSION SUBTEST</strong></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>n</td>
<td>3</td>
<td>11</td>
<td>6</td>
<td>2</td>
</tr>
<tr>
<td>%</td>
<td>14</td>
<td>50</td>
<td>27</td>
<td>9</td>
</tr>
<tr>
<td>Range</td>
<td>2.6</td>
<td></td>
<td></td>
<td>PHS</td>
</tr>
<tr>
<td><strong>SDRT FAST READING SUBTEST</strong></td>
<td></td>
<td></td>
<td></td>
<td></td>
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<tr>
<td>n</td>
<td>2</td>
<td>12</td>
<td>6</td>
<td>2</td>
</tr>
<tr>
<td>%</td>
<td>9</td>
<td>55</td>
<td>27</td>
<td>9</td>
</tr>
<tr>
<td>Range</td>
<td>3.4</td>
<td></td>
<td></td>
<td>PHS</td>
</tr>
</tbody>
</table>

Note: PHS = Post high school
### TABLE 32

**CHILDHOOD AND DEMOGRAPHIC DATA FOR CASES A, B, AND C**

**Standard Scores for Childhood Tests**

<table>
<thead>
<tr>
<th>Childhood Status</th>
<th>A(LOW)</th>
<th>B(HIGH)</th>
<th>C(MIXED)</th>
<th>AD MEAN</th>
<th>AD SD</th>
</tr>
</thead>
<tbody>
<tr>
<td>Age at diagnosis</td>
<td>12</td>
<td>6</td>
<td>10</td>
<td>9.70</td>
<td>2.15</td>
</tr>
<tr>
<td>Years at K.G./F.</td>
<td>3</td>
<td>5</td>
<td>3</td>
<td>3.27</td>
<td>1.77</td>
</tr>
<tr>
<td>Word Recog (SS)</td>
<td>65</td>
<td>85</td>
<td>62</td>
<td>72.59</td>
<td>9.76</td>
</tr>
<tr>
<td>WRAT Spell (SS)</td>
<td>67</td>
<td>74</td>
<td>66</td>
<td>75.44</td>
<td>6.92</td>
</tr>
<tr>
<td>Verbal IQ</td>
<td>91</td>
<td>114</td>
<td>105</td>
<td>97.15</td>
<td>8.51</td>
</tr>
<tr>
<td>Performance IQ</td>
<td>102</td>
<td>91</td>
<td>88</td>
<td>103.80</td>
<td>11.73</td>
</tr>
<tr>
<td>PPVT (SS)</td>
<td>91</td>
<td>110</td>
<td>110</td>
<td>97.35</td>
<td>11.21</td>
</tr>
</tbody>
</table>

**Demographics**

<table>
<thead>
<tr>
<th>A(LOW)</th>
<th>B(HIGH)</th>
<th>C(MIXED)</th>
<th>AD MEAN</th>
<th>AD SD</th>
</tr>
</thead>
<tbody>
<tr>
<td>Dad's SES</td>
<td>37.66</td>
<td>56.83</td>
<td>33.30</td>
<td>53.19</td>
</tr>
<tr>
<td>Mom's Ed</td>
<td>12</td>
<td>17</td>
<td>17</td>
<td>14.09</td>
</tr>
<tr>
<td>Family History</td>
<td>yes</td>
<td>yes</td>
<td>yes</td>
<td>63%</td>
</tr>
<tr>
<td>Follow-up age</td>
<td>23</td>
<td>19</td>
<td>21</td>
<td>19.74</td>
</tr>
<tr>
<td>Gender</td>
<td>male</td>
<td>male</td>
<td>male</td>
<td>63% male</td>
</tr>
</tbody>
</table>

