DYSLEXIA AND INFORMATION PROCESSING

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ABSTRACT

A survey of the literature on dyslexia and information processing revealed that there has not been a well-designed investigation examining the relationship between simultaneous and successive processing and the reading difficulties exhibited by dyslexic children. The initial purpose of this investigation was to systematically evaluate these relationships. Because of the stringent criteria proposed for inclusion in the dyslexic groups and the chronological and reading age control groups, the original study required an extensive screening procedure. This procedure included several steps: a) recruitment of second and fourth grade students, including reading disabled pupils; b) assessment of ADD/ADDH; c) intellectual and reading evaluations; and d) reading/spelling subtype classification, using Boder's systematic approach. Due to practical and methodological problems encountered during the screening phase of this investigation, the proposed research was not feasible. However, several characteristics of the children recruited as control subjects raised interesting questions relevant to the relationships between information processing styles and reading abilities. Thus, although the initial hypotheses regarding the differential information processing deficits found in subtypes of dyslexia were not addressed directly, the revised study was aimed at exploring information processing styles of different types of readers. Subjects consisted of second and fourth grade students in Elementary

schools in Northwestern Ohio who had been recruited as control subjects for the initial study. As control subjects, the children were screened for ADD or ADDH and at least grade level reading ability. All subjects had been solicited by letter and represented a self-selected sample. This sample was composed of 18 second grade and 15 fourth grade students. For the purposes of the present investigation, further subclassification into "split", "flat average" and "flat above average" reading profiles was necessary. All subjects were administered the WISC-R and K-ABC mental processing scales in a fixed order.

The results suggest significant differences in second and fourth grade readers in relation to the interrelatedness of reading skills and the importance of sequential processing and phonetic abilities and emphasize the importance of attending to developmental factors in reading research. In addition, the usefulness of the K-ABC mental processing scales with verbally bright children is discussed.

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Dyslexia and Information Processing

INTRODUCTION

Since the late 19th century, it has been recognized that there are some children who, despite average to above average intellectual ability and educational opportunities, find it exceedingly difficult to learn how to read. As early as 1896, children were diagnosed as having "congenital word blindness," a condition thought to be caused by some form of delay or deficit in the cortical areas of the brain responsible for the "visual memory of words" (Hynd & Cohen, 1983, p.11). Research on the reading difficulties displayed by these children has continued to proliferate, producing a variety of descriptive characteristics, causal hypotheses, and nominal labels (e.g., developmental dyslexia, dyslexia, congenital dyslexia, reading retardation and specific reading disability). Despite such attention, little progress has been made towards understanding the disorder now commonly referred to as dyslexia. Even prevalence estimates vary significantly, depending upon the source of the information. For example, Gaddes (1979) states that between 10 and 15% of the school age children in the United States suffer from dyslexia, whereas Taylor and Taylor (1983) place this estimate between 3 and 10%, and the Diagnostic and

Statistical Manual of the American Psychiatric Association (DSM-III) (1980) simply states that "the disorder is fairly common."

The research literature in the areas of reading disorders has been plagued with theoretical and methodological problems. Many studies have been atheoretical and have focused solely on a behavioral level. Investigators, for example, have examined variables such as cerebral lateralization (Hiscock & Kinsbourne, 1978; Newell & Rugel, 1981), eye movements (Pavilides, 1981; Pirozzolo & Rayner, 1979), and perceptual discrimination (Dworkin, 1985; Hynd & Cohen, 1983) which have unknown relationships to actual reading processes. Poorer performances by dyslexic children on these variables have then been used to explain the disorder. No attempts have been made to integrate the different variables, assess their relationship to reading or identify possible underlying common sources of variance. The result has been a series of discrete descriptions of dyslexia which lack the theoretical foundation needed to consolidate and interpret such information.

Compounding these difficulties has been a major methodological failure to define dyslexia in precise, operational terms. Without such a definition, it is impossible to compare the samples used in different studies and arrive at meaningful conclusions. This problem has been

further complicated by the failure of researchers to recognize the heterogeneity of the dyslexia syndrome. Although it had often been assumed that all children with dyslexia experienced the same problems, evidence has accumulated that two distinct subtypes of the syndrome can be reliably identified (Boder, 1971, 1973; Lovett, 1984; Mattis, French, & Rapin, 1975; Mitterer, 1982). Nevertheless, many investigators continue to neglect this finding, raising serious doubts as to the homogeneity of their sample and the validity of their results.

On the methodological level, a definition of dyslexia must be derived which describes the disorder in operational terms. This definition would not only include explicit criteria (e.g., test scores, academic grades) for relevant variables (e.g., intelligence, reading levels), but would acknowledge and account for the heterogeneity of the syndrome as well. Using such a definition to select research samples would help ensure both the homogeneity of the groups studied and the replicability of the research. A critique of previously proposed definitions is presented to highlight the difficulties which arise when terminology is vague and imprecise, and to support the need for a new, operationalized definition of dyslexia.

In order to obtain a better understanding of dyslexia, it seems imperative that the disorder be studied within a

coherent theoretical framework. Such a theoretical framework would begin to consolidate the previous findings in the field and to integrate these with the current theories of reading development. Optimally, this framework would delineate underlying principles which could reconcile both the behavioral data and the actual processes thought to be involved in reading. Furthermore, this framework should be able to generate specific a priori hypotheses on dyslexia which can then be examined empirically.

One potentially useful framework for understanding dyslexia is the dualistic information processing model proposed by Das, Kirby and Jarman (1975, 1979). This model, which has its theoretical roots in Luria's conceptualization of the working brain, states that information is processed by the brain either in a successive or simultaneous manner. Briefly, simultaneous processing involves the synthesis of separate information into simultaneous groups or gestalts, whereas successive processing features serial and temporal handling of information. A review of the literature on dyslexia, focusing especially on studies which have attempted to delineate and describe the different subtypes of the disorder, as well as a discussion of current theories on the reading process, are presented below to support the validity and usefulness of a simultaneous vs. successive information processing framework for dyslexia.

Based on the literature bearing on dyslexia, developmental reading theory and cognitive information processing, the next logical step appeared to be an investigation of information processing styles of children within the two reliably identified subtypes of dyslexia as well as within chronological and reading age control groups. Specifically, the previous research suggested that each dyslexic subtype would display unique difficulties in either simultaneous or successive processing which would differentiate them from each other and from normal readers. While a study that sought to investigate these variables was implemented, practical and methodological problems were encountered which prevented its completion. These problems emphasized important pitfalls in the research on dyslexia and yielded essential information for future studies in the field. The modified investigation focused on the following issues: the developmental nature of reading; the "myth" of the average reader; the concomitant problem of deriving meaningful control groups in reading research; the utility of the Boder Test of Reading-Spelling Patterns (BTRSP); and the psychometric properties of the Kaufman Assessment Battery for Children (K-ABC) and the Kaufman Test of Educational Achievement (K-TEA).

To grasp the relative importance of the present investigation, a thorough appreciation for the type of

research needed to advance our knowledge about dyslexia is essential. Briefly, it is reasoned that to conduct meaningful research on dyslexia, two basic changes need to be considered in future studies: 1) the disorder of dyslexia needs to be operationally defined and 2) a theoretical model needs to be developed which integrates previous research findings and demonstrates subtypes of dyslexia. The review which follows will provide support for these changes. It is divided into two major subdivisions: Definitional Issues and Dyslexia and Information Processing.

Definitional Issues

As previously noted, the failure to operationally define dyslexia has been one of the major shortcomings in the research. In formulating a revised definition of the disorder, a survey of the existing definitions and the problems which they have generated can help identify specific features which need to be taken into consideration.

Existing definitions and associated problems.

A review of various proposed definitions of dyslexia, reveals unmistakable similarities. DSM-III defines a Developmental Reading Disorder as: "...a significant impairment in the development of reading skills not accounted for by chronological age, mental age, or inadequate schooling" (DSM-III, 1980). Similarly, Public Law 94-142 defines a learning disability, in general, as "...a severe

discrepancy between achievement and intellectual ability in one or more of the following areas: oral expression, listening comprehension, written expression, basic reading skills, reading comprehension, mathematical calculation and mathematical reasoning" (Duane, 1979). Dyslexia would refer to the reading problem, exclusively. The definition most often used in researching dyslexia is the one proposed by the World Federation of Neurology in 1970. The Federation defined dyslexia as:

> a disorder manifested by difficulty in learning to read despite conventional instruction, adequate intelligence, and socio-cultural opportunity. It is dependent upon fundamental cognitive disabilities which are frequently of constitutional origin (Hynd & Cohen, 1983, p.9).

Explicit in all three of the above definitions is that a child must demonstrate a significant discrepancy between ability (intelligence) and reading achievement to be identified as suffering from dyslexia. While the definition provided by Public Law 94-142 is quite broad, both DSM-III and the World Federation of Neurology provide more specific criteria. The latter definitions exclude children who have not had either "adequate or conventional instruction." In addition, as Rutter (1978) explicitly stated, the Federation definition suggests that a child from a poor or unconventional background cannot be diagnosed as dyslexic. He also notes how such a definition excludes the possibility

of dyslexia coexisting with intellectual subnormality.

The National Joint Committee on Learning Disabilities (NJCLD) proposed a definition of learning disabilities which has alleviated some of these difficulties. This Committee has defined a Learning Disability (LD) as:

> a generic term that refers to a heterogeneous group of disorders manifested by significant difficulties in the acquisition and use of listening, speaking, reading, writing, reasoning or mathematical abilities. These disorders are intrinsic to individuals and presumed to be due to central nervous system dysfunction. Even though LD may occur concomitantly with other handicapping conditions (e.g., sensory impairment, mental retardation, emotional disturbances) or environmental influences (e.g., cultural differences, insufficient schooling, etc.) it is NOT the DIRECT result of these conditions or influences (NJCLD, 1981, p.1).

Such a definition, if restricted to reading disabilities begins to help define the syndrome of dyslexia by providing for other problems which may be independent but exist concurrently. However, the essential flaw with both the NJCLD and the "exclusion" definitions proposed above is their attempt to specifically outline one set of criteria for a multiform disorder. It is unlikely that dyslexia can be specifically, yet adequately, described by an all inclusive definition. Certain criteria, such as a significant discrepancy between ability (intelligence) and reading achievement, will provide a basic framework for superficial identification of dyslexic children. However, the resulting

group of children would present with a variety of characteristics and problems thus making further description and investigation, not to mention efficient remediation, impossible.

Resolution

Step 1: Subclassifications. Given the problems outlined above, subclassifications within the definition of dyslexia are necessary to help eliminate the confusion. First, a global distinction needs to be made, which subdivides the dyslexic syndrome into two categories: "pure" dyslexia and "compound" dyslexia. "Pure" dyslexia refers to a condition in which a child of average to above average intelligence demonstrates severe difficulties in learning to read but displays no other abnormalities (e.g., hyperactivity, mental retardation, sensory impairment, etc.). This classification can be contrasted with a category termed "compound" dyslexia. The latter category would include children who have dyslexia, in addition to some other handicapping condition which is not likely to be directly responsible for the dyslexia. For example, a child classified in the "compound" dyslexia category may suffer from mild mental retardation but also demonstrate difficulties in reading above and beyond that expected based on his/her limited IQ. Other conditions which may coexist with dyslexia include hyperactivity, hearing impairment, and

emotional disturbances. Hence, the "compound" dyslexia category may contain a variety of subcategories as well.

Some empirical support for the "pure" and "compound" distinction can be found in the literature. Silva, McGee, and Williams (1985) and Yule and Rutter (1976, 1978) noted that the child who shows a discrepancy between IQ and reading achievement has a much more limited set of problems than the child who shows both a discrepancy between IQ and reading achievement and chronological age and reading achievement when IQ is controlled. This latter child can be thought of as the mildly mentally retarded child who has "compound" dyslexia. It is likely that all academic subjects will be impaired in this child, although his/her reading skills will be more severely affected. Other evidence for the distinction between "pure" dyslexia and "compound" dyslexia comes from drug studies conducted on dyslexic children with and without hyperactivity (Aman, 1980; Aman & Werry, 1982). In these studies, drugs were used which have been documented to help hyperactive children control their behavioral and attentional difficulties. The general conclusions from these studies were that medications (viz., Ritalin and Dexedrine) improved reading in hyperactive children, while children with only dyslexia (i.e., "pure" dyslexia) showed no gains in reading while on the drugs. Thus, it appears that "pure" dyslexia and "compound" dyslexia-hyperactivity may be

associated with different neurological conditions.

Given the evidence cited above, it appears that future research on dyslexia needs to take into account the distinction between "pure" and "compound" groups. Another important distinction that needs to be considered concerns a further breakdown of these dyslexic groups into homogeneous subtypes. Both clinical and experimental evidence has accumulated which suggests that at least two different subtypes may be reliably identified (Bakker,1979; Boder, 1973; Boder & Jarrico, 1982; Hier, LeMay, Rosenberger & Perlo, 1978; Keefe & Swinney, 1979; Mattis, French & Rapin, 1975; Pirozzolo, 1981, 1979; Pirozzolo & Rayner, 1979). These two subtypes have unique reading problems, spelling patterns, test profiles, etc. (Boder & Jarrico, 1982; Lovett, 1984; Mattis et al., 1975; Pirozzolo, 1981). In addition, it has been recognized that each subtype requires different remediation strategies (Boder, 1973; Boder & Jarrico, 1982; Gunnison, Kaufman & Kaufman, 1982). There is, however, no reason to suspect that these subtypes appear only as characteristics of either the "pure" category or any of the "compound" subcategories. Thus, it can be assumed that the global "pure/compound" distinction and the "compound" subcategorizations may be further subdivided.

Although two dyslexic subtypes have been reliably identified, there is little agreement among researchers as to

how they may be best described. For the present, the subtypes can be most succinctly depicted in terms of the reading difficulties which children manifest. In one subtype, reading is characterized by difficulties in letter-sound integration and by relative lack of skill in the analysis-synthesis of words. Children in this group either know a word on sight or are unable to decode it. In contrast, the problems manifested by the second subtype include an inability to perceive letters and words as whole configurations. These dyslexic children read laboriously, as if each word was being seen for the first time (Boder, 1971, 1973). A more thorough discussion of the subtyping literature, together with an alternative theoretical perspective and classification system, will be presented in a later section of this review.

The classifications outlined above are likely to have far reaching implications for research. By not identifying subtypes, the past research has frequently resulted in incomparable, contradictory, and misleading findings. For example, Keefe and Swinney (1979) compared a group of dyslexic children to a control group on a measure of laterality, and found no significant differences between the mean performances of the two groups. However, after plotting individual scores, these investigators noted that the scores of the dyslexic group formed a bimodal distribution around

the mean. Thus, the dyslexic group did show significant differences from the control group, differences which were initially masked by the heterogeneity of the dyslexic sample.

On the basis of the preceding line of reasoning, it seems essential that specific sub-definitions, delineating the criteria for each unique form of the dyslexia syndrome be developed. This definition would not only help clarify and strengthen the research, but may be found to also aid in the development of more customized remediation programs. A definition is proposed which takes into account the variables noted above:

> Dyslexia is a syndrome characterized, in general, by a significant discrepancy between a child's ability (intelligence) and his/her actual reading achievement. The syndrome can be subdivided into two categories: "pure" dyslexia and "compound" dyslexia.
>
> a) "Pure" dyslexia is a condition in which the child has average to above average intelligence and displays reading disabilities in isolation, with NO other handicapping conditions. This category can further be divided into at least two distinct subtypes.
>
> b) "Compound" dyslexia consists of a reading disability as well as another handicapping condition (e.g., hyperactivity). This latter condition is not a direct cause of the reading disability. Some examples of the "compound" dyslexia subcategories are: dyslexia - hyperactivity; dyslexia - mild mental retardation; dyslexia - hearing impairment, etc. Each of these subcategories, like the "pure' dyslexia category, can be further divided into at least two subtypes.

Step 2: Operationalization. Although the detailed definition outlined above takes into consideration the

inherent complexity of the dyslexic syndrome, its translation into precise, operational terms remains a difficult task for researchers. In commenting about the World Federation's definition of dyslexia, Eisenberg (1978) noted that the phrase "difficulty in learning to read" has been interpreted in various ways. The lack of parameters to clearly delineate how "difficulty" is to be quantified has led to interpretations which lack consistency and which, in turn, make comparisons across studies virtually impossible. In the current literature, "difficulty" has been operationalized within a broad range: from at least 6 months behind chronological agemates in reading, to at least 2 years (grades) behind chronological agemates, to at least 1 or 2 years behind the level predicted using IQ and chronological age (e.g., Alyward, 1984; Leong, 1980; Lovett, 1984; Mattis et al., 1975; Rutter, 1978; Satz & Morris, 1981).

Lack of operational precision is a problem that would also plague the definition proposed above. The phrase "significant discrepancy between ability (intelligence) and actual reading achievement" must be made more specific so as to eliminate the variations in interpretations which exist in the current research. Federal as well as most state laws recognize a two year or more discrepancy between IQ and reading achievement as sufficient criteria for classification as dyslexic and eligibility for special education. Problems

arise, however, when such criteria are applied to young children (i.e., six or seven year old) who appear to be experiencing difficulties. An alternative approach to the identification of dyslexic children has been proposed by several investigators (Barkley, 1981; Rourke, 1979). These investigators have suggested that children of average intelligence who score at or below the 20th percentile on a standardized achievement test should be classified as learning disabled (LD). Use of this criterion does allow young children to be classified as LD. However, because meaningful research on dyslexia requires the inclusion of both a chronological and a reading age control group, the use of the two year discrepancy criterion (or, assuming average intelligence, two years behind chronological agemates) appears to be an essential and practical solution. Thus, it is suggested that this criterion be incorporated into the definition outlined earlier.

In addition to the inaccuracy of terms such as "significant discrepancy" and "difficulty in learning", Lovett (1984) has noted that in much of the research, different reading skills (e.g., word recognition, comprehension) are used to assess reading achievement. This inconsistency in assessment is a result of the vagueness of the term "reading achievement." The implications for research are pronounced since superimposed on the varying

quantitative levels of reading retardation used to define dyslexic samples are qualitative differences as well. Therefore, even when two studies state that children were 2 years behind in reading, it is unclear whether the samples studied are equivalent with regard to how reading was assessed.

To summarize, in order to begin to operationalize the definition of dyslexia, the phrase "significant discrepancy between a child's ability (intelligence) and his/her actual reading achievement" needs to be made more specific. Hence, the revised definition of dyslexia would incorporate the following criteria characteristics:

> a significant discrepancy of at least two years between a child's ability (intelligence) and his actual reading achievement as measured by both a standardized test of word recognition and of reading comprehension.

It is only by introducing this specificity that definitional consistency may be achieved in the research.

Related problems

The lack of attention devoted to the measurement of reading achievement in dyslexic samples seems to derive, in part, from the dissociation between research on the disorder and on the reading process. Studies on dyslexia have failed to incorporate the advances which have been made in understanding the cognitive process of reading. Briefly, investigators have found that not only are different

cognitive skills used for different aspects of reading (e.g., word recognition and comprehension) but also that these relationships undergo developmental changes as individuals become more skilled at reading (Calfee & Spector, 1981; Chall, 1983; Samuels & Eisenberg, 1981; Taylor & Taylor, 1983). A survey of the dyslexia literature, however, reveals an apparent disregard for the age of the dyslexic samples and the means by which reading achievement is assessed. This renders the comparability of such studies questionable at best.

Based on the knowledge gleaned from the current theories of reading, several steps are needed in prospective research on dyslexia to help ensure the validity of the findings. First, because of the developmental changes in reading materials and in cognitive skills which occur with increasing reading proficiency, both chronological and reading age control groups of children need to be included as the appropriate bases of comparison. In addition, it is necessary to limit the research sample to children within a relatively small age (grade) range. It is argued that standard use of these two methodological practices, along with the strict operational criteria outlined earlier, would result in a more comprehensible and integrated body of research.

Methodological and definitional changes are an

appropriate starting point for improving investigations on dyslexia. However, in designing research and in interpreting findings, a thorough understanding of developmental reading theory would be desirable as well. In the past, there has been a global failure on the part of researchers to first establish at least a correlation between the measures they plan on examining (e.g., constructional tasks, dichotic listening tasks, visual perceptual tasks, eye movements, motor dexterity, etc.) and either reading per se, or, the skills needed to acquire reading (Calfee, 1982; Calfee & Spector, 1981; Lovett, 1984). Thus, measures often chosen to "better" describe dyslexic children have uncertain relationships to the reading process. Their relevancy and scientific usefulness, therefore, is generally unknown. Despite these oversights, causal hypotheses which attempt to explain dyslexia have proliferated. Basing research on developmental reading theories would help identify which variables deserve further investigation and what contributions such variables may have to reading problems.

An additional function of a firm understanding of the reading process is that it can help answer questions such as: Do dyslexic children develop reading skills in the same sequence as normal readers?, Are there specific cognitive skills which dyslexic children either lack or are deficient in which makes acquisition of certain reading skills more

difficult?, What are the characteristic developmental reading patterns displayed by the different categories, subcategories and subtypes of dyslexia?, Do these categories overlap?, and Do dyslexic children exhibit reading patterns and cognitive skills similar to chronologically younger children who are reading at a similar grade level? Answers to these questions have great theoretical value and may contribute to the remediation strategies which are being developed for dyslexic children.

In conclusion, this investigator proposes that five significant changes should be implemented to improve future research on dyslexia. These changes are:

1) a revised definition of dyslexia which includes detailed subdivisions which account for the multifaceted nature of the disorder;
2) a precise, operational translation of this definition;
3) the use of chronological and reading age control groups;
4) restricted age or grade ranges within research samples; and
5) an incorporation of the advances in developmental reading theory into the design and interpretation of the research.

Many investigators (e.g., Aaron, 1982; Dworkin, 1985; Gaddes, 1980; Hynd & Cohen, 1983; Rourke, 1982) agree that dyslexia involves some kind of problem (deficit or delay) with the way the brain processes information. Human information acquisition is conceptualized as a two-step process which involves both sensation and perception. In most cases, dyslexic children are known to have intact sensation; i.e., they receive stimuli from the environment in the same manner as do normal children. It is hypothesized, however, that dyslexic children have difficulty in the second step: transforming raw stimuli into meaningful percepts. In the case of reading, perception would involve transforming visual stimuli into meaningful verbal symbols. While researchers tend to agree about this general model, very little is known about what is dysfunctional. This may be due, in part, to the fact that the majority of researchers attempting to examine the construct of mental processing have limited their investigations to rather specific aspects of the phenomena. For example, research on the mental processes of visual discrimination (Hynd & Cohen, 1983; Vellutino, 1977), cross modal integration (Dworkin, 1985; Hynd & Cohen, 1983), and short term memory (Hoien, 1982; Torgensen, 1982) has yielded different "causal" hypotheses to explain dyslexia. Although these studies emphasized different variables, they all implicitly assume that the problem in

dyslexia resides in the way in which the brain handles information. It appears that a broader, more inclusive approach to the construct of mental processing in dyslexia is required. Such approaches fall within the domain of cognitive psychology.