**Z Scores for Childhood Tests Based on AD Mean Standard Scores**

<table>
<thead>
<tr>
<th>Tests</th>
<th>A(LOW)</th>
<th>B(HIGH)</th>
<th>C(MIXED)</th>
<th>AD MEAN</th>
<th>AD SD</th>
</tr>
</thead>
<tbody>
<tr>
<td>Word Recognition</td>
<td>-0.78</td>
<td>+1.27</td>
<td>-1.08</td>
<td>72.59</td>
<td>9.76</td>
</tr>
<tr>
<td>WRAT Spell</td>
<td>-1.21</td>
<td>-0.20</td>
<td>-1.36</td>
<td>75.44</td>
<td>6.92</td>
</tr>
<tr>
<td>Verbal IQ</td>
<td>-0.72</td>
<td>+1.98</td>
<td>+0.93</td>
<td>97.15</td>
<td>8.51</td>
</tr>
<tr>
<td>Performance IQ</td>
<td>-0.15</td>
<td>-1.09</td>
<td>-1.35</td>
<td>103.80</td>
<td>11.73</td>
</tr>
<tr>
<td>PPVT (Vocab)</td>
<td>-0.57</td>
<td>+1.13</td>
<td>+1.13</td>
<td>97.35</td>
<td>11.21</td>
</tr>
</tbody>
</table>

Note: K.G./F. = Attendance at one or both private schools for dyslexic students.
TABLE 33
READING TEST RESULTS FOR CASES A(LOW), B(HIGH), & C(MIXED) AT FOLLOW-UP

<table>
<thead>
<tr>
<th>Reading Tests</th>
<th>A(LOW)</th>
<th>B(HIGH)</th>
<th>C(Mixed)</th>
<th>AD MEAN</th>
</tr>
</thead>
<tbody>
<tr>
<td>GORT-3 Comp</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>GORT-3 Comp</td>
<td>10.7</td>
<td>12.9+</td>
<td>12.9+</td>
<td>11.2</td>
</tr>
<tr>
<td>GORT-3 Passage</td>
<td>3.8</td>
<td>12.9+</td>
<td>4.5</td>
<td>7.7</td>
</tr>
<tr>
<td>SDRT-Blue Comp</td>
<td>2.6</td>
<td>12.9</td>
<td>10.0</td>
<td>7.3</td>
</tr>
<tr>
<td>SDRT-Blue Fast</td>
<td>3.8</td>
<td>12.9+</td>
<td>6.7</td>
<td>10.0</td>
</tr>
<tr>
<td>WRAT-R 11</td>
<td>5.0</td>
<td>12+</td>
<td>7.0</td>
<td>9</td>
</tr>
</tbody>
</table>

| Raw Scores          |         |         |          |         | D  D  |
|---------------------|---------|---------|----------|---------|
| GORT-3 Comp         | 41      | 56      | 57       | 42.68   | D  D  |
| GORT-3 Passage      | 26      | 108     | 33       | 66.16   | D  D  |
| SDRT-Blue Comp      | 16      | 53      | 49       | 43.18   | D  D  |
| SDRT-Blue Fast      | 6       | 27      | 13       | 16.86   | D  D  |
| WRAT-R 11           | 39      | 72      | 46       | 55.18   | D  D  |
| Nonword Accuracy    | 8       | 38      | 27       | 28.55   |       |
| Bruck Word Accuracy | 23      | 37      | 32       | 34.41   |       |

| Standard Scores     |         |         |          |         | D  D  |
|---------------------|---------|---------|----------|---------|
| SDRT-Blue Comp      | 562     | 740     | 711      | 685.59  | D  D  |
| SDRT-Blue Fast      | 559     | 810     | 637      | 673.50  | D  D  |
| WRAT-R 11           | 67      | 110     | 76       | 89.32   | D  D  |

| z Scores Based on AD Raw Scores |         |         |          |         | D  D  |
|--------------------------------|---------|---------|----------|---------|
| GORT-3 Comp                  | -0.16   | +1.30   | +1.40    | 42.68   | D  D  |
| GORT-3 Passage               | -1.82   | +1.89   | -1.50    | 66.16   | D  D  |
| SDRT-Blue Comp 9.58          | -2.83   | +1.02   | +0.61    | 43.18   | D  D  |
| SDRT-Blue Fast               | -2.04   | +1.91   | -0.73    | 16.86   | D  D  |
| WRAT-R 11                    | -1.85   | +1.92   | -1.05    | 55.18   | D  D  |
| Nonword Accuracy             | -3.02   | +1.39   | -0.23    | 28.55   | D  D  |
| Bruck Word Accuracy          | -2.81   | +0.64   | -0.60    | 34.41   | D  D  |
### TABLE 34

**LANGUAGE TEST RESULTS FOR CASES A(LOW), B(HIGH), & C(MIXED) AT FOLLOW-UP**

<table>
<thead>
<tr>
<th></th>
<th>A(Low)</th>
<th>B(High)</th>
<th>C(Mixed)</th>
<th>AD Mean</th>
<th>Z Score</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>Higher Language</strong></td>
<td></td>
<td></td>
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<td></td>
<td></td>
</tr>
<tr>
<td>Listening Comp</td>
<td>59</td>
<td>68</td>
<td>72</td>
<td>58.09</td>
<td>1.13</td>
</tr>
<tr>
<td>PPVT-R (Vocab)</td>
<td>138</td>
<td>160</td>
<td>158</td>
<td>144.68</td>
<td>1.29</td>
</tr>
<tr>
<td>10.32</td>
<td></td>
<td></td>
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</tr>
<tr>
<td>Boston Naming</td>
<td>57</td>
<td>57</td>
<td>59</td>
<td>52.46</td>
<td>3.70</td>
</tr>
<tr>
<td>Working Mem (DC)</td>
<td>2</td>
<td>3</td>
<td>2</td>
<td>2.32</td>
<td>.22</td>
</tr>
<tr>
<td><strong>Lower Language</strong></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Phoneme Count (Errors)</td>
<td>8</td>
<td>0</td>
<td>2</td>
<td>3.77</td>
<td>2.9</td>
</tr>
<tr>
<td>Phoneme Deletion (Errors)</td>
<td>11</td>
<td>0</td>
<td>5</td>
<td>4.27</td>
<td>3.5</td>
</tr>
<tr>
<td>R.A.N. Numbers</td>
<td>26</td>
<td>14</td>
<td>24</td>
<td>20.60</td>
<td>3.7</td>
</tr>
<tr>
<td>R.A.N. Colours</td>
<td>27</td>
<td>19</td>
<td>23</td>
<td>26.20</td>
<td>4.9</td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th></th>
<th>A(Low)</th>
<th>B(High)</th>
<th>C(Mixed)</th>
<th>AD Mean</th>
<th>Z Score</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>Higher Language</strong></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Listening Comp</td>
<td>+0.08</td>
<td>+0.87</td>
<td>+1.22</td>
<td>58.09</td>
<td>1.13</td>
</tr>
<tr>
<td>PPVT-R (Vocab)</td>
<td>-0.65</td>
<td>+1.48</td>
<td>+1.29</td>
<td>144.68</td>
<td>3.70</td>
</tr>
<tr>
<td>10.32</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Boston Naming</td>
<td>+1.22</td>
<td>+1.22</td>
<td>+1.77</td>
<td>52.46</td>
<td>3.70</td>
</tr>
<tr>
<td>Working Mem (DC)</td>
<td>-0.44</td>
<td>+0.94</td>
<td>-0.44</td>
<td>2.32</td>
<td>.22</td>
</tr>
<tr>
<td><strong>Lower Language</strong></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Phoneme Count (Errors)</td>
<td>+1.46</td>
<td>-1.30</td>
<td>-.60</td>
<td>3.77</td>
<td>2.9</td>
</tr>
<tr>
<td>Phoneme Deletion (Errors)</td>
<td>+1.92</td>
<td>-1.22</td>
<td>+0.21</td>
<td>4.27</td>
<td>3.5</td>
</tr>
<tr>
<td>R.A.N. Letters</td>
<td>+0.69</td>
<td>-1.43</td>
<td>+0.49</td>
<td>21.72</td>
<td>4.7</td>
</tr>
<tr>
<td>R.A.N. Numbers</td>
<td>+1.46</td>
<td>-1.78</td>
<td>+0.92</td>
<td>20.60</td>
<td>3.7</td>
</tr>
<tr>
<td>R.A.N. Colours</td>
<td>+0.16</td>
<td>-1.47</td>
<td>-0.65</td>
<td>26.20</td>
<td>4.9</td>
</tr>
</tbody>
</table>