Within the field of cognitive psychology, information processing strategies have been proposed to account for what occurs when incoming stimuli are interpreted by the brain. Of particular interest to the present discussion on dyslexia is the simultaneous and successive processing model expounded by Das, Kirby and Jarman (1975, 1979). This model is derived from Luria's conceptualization of the working brain. What follows is a brief description of Luria's model of the brain and of Das et al.'s theory on simultaneous and successive information processing. Subsequently, evidence from previous research on dyslexia and on the reading process will be introduced to support a dualistic processing framework for this disorder. Finally, the benefits of such a framework will be presented.

Luria: The Working Brain

Luria (1966, 1980) proposed a model of psychological functioning which involved three independent but interactive areas (referred to as "Blocks"). Block 1 is described as the arousal and attention unit of the brain. The focal circuitry for these functions are located in the upper brain stem, the

reticular formation and, to a lesser degree, in the limbic cortex and hippocampus. Block 1 is hypothesized to have diffuse neural connections which course throughout the brain and which place the brain in a state of readiness.

Luria postulated that higher psychological processes in man were the result of the functional system of Block 2, located in the fronto-temporal, parietal and occipital regions of the cortex. Luria further subdivided each of the three anatomical regions comprising Block 2 into primary, secondary and tertiary areas or zones. The primary zones are concerned with sensory input for visual, auditory, and somatosensory stimuli and are modality specific. The secondary projection areas lie adjacent to each primary zone and cover a larger area of the cortex. Although these secondary zones are also modality specific, they function to transform raw sensory stimuli into meaningful, recognizable percepts. In other words, these areas are important for the synthesis of complete visual, auditory and tactile images. The tertiary projection areas lying adjacent to the secondary zones overlap one another and are responsible for the most complex tasks of all: intersensory information processing. Two major tertiary regions are hypothesized to exist: the parieto-occipital and the fronto-temporal junctions. Luria postulated that each of these regions was responsible for a unique form of information synthesis. The parieto-occipital

area was thought to be the site of simultaneous processing, while the fronto-temporal area was believed to be the locus of successive processing. These anatomical areas will be discussed more thoroughly below.

Luria's Block 3 is located in the prefrontal area of the cortex. He stated that this unit was absolutely essential for the planning and execution of behavior and for verifying the results of any intended action. In short, this is the organizational unit of the human brain responsible for planning, executing and verifying behavior.

As noted above, it is the posterior areas of the cortex (Block 2) which Luria identified as responsible for the higher psychological processes in humans. More specifically, he hypothesized that the two tertiary zones of Block 2 (i.e., the parietal-occipital and fronto-temporal regions) exhibit unique forms of information synthesis (viz., simultaneous and successive). Simultaneous synthesis is thought to involve the integration of separate elements into groups. These groups often, but not necessarily resemble spatial configurations. The essential nature of this form of processing is that any portion of the finished product is immediately surveyable. Successive synthesis, on the other hand, refers to the integration of information in a serial order. Unlike simultaneous processing, during which any part of the finished product is available for inspection at any

time, in successive processing a system of cues consecutively links together the elements of the final product. Luria hypothesized that both simultaneous and successive syntheses are of three varieties: 1) direct perception; 2) a "mnestic" process, by which is meant "the organization of stimulus traces from earlier experiences" (Das et al., 1979); and 3) complex intellectual processes. At the perceptual level, for example, simultaneous synthesis may be manifested in copying geometric figures; at the mnestic level, in grammatical structure involving the arrangement of elements into one simultaneous scheme; and at the complex intellectual level, through grasping abstract and concrete relationships (e.g., how two objects are similar). Similarly, successive synthesis is manifested in the groupings of contextual verbal connections, in smooth performance of serial forms of activity (e.g., digit span, hand movements), in following verbal instructions, and in the processing of human speech.

It is clear from the above description, that mental processing is a function of Luria's Block 2. Specifically, it appears that the type of complex information processing required in reading would be a product of the tertiary zones, namely of simultaneous and successive synthesis. This thesis is further developed below.

Simultaneous and Successive Information Processing.

Das et al. (1975, 1979) have used Luria's model of the

"working brain", particularly the tertiary areas of Block 2, as the basis for their model of information processing. These investigators proposed that simultaneous and successive processing are independent of one another and are not modality specific. Thus, any type of information can be processed simultaneously or successively regardless of its manner of presentation. For example, a highly familiar word such as 'cat' is apt to be processed simultaneously regardless of whether it is presented visually as a whole word or is spelled out orally letter by letter. In fact, Das et al. (1975, 1979) stated that the mode of processing is determined by two factors: 1) an individual's habitual mode, derived from socio-cultural and genetic factors and 2) the task demands, that is what needs to be derived from the information presented. Das et al. have reasoned that it is this latter factor which contributes most to the processing of information. For example, a grammatical action phrase such as 'Tom hit Harry' would be processed differently than a comparative phrase such as 'Tom is taller than Harry.' In the former, only the proper sequencing of the elements (i.e., successive processing) is essential for a meaningful interpretation. In contrast, in the comparative phrase, both the sequence of words and the comparison of subjects (i.e., successive and simultaneous processing) are necessary for a clear understanding.

Extensive empirical support for the theory of simultaneous and successive information processing has been found across different ages, nationalities (e.g., Canadian, American and Indian); socioeconomic levels, geographic typologies (e.g., north/south, city/country), diagnostic categories (e.g., mental retardation, dyslexic, average, gifted), and test batteries. Space precludes a full treatment of this evidence; however, several studies will be discussed which have particular relevance to the present investigation. For a thorough review of these research findings, the reader is referred to Das et al., 1979, Leong, 1980, Kaufman, Kaufman, Kamphaus, and Naglieri, 1982, and Naglieri, Kaufman, Kaufman and Kamphaus, 1981.

Kirby and Das (1977) conducted a study which examined the relationship between simultaneous and successive processing and reading achievement (vocabulary and comprehension). Simultaneous and successive processing were assessed using a factor-analyzed battery developed by Kirby, Das, and Jarman (1975) which was based on Luria's original tasks of information processing. These investigators found that simultaneous and successive processing accounted for between 9 and 25% of the variance in both vocabulary and comprehension reading scores. They concluded that, "... proficiency with both forms of processing is necessary but neither by itself is sufficient for high achievement in

reading," (p. 568). In addition, these authors noted that a large deficit in either mode of processing was related to severe achievement failures.

The conclusions reached by Kirby and Das (1977) are consistent with both current theories on reading (e.g., Ferry, 1985; Lovett, 1984; Mitterer, 1982; Taylor & Taylor, 1983) and with Luria's conceptualization of the reading process (Gaddes, 1980; Luria, 1980). Taylor and Taylor (1983), Ferry (1985), Mitterer (1982) and Lovett (1984) all have proposed that familiar words are processed holistically, (i.e., as single units), whereas unfamiliar, new or especially difficult words (e.g., technical terms) are handled analytically (i.e., sequentially, letter by letter or sound by sound). Furthermore, Taylor and Taylor (1983) emphasized that these global (holistic) and analytic processing styles apply to reading comprehension as well. Specifically, these authors stated that understanding such things as syntax and functional relationships between words requires analytic processing. In contrast, comprehension of associations and of certain literary techniques (e.g., metaphors, similes, etc.), is a function of holistic processing. Thus, Taylor and Taylor (1983) see the interaction of these two types of information processing as important elements of good reading skills. Similarly, Luria hypothesized that word recognition and reading comprehension

involved both simultaneous and successive synthesis (Gaddes, 1980; Luria, 1980). Luria also stated that familiar words are processed as gestalts (simultaneously), whereas unfamiliar words are processed "bit by bit" (successively). In addition, Luria proposed that simultaneous synthesis is necessary for the understanding of logico-grammatical functions (i.e., relating one concept to another) and successive synthesis for the deciphering of syntax.

A review of the literature suggests that the only difference between the interpretations of the reading theorists and Luria's model is one of semantics. In fact, terms like "holistic and global" and "analytic and sequential" are often used as synonyms, respectively for simultaneous and successive. Therefore, it appears that the relationships found by Kirby and Das (1977) between simultaneous and successive processing and reading achievement make theoretical sense as well.

Leong (1980) extended the work of Kirby and Das (1977) to a group of retarded readers. Despite the methodological shortcomings of this study (e.g., the failure to subtype dyslexic subjects), Leong found that these "retarded" readers scored lower than their peers on both simultaneous and successive measures. The latter scores were especially depressed. Considering that successive processing would be the primary mode of processing involved in phonetic decoding,

and since a larger proportion of dyslexic children appear to be deficient in these skills, it is not surprising that Leong found larger discrepancies between his groups on the successive measures. Leong concluded that it is more useful to differentiate poor and good readers on the basis of information processing skills than it is to restrict comparisons to scores on reading achievement tests (Leong, 1980).

Cross-validation of the simultaneous/successive factors defined by Das et al. comes from Kaufman and his colleagues (Kaufman et al., 1982; Naglieri et al., 1981). In an initial standardization of the processing subscales of the Kaufman Assessment Battery for Children (K-ABC), Kaufman et al. (1982) administered 14 new tasks and 2 marker tasks selected from Das et al.'s battery of simultaneous and successive processing. These tasks were administered to 589 white and black children between the ages of 3 and 12 1/2 years. The factored scores yielded a simultaneous factor and a sequential (successive) factor (Kaufman et al., 1982). In addition, the authors noted that the factor structures were fairly consistent across age levels. The authors concluded that their findings, "...provide strong empirical support of the existence of two styles of information processing" (Naglieri et al., 1982, p. 270).

The last study to be discussed utilized the K-ABC in an

attempt to differentiate between normal and dyslexic readers matched on the basis of IQ (Hooper & Hynd, 1986). Despite the investigators' failure to classify dyslexic subjects according to subtype, they found that the K-ABC was capable of discriminating between normal and dyslexic readers with an overall accuracy rate of 91%. This lends strong support for the utility of investigating the relationships between simultaneous and successive processing and dyslexia in more detail.

Information Processing and Dyslexia: Supporting Literature.

Although simultaneous and successive processing have been shown to correlate with reading achievement (word recognition, vocabulary and comprehension) (Kirby & Das, 1977; Leong, 1980) and have been able to distinguish between normal and disabled readers (Hooper & Hynd, 1986; Leong, 1980), a simultaneous and successive information processing theory of dyslexia has not been adequately developed and investigated. Only two studies, to date, have examined dyslexia within this framework (Aaron, 1978; Hooper & Hynd, 1985).

Aaron (1982, 1978) adopted the two-stage reading model of Calfee (Calfee, 1982) which proposes that two qualitatively different types of dyslexia exist: encoding dyslexia and comprehension dyslexia. Encoding dyslexia encompasses difficulties in the recognition and

interpretation of words, whereas comprehension dyslexia is used to describe fluent reading which coexists with an inability to understand the text. Because the encoding process was hypothesized to involve both simultaneous and successive processing, Aaron reasoned that two subtypes of encoding dyslexia existed, each of which exhibited an overdependence on one type of information processing with relatively inefficient use of the other (Aaron, 1982). Such an imbalance of information processing strategies was thought to cause encoding dyslexia.

Aaron collected empirical evidence in support of his "imbalance hypothesis." He initially grouped his dyslexic subjects according to Boder's classification system and subsequently administered several tasks designed to measure simultaneous or successive processing. At the outset, Aaron equated the sequential processing deficient subtype with Boder's dysphonetic dyslexic and the simultaneous processing deficient subtype with the dyseidetic form of dyslexia. The data supported Aaron's hypothesis that the dysphonetic group scored lower on "tests of successive processing", whereas the dyseidetic group did relatively more poorly on "tests of simultaneous processing" (Aaron, 1982).