** Note: Positive z scores indicate more errors or slower times and therefore poorer performance.
The componential structure is the same for AD and RL but the magnitudes of the relationships vary by group. Thus, the correlation matrix for AD does not equal the correlation matrix for RL.
REFERENCES


APPENDIX 1

LETTER TO POTENTIAL PARTICIPANTS FROM U.B.C.
APPENDIX 2

LETTER TO POTENTIAL PARTICIPANTS FROM KENNETH

GORDON SCHOOL ADMINISTRATOR
INFORMATION FORM

NAME ___________________________ (LAST) ___________________________ (FIRST)

ADDRESS ___________________________ ___________________________ ___________________________

PHONE ___________________________ (day) ___________________________ (evening)

ID NUMBER: ___________________________ (date of birth plus order code)

GROUP ___________________________ DATE OF BIRTH ___________________________
(CA/RL/AD) ___________________________ (DAY) ___________________________ (MONTH) ___________________________ (YEAR)

DATE OF ASSESSMENT: ___________________________

AGE ON DAY OF ASSESSMENT: ___________________________
(YEARS) ___________________________ (MONTHS)

1. SCHOOL HISTORY

a. Highest grade completed in school. ___________________________

Year of high school completion. ___________________________

b. Were you ever enrolled in any special programmes in school?

Special Programmes

French Immersion ___________________________

Challenge/Gifted ___________________________

Learning Assistance (part time) ___________________________

Learning Disabilities Class (full time) ___________________________

Behaviour Class ___________________________

Reading Programme ___________________________

Other Special Programmes ___________________________

Special or Private School/s ___________________________

(Name/s) ___________________________

---

RANSBY, 1993---
2. READING HISTORY

a. Did you have any difficulties with reading in school?  
   (Note the control groups must say no)

   If yes, describe

b. Do you have difficulties with reading now?

   Describe, if yes.

   Do you have any special tricks or strategies for overcoming some of your reading difficulties?

c. Have you taken any courses designed for adults who wish to improve their reading skills?

   If yes, describe

d. Did you ever repeat a grade?  
   (yes/no)

   Which grade/s

e. How many schools did you attend between grades 1-6?

   How many schools did you attend between grades 7-12?

f. What schools, colleges, universities have you attended since secondary/high school?

   Name       Programme/Major  Level Completed?

   ___________________________________________
   ___________________________________________
   ___________________________________________
   ___________________________________________

   -RANSBY, 1993-
3. **EMPLOYMENT HISTORY**

a. Please indicate the jobs you have held since leaving high school.

<table>
<thead>
<tr>
<th>Job Title/Description</th>
<th>Dates</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
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<td></td>
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<tr>
<td></td>
<td></td>
</tr>
</tbody>
</table>

b. What type of job/career would you like to work towards over the next 5 years?

4. **FAMILY DATA** (for SES)

If uncertain, ask the subject to describe job and level of supervision.

a. Father's occupation/job

b. Mother's occupation/job

c. Father's highest grade completed in school or university.

d. Mother's highest grade completed in school or university.

e. Ages of brothers.

f. Ages of sisters

-RANSBY, 1993-
g. Did any members of your family have difficulties with reading?  
(Be sure to distinguish between biological and step family)

father    brother    uncle    grandfather

mother    sister    aunt    grandmother

What kinds of problems?


h. Do you live at home?


i. Do you live independently?


h. What is your marital status? i. Children?


j. What languages are/were spoken in your home?


PARENTAL SUPPORT
When you were in elementary school did your parents help you with reading?

alot    sometimes    never

How did you feel about your parents helping you?

(uptight)   OK    comfortable

COFFEE/TEA/POP OR JUICE
What is your preference for refreshments?