Despite the positive outcomes, a number of theoretical and methodological shortcomings must be raised. First, Aaron theorized that the two groups used in the study were

representative of only one form of dyslexia, namely encoding dyslexia. However, evidence from Lovett's study (Lovett, 1984), discussed below, suggests that comprehension may be impaired in these children as well. The condition which Aaron referred to as comprehension dyslexia is most often identified as "hyperlexia" and is not traditionally included under the rubric of dyslexia. Thus, it is reasoned that although Aaron had the right idea (i.e., that dyslexics show deficiencies in either simultaneous or successive processing), he inaccurately limited his independent variables to word recognition and spelling. Furthermore, Aaron prematurely assigned processing deficits "causal" power. In addition to these theoretical difficulties, Aaron failed to determine whether the tasks he employed measure simultaneous and successive processing (Aaron, 1982). Therefore, despite the consistency in the data, the results must be interpreted cautiously.

In a recent study, Hooper and Hynd (1985) examined the relationship between simultaneous and successive (sequential) processing, Boder's subtypes of disabled readers, and a chronological age control group. Using the Boder Test of Reading-Spelling Patterns (BTRSP) (Boder & Jarrico, 1982), these investigators preclassified disabled readers into one of four subtypes: dysphonetic, dyseidetic, alexic (mixed) dyslexia, or a nonspecific reading disorder. The mental

processing scales of the K-ABC were used as the dependent measures. Analyses revealed that the sequential processing factor separated normal subjects from dyslexic subjects; however, no significant differences were found on either the simultaneous or sequential factor between dyslexic subtypes. It is important to note that Boder hypothesized that the unspecified reading disabled group did not represent a dyslexic subtype, but was composed of children whose reading problems were due to unspecified noncognitive factors (Boder & Jarrico, 1982). Thus, it is not surprising that scores for this group were not significantly different from the control group on any of the processing variables. Hooper and Hynd (1985) concluded that: a) the sequential processing factor of the K-ABC is useful in discriminating between normal and dyslexic readers, but does not differentiate subtypes of dyslexic children; b) the simultaneous processing factor, despite its failure to significantly differentiate readers, may be depressed in some dyslexic readers; and c) the validity of the Boder classification scheme should be re-examined.

Although Hooper and Hynd (1985) used both Boder's standardized instrument to classify poor readers and the K-ABC to assess processing skills, the study contained several methodological flaws. For example, only the grade level of the Boder test word lists was used to determine a

two year deficit in reading. Although the word lists were developed from reading curricula, they were not validated with standardized achievement measures (Boder & Jarrico, 1982). The grade levels of the lists, therefore, may be inaccurate. In addition, all the difficulties associated with equating general reading ability with word recognition skills exist. Thus, the actual reading level of the disabled readers is unclear. Furthermore, Boder and Jarrico (1982) specifically caution against the use of their instrument as the sole indicator of dyslexia. They state that the BTRSP should only be used in conjunction with other diagnostic measures (e.g., standardized intelligence and achievement batteries). Hooper and Hynd (1985) failed to recognize this limitation of the BTRSP. Since these investigators used this instrument to both identify and subtype disabled readers, the composition of their sample must be questioned.

Another methodological problem present in the Hooper and Hynd study (1985) concerns the investigators' failure to assess the reading level of the control group. Without this knowledge, it is difficult to interpret the lack of differences found between groups. Similarly, the failure to screen the reading disabled sample for concomitant behavior problems (e.g., hyperactivity) raises doubt as to the homogeneity of the reading disabled groups. Lastly, a reading age control group was not included in the design.

Since it is unknown whether dyslexic children resemble younger, normal readers who are reading on an equivalent level, this shortcoming makes the interpretation of results more difficult. It is clearly evident that more research is needed to determine the applicability and usefulness of the simultaneous vs successive (sequential) processing model of dyslexia.

Based on a review of the literature on dyslexia and the reading process, it seems reasonable to state that dyslexic children have difficulty with simultaneous and/or successive processing. As noted above, there has not been a well-designed investigation which examines the relationship between simultaneous and successive processing and the reading difficulties dyslexic children exhibit. Similarly, no attempts have been made to integrate the seemingly inconsistent characteristics which have been attributed to the two reliably identified subtypes of dyslexia. Nevertheless, from a survey of both subtype descriptions and simultaneous and successive processing strategies, a pattern begins to emerge. It appears to this investigator that the two sets of characteristics described in subtyping studies reviewed can be translated into a simultaneous vs. successive information processing dichotomy. The proposed relationship between these information processing strategies and identified subtypes of dyslexia is shown in Table 1.

Selected studies bearing on dyslexia subtyping follow.

The most commonly cited and employed classification system to subtype dyslexia is the one developed by Boder (1971, 1973). This system analyzes the reading and spelling performance of dyslexic readers. The underlying assumption is that reading and spelling are interdependent functions that are strongly related and, thus, mutually predictive. Boder states that it is the analysis of the reading and spelling pattern rather than just an assessment of grade level that enables the clinician to make a diagnosis of dyslexia (Boder, 1971, 1973; Boder & Jarrico, 1982). Using this procedure, Boder has identified three distinct patterns of reading and spelling among dyslexic children, each of which is characteristic of a separate subtype (Boder, 1971, 1973; Boder & Jarrico, 1982). Boder labelled each in accordance with the major deficiency noted: dysphonetic; dyseidetic; and mixed dysphonetic-dyseidetic or alexic.

TABLE 1

Characteristics of Subtypes of Dyslexia

Researcher	Subtype characteristics		
	Successive processing deficit	Simultaneous processing deficit	Mixed processing deficit
Johnson & Myklebust (1967)	Auditory dyslexic - difficulty with auditory symbols and sequencing	Visual dyslexic - difficulty with visual perception	----------
Bateman (1968: cited in Boder, 1973)	Poor auditory	Poor visual	Poor in both
Ingram, Mason & Blackburn (1970)	Audiophonic errors	Visual-spatial errors	Both
Boder (1971, 1973)	Dysphonetic - difficulty in symbol/sound integration; inability to develop phonetic analysis/synthesis skills	Dyseidetic - difficulty in perceiving words as visual gestalts	Mixed (alexic) shows signs of both groups
Mattis et al. (1975)	Articulatory and graphomotor dyscoordination	Visual-perception group - VIQ greater than PIQ; deficit Raven Progressive Matrices Benton	Language group - deficit performance on Token test; deficit on naming test
Pirozzolo (1979, 1981)	Auditory-linguistic group - VIQ less than PIQ; Raven greater than VIQ; articulation problems; faulty grapheme/phoneme translation; agrammatism; intact visual-spatial skills	Visual-spatial group - VIQ greater than PIQ; deficit in Raven; spatial dysgraphia; good phonetic decoding	----------
Mitterer (1982)	Recoding deficit poor accuracy; difficulty with print/sound analysis of words	Whole word deficit slow, methodical reading; phonetic strategy; poor whole word recognition	----------
Lovett (1984)	Accuracy deficit - inferior decoding (phonological) skills; difficulty understanding the structure of language	Rate deficit - slow, methodical phonetic approach; no whole word recognition	----------

In dysphonetic dyslexia, a primary deficit exists in letter-sound integration and in the ability to develop skills to phonetically analyze words. Children with this type of dyslexia read globally, responding to whole words as gestalts. They recognize words on sight or, because they lack phonetic skills, are unable to decipher them at all. In contrast, dyseidetic dyslexics exhibit an inability to perceive whole words as gestalts. These children read laboriously, sounding out most words, familiar and unfamiliar, as if they were being seen for the first time. The mixed dysphonetic-dyseidetic group, as the name implies, shows deficits in both phonetic analysis-synthesis and holistic perception of words. Children in this group are the most severely handicapped and may remain nonreaders through high school (Boder, 1971, 1973; Boder & Jarrico, 1982).

Based on the above review, this investigator proposes that Boder's dyslexia subtypes can be reconceptualized within a simultaneous and successive information processing schema. Dysphonetic dyslexics are unable to phonetically analyze words and tend to read globally. Thus, they can be thought of as having intact simultaneous but defective successive information processing skills. The picture is reversed for dyseidetic dyslexics. These children display intact analytic skills but cannot perceive words as gestalts. In processing terms, they possess good successive but poor simultaneous

processing abilities. It is apparent that the mixed dyslexic is conceptualized as being deficient in both simultaneous and successive information processing. The validity of Boder's last group is questionable, however, since other investigations have not consistently found a comparable group (e.g., see Table 1).

Boder's classification system is based on a direct analysis of the reading and spelling performances of dyslexic children. Interestingly, this system was not developed in conjunction with a theory on reading processes. Nevertheless, studies which have taken a reading theory approach to the task of subtyping dyslexia, have produced results which possess striking similarities to Boder's findings. For example, Mitterer (1982) hypothetically identified two subtypes of dyslexia, recoding deficient and whole word deficient, based on several theories of reading (e.g., Rumelhart and LaBerge & Samuels). Mitterer then assessed whether these subtypes would, in fact, emerge from empirical data. Employing both good and poor readers and several measures of spelling and reading, Mitterer found that: a) a recoding/whole word factor emerged which accounted for 27% of the variance in the reading scores of the poor readers; b) the poor readers fell into two discrete groups - those poor in recoding and good in whole word recognition and those poor in whole word recognition and good

in recoding; and c) a recoding/whole word factor did NOT emerge for the scores of the good readers (Mitterer, 1982). Mitterer concluded that the data support his initial classification scheme. In addition, he stated that a recoding deficit - whole word deficit division of dyslexia is thoroughly consistent with Boder's dysphonetic - dyseidetic dichotomy. It also appears to this investigator that Mitterer's dyslexic subtypes may be viewed in terms of simultaneous and successive processing skills. Recoding deficient dyslexics, which are identical to the dysphonetic dyslexics recognized by Boder, would display a weakness in successive processing whereas the whole word deficient dyslexics (Boder's dyseidetics) would show difficulties in simultaneous processing.

In a follow-up study of these two dyslexic subtypes, Mitterer (1982) examined additional descriptive characteristics of the reading skills of both groups. He found that his recoding group showed poor accuracy on word recognition and seemingly used whole word processing skills to identify words. Thus, different words which had the same outer contours (e.g., "heat" & "hoot") were read as the same word. In contrast, Mitterer related that the most outstanding feature of the whole word deficient dyslexics was their rate of reading. These dyslexics read slow and methodically, relying almost exclusively on their phonetic

skills to decipher words.

Mitterer's descriptive findings coincide with the method employed by Lovett (1984) to subtype dyslexic readers. Lovett (1984) based her classification system on the LaBerge-Samuels model of reading which focuses attention on the accuracy/speed dimensions of readers. Lovett found that poor readers could be reliably characterized as either "accuracy deficient" or "rate deficient." Lovett noted that "accuracy deficient" readers have particular difficulty with phonetically decoding words, acquiring spelling strategies, and in understanding the syntax of a sentence. Conversely, "rate deficient" readers appear to lack the ability to recognize words as whole configurations. They tend to exclusively utilize phonetic decoding skills, making their reading styles slow and laborious (Lovett, 1984). Lovett (1984) also documented that both groups are equally impaired in reading comprehension. Considering the consistency between the subtypes identified by Lovett (1984), Mitterer (1982), and Boder (1971, 1973), the accuracy disabled and rate disabled groups can also be viewed from a successive vs. simultaneous dichotomy. Given this conceptualization, Lovett's findings support the earlier conclusions drawn by Kirby and Das (1977) that both types of processing are needed for good reading skills. In addition, Lovett's findings strengthen the dual processing reading models (e.g., Ferry,

1985; Taylor & Taylor, 1983) which have been proposed to explain the cognitive processes involved in reading.

The last subtyping study to be discussed approaches the task through profile analysis of a comprehensive neuropsychological test battery (Pirozzolo, 1979, 1981). Pirozzolo (1979, 1981) has identified two distinct subtypes of dyslexia: auditory-linguistic and visual-spatial. Auditory-linguistic dyslexia is characterized by having a Wechsler Verbal IQ lower than both Performance IQ and Raven Progressive Matrices scores, by articulation problems, by agrammatisms, and by reading and writing errors involving faulty grapheme-to-phoneme translation. Conversely, visual-spatial dyslexia is characterized by a Verbal IQ which is higher than both Performance IQ and Raven scores, by spatial dysgraphia, and by the use of a primarily phonetic decoding strategy (Pirozzolo, 1979, 1981). Pirozzolo's auditory-linguistic and visual-spatial dyslexics share many of the same features with the previously described subtyping dichotomies. Thus, it seems plausible to also interpret this system in terms of difficulties in successive and simultaneous processing. Interestingly, Pirozzolo's two subtypes show a distinct difference in performance on the Raven test (Pirozzolo, 1979, 1981). In Das et al.'s studies on simultaneous and successive processing, the highest loading on the simultaneous processing factor was

consistently obtained by the Raven test. Furthermore, this test was subsequently used as a "marker" for simultaneous processing by Kaufman, et al. (1982) to determine the factor structure of the K-ABC. Thus, it may be viewed as a well-established test of simultaneous processing. The fact that visual-spatial dyslexics actually perform poorly on the Raven, supports the notion that they exhibit deficiencies in simultaneous processing, and, in turn, lends strength to the hypothesis that dyslexia can be most parsimoniously described in terms of difficulties in simultaneous or successive processing.

To summarize, the above discussion of dyslexia subtyping studies illustrates the feasibility and usefulness of a simultaneous vs. successive information processing hypothesis of dyslexia. Specifically, it has been argued that despite the variety of approaches used to subtype dyslexics, all may be viewed within a model which emphasizes simultaneous and successive processing. Furthermore, such a distinction is consistent with current reading models which propose that both "holistic" and "analytic" processing of information are important for skilled reading (Ferry, 1985; Taylor & Taylor, 1983).

Benefits of an Information Processing Hypothesis.

The literature reviewed strongly suggests that a simultaneous vs. successive processing model of dyslexia has

distinct advantages. As noted above, such a model parsimoniously integrates previous research findings and introduces the possibility of subdividing dyslexic children on an inferred cognitive dimension. Since highly reliable and valid measures of simultaneous and successive processing do exist (e.g., K-ABC), viewing dyslexia in this manner will permit clear and consistent classification of dyslexic children. This has significant ramifications for future research in the field. With a reliable means of subdividing dyslexic readers into hypothetically homogeneous groups, studies can begin to investigate other between group differences (e.g., neuroelectrical patterns, anatomical differences, sex ratios, etc.).

On the practical level, a simultaneous vs. successive processing theory of dyslexia will help highlight the areas in which past remedial programs have failed and why (e.g., techniques too specifically focused on phonics). It may also begin to help forge new, more comprehensive strategic approaches to the treatment of the disorder.

To investigate an information processing approach to dyslexia, a study was designed to examine simultaneous and successive (sequential) processing and reading comprehension and decoding across well-defined subtypes of dyslexic children and control groups. The K-ABC mental processing scales were used to assess simultaneous and sequential

processing and the Kaufman Test of Educational Achievement (K-TEA) reading subtests were given to measure comprehension and decoding. In addition, the relationship between the K-ABC mental processing scales and the hypothesized simultaneous and successive factors of the WISC-R were examined. The homogeneity of dyslexic subtypes was thought to be crucial. Thus, a rigorous attempt was made to adhere to the definition proposed above (p. 13 and 16).

Dyslexic children were screened for coexisiting problems (i.e., borderline intelligence, sensory deficits, and attention deficit disorders) so that only "pure" dyslexics were included in the investigation.

"Pure" dyslexic subjects were subtyped as either dysphonetic or dyseidetic, according to the criteria established by Boder (1971, 1973; Boder & Jarrico, 1982). Boder's classification system was selected because it has frequently been replicated and a standardized instrument (i.e., the Boder Test of Reading-Spelling Patterns [BTRSP]) was available to identify these subtypes. Additionally, this classification system appears to be the one most commonly used in educational settings. Thus, convention and psychometric rigor argue for the use of Boder's classification scheme. It should be noted, however, that because of the lack of support for Boder's alexic (mixed) subtype from independent studies, only the dysphonetic and

dyseidetic subtypes were utilized.

As a result of the changes which occur in reading processes as a function of increasing reading proficiency, both chronological age (CA) and reading age (RA) control subjects were employed. Each subject was screened for grade appropriate comprehension and decoding skills as well as the absence of an attention deficit disorder.

From the previous research on dyslexic subtypes, the reading process, and simultaneous and successive (sequential) processing, six hypotheses were formulated: 1) the dysphonetic group will score lower than the dyseidetic group on both the K-ABC Sequential processing scale and on the successive factor of the WISC-R; 2) the dysphonetic group will score lower than the CA control group on both the K-ABC Sequential processing scale and on the successive factor of the WISC-R; 3) the dyseidetic group will be equal to the CA control group on both sequential and successive measures; 4) the dyseidetic group will score lower than the dysphonetic group on both the K-ABC Simultaneous processing scale and on the simultaneous factor of the WISC-R; 5) the dyseidetic group will score lower than the CA control group on both simultaneous processing measures; and 6) the dysphonetic group will be equal to the CA control group on both simultaneous measures.

No a priori hypotheses were proposed regarding the

similarity between the two dyslexic groups and the RA control group in terms of processing scores. Group differences on the individual simultaneous and successive (sequential) processing tasks of the K-ABC and WISC-R were to be examined. Contrasting strengths and weaknesses were expected for the dysphonetic, dyseidetic and CA control groups.

Due to practical and methodological problems encountered during the screening phase of this investigation (discussed below), the proposed research was not feasible. However, several characteristics of the children recruited as control subjects raised interesting questions relevant to the relationships between information processing styles and reading abilities. Thus, although the initial hypotheses regarding the differential information processing deficits found in subtypes of dyslexia were not addressed directly, the revised study was aimed at exploring information processing styles of different types of readers.

PRESENT INVESTIGATION

A survey of the literature on dyslexia and information processing revealed that there has not been a well-designed investigation examining the relationship between simultaneous and successive processing and the reading difficulties exhibited by dyslexic children. The initial purpose of this investigation was to systematically evaluate these relationships. Specifically, simultaneous and successive (sequential) processing, reading comprehension, word recognition, and the simultaneous and successive factors on a measure of intelligence (WISC-R) were to be examined across well-defined subtypes of dyslexic children and control groups. The methodological refinements included the use of: 1) a precise, operationalized definition of dyslexia (see pg. 13); 2) a screening of dyslexic children for concomitant problems (e.g., borderline IQ, hyperactivity); 3) a standardized instrument for classification of subtypes; and 4) chronological and reading age control groups.

Because of the stringent criteria proposed for inclusion in the dyslexic groups and the chronological and reading age control groups (viz., VIQ or PIQ $\geq$ 90; either 2 years below grade level in both reading decoding and comprehension [dyslexic group] or grade level achievement in both areas [control groups]; no symptoms of Attention Deficit Disorder or Attention Deficit Disorder with Hyperactivity; etc.), the

original study required an extensive screening procedure. This procedure included several steps: a) recruitment of second and fourth grade students, including reading disabled pupils; b) assessment of ADD/ADDH; c) intellectual and reading evaluations; and d) reading/spelling subtype classification, using Boder's systematic approach. After screening approximately 60 children, it became apparent that the study, as proposed, was not feasible. This was due to several factors. The major factor was a poor response rate from four school systems. Only 5 children out of a pool of 53 identified by school personnel as being "dyslexic" agreed to participate. Of this group of five, only one met the criteria outlined in the proposed study. In addition, the chronological age control group was difficult to recruit. Although a substantial number of children agreed to participate in the study, only a few were achieving at the required grade level in both reading decoding and comprehension. Thus, given the community in which the study was conducted, it was not possible to compile a large enough sample of children to compose the diagnostic groups.

Several practical and methodological problems were raised by the screening procedure and provided the basis for the present investigation. These problems can be divided into two general categories: reading characteristics and standardized test properties. Reading is a complex cognitive

task which involves different characteristics, skills, and abilities. Despite the knowledge that reading, like most cognitive tasks, is developmental in nature, the majority of studies on dyslexia have overlooked the impact that developmental changes may have on findings (e.g., by using large age-ranges in samples, not including younger, reading age controls, etc.). To further investigate and identify developmental changes in reading which may have particular significance for the study of dyslexia, this study examined the relationship between reading decoding, reading comprehension, intelligence (WISC-R), simultaneous and successive (sequential) processing abilities (K-ABC scales), and measures derived from the BTRSP (i.e., a reading quotient [RQ] and a good phonetic equivalent percentage [GFE]) in second and fourth grade students. Particular attention was devoted to differences between the two grades.

In addition to the inattention to developmental factors prevalent in research on dyslexia, the use of only one measure of reading (viz., word recognition) to select reading disabled and control groups is common practice. During the initial screening process of this research, it became clear that many children show significant discrepancies (i.e., more than 11 standard score points which has been demonstrated by Kaufman & Kaufman [1985] to be significant at $p < .05$) between reading decoding and reading comprehension skills.

In fact, very few children displayed average skills in both. This discrepancy raises serious methodological and theoretical considerations for dyslexia research as well as for reading instruction. If, as the screening process suggested, many children actually demonstrate "split" reading profiles, how should reading skill level be measured? A descriptive comparison of "split" readers (i.e., readers with a significant discrepancy between comprehension and decoding) and "flat" readers (comparable comprehension and decoding scores) in the second and fourth grades was pursued. Within this latter group, a further distinction between average and above average readers appeared warranted. Thus, the "flat" readers actually formed two groups within each grade. Particular attention was paid to differences in information processing abilities between the groups and provided indirect support for the initial hypotheses on dyslexic subtypes and information processing deficits.

Performance on psychometric measures such as the WISC-R and K-ABC was examined, as were the reading-spelling patterns found on the BTRSP. Within and across grade comparisons of the reading groups ("split", "flat-average", and "flat-above average") were made by matching subjects on FSIQ. This permitted an inspection of recurring patterns of differences among the groups across IQ levels (average to very superior). An attempt was made to uncover distinctive characteristics of

each reading group and to determine whether these show developmental stability. Because of the small number of subjects in each group, analyses were limited to a visual inspection of the data and are sensitive to chance findings. With this in mind, an effort was made to focus only on robust patterns. Nevertheless, any conclusions need to be interpreted with extreme caution.

The other area of concern raised during the screening procedure focused on psychometric properties of the assessment instruments. The first concerns the K-ABC. Kaufman and Kaufman proposed that the K-ABC mental processing scales (i.e., simultaneous and sequential information processing) be used as a measure of intelligence. These authors stated that this instrument is more "culture-free" than the WISC-R (Kaufman & Kaufman, 1983). Indeed, the K-ABC does minimize the amount of verbal responses by the child. However, it seems possible that for exceptionally verbal children, the K-ABC may underestimate intellectual functioning. In addition, cognitive information processing theorists (e.g., Das, Kirby, and Jarman), whose work formed the basis for the conceptualization of the K-ABC, did not claim that simultaneous and successive information processing is a measure of intelligence. Thus, the K-ABC may not be an appropriate measure of intelligence. Since the K-ABC and the WISC-R were administered to second and fourth graders, an

analysis of the relationship between these measures was undertaken.

The K-TEA was used to measure reading decoding and comprehension skills in the second and fourth grade samples. Initially, the instrument's standardized grade equivalent data was used to help classify subjects into dyslexic, chronological age and reading age control groups. However, an examination of the K-TEA's grade equivalent data revealed that significant discrepancies exist between "average" standard scores and appropriate grade equivalents. These discrepancies and their academic, research, and clinical implications are discussed.

Lastly, numerous difficulties were encountered with the use of the BTRSP. These administrative and interpretive difficulties produce uncertainty as to the validity of the instrument. The Boder Test is critically examined and discussed.