THANK YOU VERY MUCH FOR ANSWERING THESE QUESTIONS. NOW I AM GOING TO ASK YOU TO DO SOME LANGUAGE, READING AND PROBLEM SOLVING TASKS. WE WILL WORK FOR ABOUT 1 HOUR AND 15 MINUTES AND THEN TAKE A BREAK.
THE NEWSPAPER RECOGNITION TEST

INSTRUCTIONS: "Below you will see a list of titles. Some of them are the names of actual newspapers and some of them are not. You are to read the names and put a check mark next to the names of those you know to be newspapers. Do not guess but only check those that you know to be actual newspapers. Remember some of the titles are not those of popular newspapers, so guessing can be easily detected.

<table>
<thead>
<tr>
<th>TITLES</th>
<th>CHECK IF A NEWSPAPER</th>
</tr>
</thead>
<tbody>
<tr>
<td>1. Calgary Courier</td>
<td></td>
</tr>
<tr>
<td>2. Calgary Herald</td>
<td></td>
</tr>
<tr>
<td>3. Canadian Post</td>
<td></td>
</tr>
<tr>
<td>4. Christian Science Monitor</td>
<td></td>
</tr>
<tr>
<td>5. Edmonton Examiner</td>
<td></td>
</tr>
<tr>
<td>6. Edmonton Tribune</td>
<td></td>
</tr>
<tr>
<td>7. Financial Post</td>
<td></td>
</tr>
<tr>
<td>8. Globe and Mail</td>
<td></td>
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<tr>
<td>9. Los Angelos Examiner</td>
<td></td>
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<tr>
<td>10 Los Angelos Times</td>
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<tr>
<td>11 Monetary Observer</td>
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<td>12 Province</td>
<td></td>
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<tr>
<td>13 Provincial News</td>
<td></td>
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<tr>
<td>14 San Diego Daily News</td>
<td></td>
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<tr>
<td>15 San Francisco Chronicle</td>
<td></td>
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<tr>
<td>16 Saskatoon Courier</td>
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<td>17 Seattle Times</td>
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<td>18 Skydome News</td>
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<td>19 Toronto Star</td>
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<td>20 USA Today</td>
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<td>21 Vancouver Sun</td>
<td></td>
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<tr>
<td>22 Victoria Islander</td>
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<tr>
<td>23 Western Times</td>
<td></td>
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<tr>
<td>24 Winnipeg Free Press</td>
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</table>
APPENDIX 7

GORT-3 (Form B)
Listening Comprehension Test Adaptation
(Ransby, 1993)

Part A: INSTRUCTIONS FOR ADMINISTRATION

1. Use the GORT-3 Reading Comprehension Ceiling to establish the starting paragraph.

2. Reading Comprehension Ceiling = GORT-3 Form A Passage at which 2 of 5 questions were correct.

3. Start Listening Comprehension Passage at the Reading Comprehension Ceiling level.

4. BASAL ON LISTENING COMPREHENSION:
   1. Subjects respond to at least 3 passages.

5. Note: For subjects who do not reach ceiling on the highest passage (Grade 13) in reading comprehension (very strong readers), make sure they listen to AT LEAST 3 passages (Grades 11, 12, 13) to provide a sample of at least 9 questions.

6. Instructions:
   "Now I am going to read some stories to you. Listen as carefully as you can because I will ask you some questions about the passages after I am finished."

   "This story is about..."
Part B: LISTENING COMPREHENSION QUESTIONS

STORY 1 B: This story is about an animal.

1. Where does the cat like to sit?  
   (on top of the house, on the roof)

2. What does the cat like to watch?  
   (likes to see the birds)

3. When does the cat come down from the roof?  
   (when it's time to eat)

---------------------------------

STORY 2 B: This story is about a family party.

1. What was the boy doing?  
   (making a cake)

2. Who was having a birthday?  
   (Mother)

3. What is a good name for this story?  
   (The Best Present)

---------------------------------

STORY 3 B: This story is about what happens to a family one morning.