In conclusion, the present investigation attempted to set a precedent in the field of dyslexia and reading research by suggesting a more qualitative approach to data analysis and by recognizing the heterogeneity of reading skills. The following specific issues were addressed: whether differences exist in second and fourth grade readers in the relationship between simultaneous and successive processing, WISC-R intelligence, and reading comprehension and decoding;

the differences amongst "normal" readers noted during screening; and a brief comparison of the K-ABC mental processing scales and the WISC-R in verbally bright children as well as examining the interrelationship between WISC-R simultaneous/successive factors and simultaneous and sequential scores on the K-ABC. In addition, important methodological, theoretical, and psychometric issues were addressed which have significant implications for future academic, clinical, and research activities.

Method

Subjects

Subjects consisted of second and fourth grade students in Elementary schools in Northwestern Ohio who had been recruited as control subjects for the initial study. As control subjects, the children were screened for ADD or ADDH and at least grade level reading ability. All subjects had been solicited by letter and represented a self-selected sample. This sample was composed of 18 second grade and 15 fourth grade students. For the purposes of the present investigation, further subclassification by reading profile was necessary. The breakdown of the sample into three groups is depicted in Table 2. Children designated as "split readers" demonstrated a significant discrepancy between their reading decoding and reading comprehension standard scores on the K-TEA (i.e., at least 11 points, $p < .05$). In

contrast, "flat-average" and "flat-above average" readers showed no such discrepancy. The "flat-average" readers were children who obtained standard scores between 90 and 114 on both the decoding and comprehension subtests, whereas the "flat-above average" readers achieved standard scores above 115 on both tasks.

TABLE 2

Breakdown of Reading Groups by Grade

READING GROUP	GRADE	
	Second	Fourth
Split Readers	7	9
Flat-Average Readers	7	3
Flat-Above Average Readers	4	3

Measures

The Boder Test of Reading-Spelling Patterns (BTRSP).

The BTRSP (Boder & Jarrico, 1982) is a diagnostic screening instrument that purports to differentiate dyslexia from nonspecific reading disorders and normal reading patterns, and identifies distinct dyslexic subtypes. This test is based on the premise that the dyslexic reader has a characteristic pattern of cognitive strengths and weaknesses in two distinct components of the reading process: the visual gestalt function and the auditory analytic function. The visual gestalt function is thought to underlie the ability to develop a sight vocabulary through visual perception and memory for whole words, whereas the auditory analytic function is thought to underlie the ability to develop phonic word analysis skills.

The BTRSP is divided into reading and spelling subtests. The Reading test consists of 13 graded reading lists of 20 words each - 10 phonetic and 10 nonphonetic. Word lists are presented in two ways: "flash" and "untimed" (Boder & Jarrico, 1982). The "flash" presentation reveals which words are in the child's sight vocabulary, whereas the "untimed" presentation reveals the child's phonic word-analysis skills. The child's reading level is defined as, "...the highest grade level at which he reads at least 50% of the word list on flash presentation" (Boder & Jarrico, 1982, p. 17). The main objective of the reading test is to identify a child's sight vocabulary so that a reading level may be established and appropriate spelling words may be selected.

The BTRSP's Spelling test is different for each child since it is based on his/her reading performance. Briefly, the examiner prepares two spelling lists, one of which is composed on ten known words (sight vocabulary), while the other contains ten unknown words (i.e., words that have not been read). Each spelling list contains an equal number of phonetic and nonphonetic words. Spelling words are dictated to the child. They are read once, used in a sentence, and then spoken again.

Boder and Jarrico (1982) presented validated diagnostic criteria for the emerging reading-spelling patterns. The criteria for differentiating the dysphonetic and dyseidetic

subtypes of dyslexia from normal readers are presented in Appendix A.

The BTRSP is a clinically derived measure which has been found to have adequate reliability and validity. Internal consistency was determined for four components of the BTRSP (sight vocabulary, reading level, correct spelling of known words and good phonetic equivalents) and ranged from r = .82 to r = .99. Test-retest reliability for the same components was also impressive (r = .76 to r = .97). More importantly, however, test-retest reliability of subtype classification was highly significant, indicating strong agreement on classifications across time.

Boder and Jarrico (1982) stated that the validity of the BTRSP is derived from the dyslexic subtypes it identifies. From the literature reviewed above, it seems reasonable to accept the validity of the dysphonetic and dyseidetic subtypes. Furthermore, four studies using the BTRSP identified almost identical percentages of the dyslexic subtypes within their samples (Boder & Jarrico, 1982). Lastly, Boder and Jarrico (1982) cited evidence from neuropsychological and electrophysiological studies to support the construct validity of their subtype classification scheme.

Kaufman Assessment Battery for Children (K-ABC).

The K-ABC is an individually administered test designed to

measure both intelligence, as defined by the simultaneous and sequential (successive) processing model, and achievement in children ages 2 1/2 to 12 1/2 years. Only the mental processing scales were used in the present investigation. The Simultaneous Processing Scale is composed of five subtests: Gestalt Closure, Triangles, Matrix Analogies, Spatial Memory, and Photo Series. Subtests included on the Sequential Processing Scale include: Hand Movements, Number Recall and Word Order. For a description of these subtests and administration procedures, the reader is referred to the K-ABC Administration and Scoring Manual (Kaufman & Kaufman, 1983).

The mental processing scales of the K-ABC were theoretically derived from the independent work of cognitive psychologists and neuropsychologists (Kaufman & Kaufman, 1983). Especially influential in the development of the scales was Das, Kirby and Jarman's model of simultaneous and successive information processing, discussed earlier. Kaufman et al. (1982) factor analyzed a preliminary version of the K-ABC processing scales using two marker tasks selected from Das et al.'s original simultaneous-successive battery. Based on this factor analysis, these investigators selected those tasks which had high loadings on only one of the processing factors. Thus, Kaufman and Kaufman (1983) argue that the processing scales of the K-ABC were developed

with inherent construct validity. The K-ABC has been standardized on a representative sample of children stratified on the variables of age, sex, parental education, ethnic group, geographic region, community size and educational placement. Age and grade norms are available for the processing and achievement scales.

The Simultaneous and Sequential processing scales of the K-ABC have been shown to have very good internal consistency: r = .86 and r = .90, respectively. The split-half reliability of the individual subtests ranges from r = .71 to r = .85. Test-retest reliability coefficients over an interval of 2 to 4 weeks were equally impressive (e.g., r = .88 for Sequential processing scale and r = .91 for Simultaneous processing scale).

As noted above, Kaufman and Kaufman (1983) hypothesized that the mental processing scales of the K-ABC have inherent construct validity. In addition, over forty studies have been conducted comparing the K-ABC with various well-established instruments such as the Stanford-Binet, Iowa Tests of Basic Skills, Wide Range Achievement Test (WRAT), WISC-R, Das-Kirby-Jarman Battery, and The Luria-Nebraska Children's Neuropsychological Battery. These studies spanned a wide range of diagnostic categories (e.g., mental retardation, learning disabled, gifted), ethnic backgrounds (e.g., white, black, hispanic, Asian), geographic locations

and settings (e.g., North, South, Urban, rural), income levels and ages. Construct, predictive, and concurrent validity were assessed. Construct validity coefficients ranged from r = .30 to r = .70. Predictive validity data revealed coefficients between r = .02 and r = .39. The lower coefficients were obtained when the mental processing scales were used to predict performance on the achievement measures. However, concurrent validity between other achievement measures (e.g., WRAT and KeyMath) is higher: r = .35 to r = .62. For a detailed account of these studies, see Kaufman and Kaufman, 1983.

Kaufman Test of Educational Achievement (K-TEA).

The K-TEA is a relatively new measure of academic achievement. The battery is subdivided into five independent subtests: Reading Decoding; Reading Comprehension; Spelling; Mathematics Computation; and Mathematics Application. Only the reading subtests were used in this study.

Items for the K-TEA were developed from academic curricula. Preliminary empirical comparisons with established achievement measures (e.g., KeyMath and Peabody Individual Achievement Test) were then conducted (Kaufman & Kaufman, 1985). Despite the recency of its development, the K-TEA has been rigorously standardized on a large, representative sample of children in grades 1 through 12. Two sets of standardized age and grade norms are available,

corresponding to two different periods in the academic year (i.e., Fall and Spring). Standardization samples were stratified on the variables of grade, sex, geographic region, parental educational level, and ethnic group.

The internal consistency of the Reading Decoding and Reading Comprehension subtests of the K-TEA are r = .95 and r = .92, respectively. Similarly, test-retest reliability coefficients are equally high (r = .95 and r = .92). Kaufman and Kaufman (1985) state that the content validity of the K-TEA is ensured by the methods employed in item development and selection. In addition, the K-TEA has been compared with other measures of achievement, such as the PIAT, WRAT, and Stanford Achievement Test. Concurrent validity coefficients for the reading subtests of the K-TEA and similar subtests of the WRAT and PIAT range from r= .62 to r = .88 (Kaufman & Kaufman, 1985). Thus, despite the recent publication of the K-TEA, this measure appears to be psychometrically sound.

SNAP. The SNAP is a 16-item screening measure which is used to assess the presence of ADD or ADDH and is completed by teachers. SNAP items are based on the DSM-III (1980) definitions of ADD and ADDH. Swanson et al. (1981) provide criterion cut-off scores which classify the child as ADD, ADDH, or normal.

The SNAP has been shown to have adequate reliability and concurrent validity. Internal consistency was computed to be

r = .92 (deHaas, 1983, cited in Roth, 1986). Furthermore, in a study using a sample of 8 and 9 year old boys and girls, test-retest reliability was measured at r = .91 for all raters, with a range from r = .83 to r = .99 (Roth, 1986). Thus, the SNAP is thought to have acceptable reliability. The concurrent validity of the SNAP has been assessed by a comparison of scores obtained on the SNAP and on the Conners Teacher Rating Scale (Swanson et al., 1981). The resulting correlation of r= .90 supports the validity of the SNAP.

Wechsler Intelligence Scale for Children-Revised (WISC-R). The WISC-R is a conventional measure of intelligence in children aged 6 to 16 1/2 years. It has been standardized on a large, representative sample of children from diverse backgrounds. The WISC-R has been shown to have excellent test-retest and split-half reliability (r=.95 and r=.96, respectively) (Wechsler, 1974). The validity of the WISC-R is based on the concept of global intelligence. For a full treatment of this issue, the reader is referred to Wechsler, 1974. The WISC-R yields three summary IQ scores: Verbal; Performance; and Full Scale. The Verbal Scale is composed of the following subtests: Information, Vocabulary, Similarities, Comprehension, Arithmetic, and Digit Span. Subtests included on the Performance Scale include: Picture Arrangement, Block Design, Object Assembly, Picture Completion, Coding, and Mazes. The test-retest reliability

of the individual subtests range from r=.77 to r=.88 on the Verbal Scale and from r=.71 to r=.81 on the Performance Scale (Wechsler, 1974).

Recently, Naglieri, Kamphaus and Kaufman (1983) and Kaufman (1979) have proposed that the subtests of the Verbal and Performance Scales of the WISC-R can be reorganized in terms of whether they involve simultaneous or successive (sequential) processing. After factor analyzing the WISC-R, these investigators suggested that the Similarities, Block Design, Object Assembly, and Picture Completion subtests compose a simultaneous factor, and that the Digit Span, Coding, and Picture Arrangement subtests comprise a successive (sequential) factor. To investigate this reorganization, simultaneous and successive (sequential) scores were derived from the WISC-R data and compared with corresponding mental processing scores from the K-ABC.

Procedure

The present investigation was derived from the lengthy recruitment and screening phases of an aborted study. This included: solicitation, by letter, (see Appendix C) of voluntary participants in the second and fourth grades; teacher-completed SNAPs on each potential subject to rule out ADD or ADDH; and administration of K-TEA and BTRSP to determine reading achievement and subtype classification. Thus, subjects who were included in this study demonstrated

at least grade-level reading achievement and no associated symptoms of ADD or ADDH. For a complete description of relevant aspects of the recruitment and screening phases of the aborted study, see Appendix B.