1. What had Father lost?  
   (keys)

2. What is the best name for this story?  
   (getting ready for a new day)

3. What word would you use to describe this time of day?  
   (busy)

---------------------------------

STORY 4 B: This story is about two people who are having fun.

1. What happened when the boy got a bite?  
   (he let go of the pole)

2. What is the best title for this story?  
   (The Pole that Got Away)

3. How do you think the boy felt when he got a bite?  
   (excited)

---------------------------------
STORY 5 B: This story is about two animals who spend some time together.

1. Why did the turtle want to go with the eagle?
   (she wanted to have an adventure to talk about)

2. What's the best name for this story?
   (The Foolish Turtle)

3. Why do you think the eagle agreed to take the turtle on the journey?
   (he felt sorry for the turtle)

---------------------

STORY 6 B: This story is about problems that some workers face.

1. How do farmers protect their crops from insects?
   (they use poison)

2. What is one problem with using chemicals to kill insects?
   (they can affect food)

3. Why is weather a more serious problem than insects for farmers?
   (it cannot be planned for)

---------------------

STORY 7 B: This story is about a very courageous woman.

1. How did Harriet Tubman help slaves?
   (by leading them to the North)

2. What was the Underground Railway?
   (a chain of houses that hid runaway slaves)

3. How do you think Harriet felt about slavery?
   (she was opposed to it)

---------------------

STORY 8 B: This story is about people who are in danger.

1. What does Winnie intend to do with the boat?
   (turn the boat upside down for shelter)

2. Why is Winnie worried?
   (her brother needs medical attention)

3. What probably explains why Winnie and Nat are in this situation?
   (they were in difficult waters when a sudden storm came up)

---------------------
STORY 9 B: This story is about a person who is trying to protect a group of animals.

1. What is the ranger's immediate task? (to tally the horses in the area)
2. What is happening to the wild horses? (their numbers are decreasing)
3. Where does the ranger probably work? (on federal lands)

STORY 10 B: This story is about different types of stories.

1. According to this passage, what are legends? (narratives with an aura of realism)
2. What distinguishes a legend from other genres of folk narratives? (it purports to be the truth)
3. What is a tall tale? (untrue story, and exaggerated story)

STORY 11 B: This story is about a leader.

1. Why do you think that the Queen did not discuss important matters with others? (she did not want to provide opportunity to be thwarted)
2. How do you think the Queen dealt with opposition to her wishes? (she had the offenders executed)
3. How do you think the Queen felt when Claypole died? (shaken)

STORY 12 B: This story is about words that mean the same thing.

1. What is the main idea of this passage? (the terms film, movie, and cinema should be used more precisely)
2. Why does the author think that distinguishing among these terms would be a good idea? (would provide a more stringent approach for film critics)
3. Which of these words is considered more ostentatious? Film, Movie, or Cinema? (film and cinema)
STORY 13 B: This story is about what some employers did for their workers.

1. As a result of the new housing construction, where did the workers live?
   (in congested conditions, by the highway or under the viaduct)

2. What is the tone of this passage?
   (tongue-in-cheek)

3. How do you think the writer of this passage feels about the industrialists?
   (they are motivated by avarice, they exploited the workers)
Part C: LISTENING COMPREHENSION SCORING GUIDELINES

General Guidelines:

1. Assign each response a score of 0, 1, or 2.

2. The responses will be ranked for correctness based on the passage that was read to the subject.

3. How to determine the score:
   1. A score of 0 is WRONG.
   2. A score of 1 is CORRECT TO SOME EXTENT but is qualitatively inferior to a score of 2.
      a) it is correct to some extent;
      b) shows evidence of having heard the passage or represents a reasonable inference based on other information in the passage;
      c) is generally correct but lacks precision and sophistication in choice of words.
   3. A score of 2 is CORRECT AND PRECISE.
      a) it reflects knowledge of the passage;
      b) it is expressed in a form that is precise and linguistically correct (with respect to the semantic content of the answer).