Second and fourth grade subjects were contacted subsequent to the screening process and a second two-hour session was scheduled. During this period, the WISC-R and the mental processing scales of the K-ABC were individually administered. The tests were separated by a ten minute rest and snack period. At the conclusion of this session, subjects were presented with a $5 gift certificate and a "good subject" diploma. Only subjects with Full Scale IQ scores at or above 90 were included in data analysis.

RESULTS

The results of this study are divided into two subcategories: Reading Characteristics and Psychometric Properties.

Reading Characteristics

Eighteen second grade and 15 fourth grade students were compared on measures of reading achievement (K-TEA decoding, comprehension, and a composite score), WISC-R Verbal, Performance, and Full Scale IQ, and K-ABC simultaneous and sequential processing scores and a mental processing composite score. Descriptive statistics for the two groups can be found in Table 3 and are highlighted below. In general, the two groups are comparable. Both second and fourth grade groups are characterized by above average FSIQ, M = 118 and 124; VIQ, M = 117 and 125; and PIQ, M = 116 and 117, respectively. T-tests for differences between the means were non-significant. In addition, the range of scores and standard deviations (SD) in both groups were quite similar. Thus the two groups appear to be of comparable intellectual ability. Similarly, both groups exhibited above average reading comprehension scores (M = 118 and M = 123 for second and fourth graders, respectively). Reading decoding scores were elevated in both groups, but were less than 1 SD above the K-TEA subtest mean (M = 100, SD = 15). The t-tests on the means were non-significant and the score ranges and SDs

on the reading measures were consistent for each group. The second and fourth grade groups' performance on the K-ABC scales was in keeping with the above findings. The mean of both groups fell within +1 SD of the standardized test means on the two K-ABC mental processing scales (simultaneous and sequential) as well as the composite score. T-tests revealed no significant differences in the means of the two groups.

TABLE 3

Reading, Intellectual, and Mental Processing Variables for Grades 2 and 4

Measure	Grade 2 (N=18)			Grade 4 (N=15)		
	X	SD	Range	X	SD	Range
K-TEA:						
Comprehension	118	14.87	94-142	123	12.08	103-143
Decoding	110	14.37	93-134	112	13.35	92-141
Composite	113	14.22	93-136	119	11.66	101-147
WISC-R:						
FSIQ	118	12.93	98-144	124	10.18	108-145
VIQ	117	15.75	94-146	125	12.13	109-149
PIQ	116	13.33	88-145	117	10.75	98-133
K-ABC:						
Simultaneous	113	10.93	93-139	111	11.33	91-136
Sequential	110	8.9	95-131	109	12.07	87-129
Composite	114	10.93	100-137	112	10.20	98-137

In general, the second and fourth grade groups are of comparable intellectual, reading, and simultaneous and sequential processing abilities. This correspondence permits comparison of the correlational patterns amongst the variables across the groups. Only those correlations which have practical meaningfulness and which are equal to or

exceed a $p < .05$ of significance are presented and discussed. The $p < .05$ criterion was chosen based on the descriptive and exploratory nature of the study and the small sample sizes.

Zero order correlations for both groups disclosed highly significant correlations ($r = .49$ to $r = .79$) between reading, intelligence, and processing variables. As the relationships between the different reading measures (e.g., decoding and comprehension) and their relationship to processing skills were of particular interest, as well as the fact that intellectual ability is commonly believed to underlie achievement potential, partial correlations controlling for FSIQ were calculated. As cognitive information processing theory postulates that simultaneous and successive processing capacities are fundamental to mental abilities (e.g., intelligence), the data were also analyzed controlling for a mental processing composite score (MPC). An examination of the data from both of these perspectives allows one to estimate the unique contributions of intelligence (as measured by the WISC-R) and cognitive information processing abilities (as assessed by the K-ABC) to reading decoding and comprehension skills.

An inspection of Tables 4, 5, 6, and 7 reveals some interesting differences in the relationships of reading skills in each of the grades. Regardless of whether FSIQ or

MPC is controlled for, the correlations among reading skills are higher in grade 2 than in grade 4. Specifically, the correlation between K-TEA decoding and comprehension (controlling for FSIQ) is r = .71 and r = .13 in grades 2 and 4, respectively. Using Fisher's Z transformation, the difference between the correlations was found to be significant at the $p \leq .05$ level. Similarly, when controlling for MPC, the correlation between decoding and comprehension in grades 2 and 4 was r = .80 and r = .35. This difference failed to meet significance ($z = 1.89$, $p \leq .06$) most likely due to small sample sizes. Consistent with these findings is the difference in the relationship between GFEs and reading comprehension in Grades 2 and 4: r = .23 and r = -.46, when FSIQ is controlled and r = .16 and r = -.47, when MPC is controlled (significant at $p \leq .05$).

Another example of the greater degree of interrelatedness in reading skills in grade 2 was found in the relationship between comprehension skills and the Boder Reading Quotient (RQ). When FSIQ is controlled, the relationship between these variables in grade 2 (r = .80) is significantly greater ($p \leq .005$) than that found in grade 4 (r = .03). When MPC is partialled out, a similar effect is exhibited: for grade 2 r = .92, while for grade 4 r = .23. The difference between these coefficients is significant at $p \leq .0005$. Interestingly, no difference was found in the

relationship between reading decoding and Boder RQ for the two grade levels, irrespective of whether FSIQ or MPC was partialled out. Lastly, there were no significant differences in the relationships between intelligence and reading skills between grades 2 and 4, despite the tendency towards a stronger positive correlation between both decoding and Boder RQ and VIQ and FSIQ in grade 2. It is important to mention that PIQ was not significantly related to any of the reading measures in either grade. In addition, virtually no significant relationships were found between simultaneous and sequential processing, the MPC, and reading skills in either grade. The exception was in grade 4 where a significant relationship was found between decoding and sequential processing ($r = .45$, $p \leq .05$). In addition, a pronounced change in the direction of the relationship between reading comprehension and sequential processing was found when FSIQ was controlled. In Grade 2, these two measures were positively related ($r = .26$) whereas in Grade 4 the relationship was negative ($r = -.39$).

TABLE 4

Grade 2 Partial Correlations of Reading Skills and Cognitive Information Processing Variables, controlled for FSIQ. (N=18)

	1	2	3	4	5	6	7	8
1. K-TEA Decoding	1.00	.71 *	.92 ***	.80 ***	.35	-.17	.26	.00
2. K-TEA Comprehension		1.00	.87 ***	.80 ***	.23	.04	.26	.16
3. K-TEA Composite			1.00	.89 ***	.34	-.12	.25	.02
4. Boder RQ				1.00	.32	-.33	.04	-.25
5. Boder GFE					1.00	-.27	-.16	-.25 ***
6. K-ABC Simultaneous						1.00	.18	.88 **
7. K-ABC Sequential							1.00	.62
8. K-ABC MPC								1.00

*p < .001
**p < .005
***p < .0001

TABLE 5

Grade 4 Partial Correlations of Reading Skills and Cognitive Information Processing Variables, controlled for FSIQ (N=15)

	1	2	3	4	5	6	7	8
1. K-TEA Decoding	1.00	.13	.83****	.78***	.28	-.09	.45*	.23
2. K-TEA Comprehension		1.00	.62**	.03	-.46*	.06	-.39	-.20
3. K-TEA Composite			1.00	.65**	-.10	-.04	.18	.09
4. Boder RQ				1.00	.33	.16	.27	.35*
5. Boder GFE					1.00	.38	.29	.54***
6. K-ABC Simultaneous						1.00	-.30	.76
7. K-ABC Sequential							1.00	.39
8. K-ABC MPC								1.00

*p < .05
**p < .01
***p < .001
****p < .0001

TABLE 6

Grade 2 Partial Correlations of Reading Skills and WISC-R IQs, controlled for K-ABC Mental Processing Composite Score (N=18)

	1	2	3	4	5	6	7	8
1. K-TEA Decoding	1.00	.80	.82****	.87****	-.10****	.53**	.07	.50*
2. K-TEA Comprehension		1.00	.94	.92****	.16****	.68***	.00	.60**
3. K-TEA Composite			1.00	.95****	.21****	.63***	.04	.57**
4. Boder RQ				1.00	.16	.63***	.07	.59**
5. Boder GFE					1.00	-.12	-.04	-.11
6. WISC-R VIQ						1.00	-.03	.83****
7. WISC-R PIQ							1.00	.20
8. WISC-R FSIQ								1.00

*p < .05
**p < .01
***p < .005
****p < .0001

TABLE 7

Grade 4 Partial Correlations of Reading Skills and WISC-R IQs, controlled for K-ABC Mental Processing Composite Score (N=15)

	1	2	3	4	5	6	7	8
1. K-TEA Decoding	1.00	.35	.82 ****	.77 ***	.09	.33	.08	.32
2. K-TEA Comprehension		1.00	.81 ****	.23	-.47 *	.56 *	.34	.70 ***
3. K-TEA Composite			1.00	.64 **	-.30	.58 **	.22	.63 **
4. Boder RQ				1.00	.12	.16	.07	.22
5. Boder GFE					1.00	-.45 *	.25	.25
6. WISC-R VIQ						1.00	-.05	.26
7. WISC-R PIQ							1.00	.19
8. WISC-R FSIQ								1.00

*p < .05
**p < .01
***p < .005
****p < .0001

Three characteristic reading patterns were uncovered across the grades: "split readers;" "flat-average readers;" and "flat-above average readers." "Split readers" were children who demonstrated a significant discrepancy (11 points) or "split" between decoding and comprehension scores. Interestingly, all children who fell into this group achieved comprehension scores greater than decoding scores. "Flat-average" readers exhibited highly similar decoding and comprehension scores that fell between a standard score (SS) of 90 and +1 SD of the test mean (i.e., scores between 90 and 114). Similarly, "flat-above average" readers had equivalent scores which were greater than or equal to +1 SD (i.e., scores of 115 or higher). Based on the reading comprehension and decoding means, the three groups differed significantly from each other on at least one reading measure (see Table 8). T-tests on the means of intelligence and mental processing variables, however, revealed no significant differences among the groups in these abilities. It should be noted, however, that the FSIQ mean of the "flat-average" group was significantly lower than that of both the "split" and "flat-above average" groups when the scores were compared to WISC-R standardization data. This difference needs to be kept in mind when descriptively examining the data.

TABLE 8

Reading, Intelligence and Processing Means of Split, Flat-Average and Flat-Above Average Groups

MEASURE	GROUP		
	Split (N=16)	Flat Average (N=10)	Flat Above Average (N=7)
Reading:			
Comprehension	128	103	127
Decoding	109	101	129
Composite	119	102	129
WISC-R:			
FSIQ	126	110	126
VIQ	125	109	127
PIQ	120	109	119
K-ABC:			
Simultaneous	115	106	117
Sequential	109	105	117
MPC	114	106	120

Several features were noted within these three reading groups. The first was the greater percentage of "split" and "flat-above average" readers as compared to "flat-average" readers who showed a 13 point or more discrepancy between VIQ and PIQ. A difference of this magnitude is significant at $p < .05$ (Wechsler, 1974). The percentage of "flat-average" readers who demonstrated this discrepancy was identical to the test's standardization sample (33%), although the VIQ/PIQ discrepancy in the "split" group (69%) and the "flat-above average" group (71%) was substantially higher. In contrast, an inspection of the groups' K-ABC profiles revealed a divergence between the "split" and the "flat-above average" groups. In 56% of the "split" group (N=9), there was at least a 15 point discrepancy ($p < .01$) between FSIQ and MPC, favoring FSIQ. The percentages of significant FSIQ/MPC differences in the "flat-average" and "flat-above average" groups were 10% and 14%, respectively. These data are presented in Table 9.