4. Each response should be considered independently from other questions pertaining to the same story.

5. Allow some degree of inference on questions in which "probably" appears.

6. Scoreable responses should reflect an understanding of the passage.

7. Differentiate between an unsophisticated response and a lack of understanding of the passage. Examinees should not be penalized for unsophisticated answers if they have been able to demonstrate a clear understanding of the passage.

8. Some responses require a greater or lesser degree of strength. (e.g., "extinction" is an inadequate replacement for "dwindling", "doesn't like" is an inadequate replacement for "abhors").

Specific Guidelines: (only provided for STORY 6 B to STORY 13 B)

STORY 6 B

1. -they use poison, chemicals, insecticide, spraying = 2

2. -they can affect food - requires an element of harmfulness, poisonous, contamination of food, birds, animals = 2
   -some are poisonous, it will be bad for them to eat the food = 1 (too vague)

3. -it cannot be planned for - unpredictability, lack of control = 2
   -kills/destroys crops = 1
STORY 7 B

1. -by leading them to the North - element of freedom, escape = 2
   -going to the North (without mention of freedom or help) = 1
2. -a chain of houses that hid runaway slaves - understanding of chain of houses as opposed to unused railroad = 2
   -hiding place = 1
3. -she was opposed to it - requires a fairly strong degree of disliking/hatred
   -it wasn't good = 1

STORY 8 B

1. -turn the boat upside down for shelter - applies specifically to boat for shelter = 2
   -element of saving the boat = 1
   -waiting for help/assistance = 1
   -if waiting for help paired with reference to boat = 2
2. -her brother needs medical assistance - requires understanding of "brother" and "medical help"
   -general observations of danger or fear = 1
   -unclear observations of individuals involved = 1
3. -they were in difficult waters when a sudden storm came up = 2
   -some inference allowed
   -some indication of storm or bad weather = 2
   -reef or crash = 2
   -inferences not related to storm or reef = 1

STORY 9 B

1. -to tally the horses in the area - immediate task - counting horses = 2
   -some good for horses = protection = 1
2. -their numbers are decreasing - note strength of response
   -dwindling/decreasing/declining = 2
   -dying off/extinction = 1 (too strong)
3. -on federal lands = 2
   -some inference allowed
   -government/protected area = 2
   -desert = 2
   -wilderness/ranger station = 1

STORY 10 B

1. -narratives with an aura of realism - requires element of truth and element of exaggeration = 2
2. -it purports to be the truth - truth = 2
3. - untrue story, an exaggerated story - untruth, exaggeration, deception = 2
   - exaggeration alone = 1
   - lie = 2
   - stretching of truth = 1 (not strong enough)

STORY 11 B
1. - she did not want to provide an opportunity to be thwarted = 2
   - complete control/autonomy = 2
   - others might plot against her = 2
   - mistrust of others = 1
   - requires some degree of strength - iron-handedness, independence
   - fear or dislike or privacy = 1
   - specific detail from passage plus control, plotting = 2
2. - she had the offenders executed = 2
   - execution, guillotine = 2
   - intolerance = 1
   - ignorance = 0 (or didn't like, not happy)
3. - shaken = 2
   - sadness/remorse = 1
   - upset, distracted, thoughtful - includes some degree of consideration = 2

STORY 12 B
1. - the terms film, movie, cinema should be used more precisely = 2
   - some idea of differentiation - precision of these terms = 2
   - used to mean the same thing but different (not specific to passage) = 1, 2 if specifically applied to the passage
   - mean the same thing = 0
2. - would provide a more stringent approach for film critics = 2
   - theoretical boundaries, precise definitions = 2
   - less confusion, know what to expect = 1
3. - film and cinema, either will suffice = 2

STORY 13 B
1. - in congested conditions, by the highway or under the viaduct = 2
   - near mills, under viaduct, by highway = 2
   - company dwellings, outskirts = 1
   - in villas = 0
2. - tongue-in-cheek = 2
   - ironic, satirical, cynical = 2
   - sympathetic to the workers = 1
3. - they are motivated by avarice, exploit the workers = 2
   - element of greed and exploitation = 2
   - fairly strong feelings against the industrialists = 2
   - doesn't like them = 1 (too weak)