TABLE 9

Discrepancy Between WISC-R and K-ABC in Split, Flat-Average and Flat-Above Average Groups (in percentages)

Group (N)	VIQ/PIQ Difference > 13	FSIQ - MPC > 15
Split (16)	69% (11)	56% (9)
Flat-Average (10)	33% (3)	10% (1)
Flat-Above Average (7)	71% (5)	14% (1)

The last characteristic illustrated was that the "split" group displayed relatively weaker spelling (at reading level) and phonetic construction abilities (i.e., the ability to produce good phonetic equivalents of words they did not know) than either of the other two groups. The distinct features of the "split" group (e.g., the significant discrepancy between comprehension and decoding; VIQ and PIQ; FSIQ and MPC; and poorer phonetic construction abilities) suggest that this group may be qualitatively different than the "flat" reading groups.

Standardized Test Properties

The relationship between the K-ABC and the WISC-R was examined in 33 second and fourth grade subjects. As there were no significant differences between the two grades on either measure (see above), the groups were combined for the purpose of the present analysis.

The correlation matrix presented in Table 10 indicates that the WISC-R Verbal and Performance scales do not correlate significantly for this sample ($r = .26$). Similarly, a non-significant relationship was found between K-ABC sequential and simultaneous processing scores ($r = .24$). Intertest correlations, however, indicate that the WISC-R FSIQ and K-ABC MPC share 39.6% of variance ($r = .63$, $p<.0001$). When the relationships between the different scales (i.e., Verbal, Performance, Simultaneous and Sequential) were analyzed, the following pattern emerged. PIQ was very significantly ($p < .0001$) related to both the K-ABC simultaneous scale ($r = .65$) and the MPC ($r = .63$), but not related to the K-ABC sequential scale ($r = .26$). The relationship between PIQ and the K-ABC simultaneous scale accounts for 42% of the variance in these scales. Similarly, PIQ and MPC share 39.6% of common variance. Thus, the K-ABC simultaneous scale and the WISC-R Performance scale appear to assess very similar abilities. In contrast, VIQ was strongly related to K-ABC sequential ($r = .50$, $p < .0005$) and modestly to MPC ($r = .42$, $p < .01$), but not significantly to K-ABC simultaneous ($r = .24$). The WISC-R Verbal scale shares 25% of its variance with the K-ABC sequential scale and only 17.6% with MPC. This suggests that VIQ is not well represented by the K-ABC mental processing scales. In fact, PIQ correlates more highly with simultaneous processing and

equally as strongly with MPC than does FSIQ.

An analysis of the correlations between the K-ABC simultaneous and sequential scores and the WISC-R "simultaneous factor" (i.e., the Similarities, Block Design, Object Assembly, and Picture Completion subtests) and "successive factor" (i.e., Digit Span, Picture Arrangement, and Coding) is somewhat confusing. Both "simultaneous" and "successive" factors of the WISC-R correlated significantly with K-ABC simultaneous scores ($r = .63$, $p < .0001$; and $r = .41$, $p < .02$, respectively). However, only the WISC-R "simultaneous" factor was significantly related to K-ABC sequential processing ($r = .45$, $p < .009$). In addition, a very robust correlation was found between the "simultaneous" factor and the MPC ($r = .70$, $p < .0001$), explaining more of the variance shared by the WISC-R and K-ABC than the summary scores (i.e., FSIQ and MPC) of these measures.

A closer look at the WISC-R subtests which comprise each factor revealed that except for Similarities, all "simultaneous" factor subtests were significantly correlated to K-ABC simultaneous scores at the $p < .05$ level ($r = .38$ to $r = .66$) and none were found to be individually related to K-ABC sequential processing. However, two of the three subtests comprising the "successive" factor (Digit Span and Picture Arrangement) were also related, to the same degree, to the K-ABC simultaneous scale ($r = .50$ and $r = .37$).Of the

"successive" factor, only Digit Span was significantly correlated to the K-ABC sequential scale ($r = .55$, $p < .001$).

TABLE 10

Correlations between WISC-R and K-ABC for Second and Fourth Graders (N=33)

	1	2	3	4	5	6	7	8
1. WISC-R FSIQ	1.00	.85 ****	.72 ****	.85 ****	.56 ***	.63 ***	.52 ***	.48 ***
2. WISC-R VIQ		1.00	.26	.59 ***	.28	.42 **	.24	.50 ***
3. WISC-R PIQ			1.00	.76 ****	.68 ****	.63 ****	.65 ****	.26
4. WISC-R Simultaneous				1.00	.36 *	.70 ****	.63 ****	.45 **
5. WISC-R Successive					1.00	.42 **	.41 **	.22
6. K-ABC MPC						1.00	.88 ****	.67 ****
7. K-ABC Simultaneous							1.00	.24
8. K-ABC Sequential								1.00

*p < .05
**p < .01
***p < .005
****p < .0001

DISCUSSION

The principle findings of this investigation were that: 1) samples of dyslexic children are difficult to recruit; 2) the use of strigent inclusion criteria to define dyslexia did not always overlap with definitions used in educational settings; 3) reading skills (decoding and comprehension) are more strongly interrelated in Grade 2 than in Grade 4; 4) there is a change in the direction of the relationships (from positive to negative) between reading comprehension and Sequential processing and GFEs from Grade 2 to Grade 4; 5) a sizable percentage (53%) of "normal" readers scored significantly higher on comprehension than decoding, and demonstrated relatively weaker phonetic analysis/synthesis skills when compared with their comprehension abilities; and 6) significant discrepancies (i.e., equal to or greater than standard score 15 points) exist between WISC-R FSIQ and K-ABC MPC scores, at least for verbally bright children. These results raise a number of important methodological, theoretical, and clinical issues for research on dyslexia and reading.

Methodological

Sampling Difficulties. Perhaps the most significant issue in terms of planning future investigations is the difficulty in obtaining adequate samples of "pure" dyslexic

readers and CA and RA control groups. As noted earlier (p.46), the response rate for dyslexic subjects was poor. Of the potential 53 reading disabled children pre-identified by the school psychologists, only five agreed to participate and of these, only one met the specified criteria for "pure" dyslexia. Based on this, it is tempting to loosen the definitional criteria outlined for dyslexia in order to obtain research samples (e.g., combining multi-problem children with children who exhibit only a reading disability, including a wider range of deficits, etc.). However, such a solution appears premature as the difficulties encountered in the present investigation may be to the small size of the community where the study was conducted and to the time commitment required of participants. Furthermore, considering the changes which occur in reading skills with increased proficiency (e.g., see Chall, 1983) as well as the documented differences among dyslexic readings (e.g., subtyping studies, drug studies, etc.), this researcher maintains that stringent definitional criteria must be consistently utilized in order to advance the field of dyslexia.

Several alternative sampling strategies could improve the quality of research on dyslexia. Acess to a large metropolitan area would increase the likelihood of obtaining substantial samples and more diverse and representative

groups. Another approach would involve establishing an ongoing research program within the school system. Since all children experiencing educational difficulty are evaluated before receiving specialized remediation, the inclusion of a number of basic psychometric instruments as a routine part of the child's assessment could maximize the chances of obtaining substantial, unbiased samples of children with specific learning problems (e.g., "pure" dyslexia). Such a program would require extensive preplanning and the cooperation of the schools' administrative and teaching staffs as well as the coordinated efforts of the research and school psychologists. This approach would take several years to fully implement. Nevertheless, the potential of such a research program to provide unbiased, homogeneous samples of learning disabled children is thought to compensate for the time and complexity involved in its development.

A third alternative to overcome the sampling problems found in dyslexia research is to design a collaborative study which includes various research sites. The major advantage of this procedure is the inclusion of larger, more culturally diverse and representative samples. This permits greater generalizability of the results. Lastly, the use of qualitative case study and idiographic research techniques may be a viable approach to dyslexia research. This may be particularly informative in light of the strong family

histories of learning problems these children often have, as well as the qualitative differences in their academic performances.

There are no ready solutions which can address both the problems of obtaining a substantial sample and maintaining methodological rigor. The alternatives listed above all have some weaknesses. In general, a great deal of effort will be needed to find a solution that is feasible. Nevertheless, it is believed that a continued failure to do so will obstruct the progress of our understanding of this pervasive problem.

Matching Control Groups. In addition to the sampling problems created by low response rate, psychometric difficulties encountered with the standardization data of the K-TEA precluded adequate categorization of the experimental and control groups. Specifically, the K-TEA was standardized to the normal curve with a M = 100 and SD = 15. Two sets of norms were developed: one for testing which occurs between August and January (Fall norms), and the other for testing between February and July (Spring norms). The present investigation used the latter norms as it was past mid-year when the study began. Thus, one would expect a SS = 100 on either the reading decoding or comprehension subtest to translate to either a grade equivalent (G.E.) of either 4.5 or 2.5. However, the standard tables included in the test manual produced G.E.'s of at least .5 grade higher. In

addition, the Standard Error of Measurement (S.E.M.) for subtests in each grade is ±7 T-score points. Therefore, the actual G.E.'s may vary by almost 2 years. For example, a SS = 107 in the fourth grade on the comprehension subtest converts to a G.E. of 6.1. This estimate is over 1.5 years above actual grade placement despite the fact that the SS is well within 1 SD of the mean. Consequently, using G.E.'s to define "average" reading in fourth and second grade control groups was imprecise.

The use of G.E.'s also created problems for defining the group of dyslexic readers. In the middle of fourth grade the SS which corresponds to a G.E. of 2.5 (i.e., two years below expected placement) is 77 and 79 for decoding and comprehension, respectively. This is approximately -1.5 SD below the mean of the test. When the S.E.M. is taken into consideration, however, the SS range widens from 70 to 84 for decoding and from 72 to 86 for comprehension. At the upper end of this range, the G.E.'s are almost 1.5 years below expected grade placement whereas at the lower end the G.E.'s are over 2.5 years below. Such variation makes it difficult to define homogeneous samples of reading disabled children.

The problem appears to be inherent in the G.E. statistic. As Anastasi (1982) points out, a fourth grade child who achieves a G.E. of 6.9 in a subject area has not mastered the skills taught in the 6th grade nor can he/she be

assumed to have the prerequisites for 7th grade work. Rather, the student "...undoubtedly obtained her score largely by superior performance in fourth grade" work (p. 73). In addition, Anastasi notes that "...individual differences within any one grade are such that the range of achievement test scores will inevitably extend over several grades" (p. 73).

There is considerable evidence to suggest that children who read between -1 SD of the mean and the mean (i.e., scores between 85 and 100) may be qualitatively different readers than children who read both above and below this level. Hence, the use of SD's may be a more relevant statistic for defining the characteristics of experimental groups in reading research. If the K-TEA decoding and comprehension subtests are to be used as markers, it is suggested that scores which fall within a range of $-2\ SD \leq X < -1\ SD$ be used to identify reading disabled samples. This range of scores converts to SS's between 70 and 84, and G.E.'s approximately between 2.5 and 1.5 years below expectancy. Children scoring between -1 SD and the mean should be considered separately as they may provide an interesting comparison group. Similarly, children scoring below -2 SD should also be a distinct group. Using these criteria, researchers could restrict their samples to a fairly small range of reading disabled children while recognizing both the weakness of G.E.'s and the

imprecision of their assessment instrument.

A potential problem with using SD's to define research groups concerns the delineation of CA and RA control groups. It was suggested in the present study that these groups be comprised of children who displayed reading skills at grade level (i.e., G.E. equal to grade placement). This definition does not translate into SD units and makes comparability across groups difficult. For example, does a fourth grade reading disabled child who achieves a SS = 70 (G.E. 1.9) in comprehension have the same skills as a second grade child who achieves a SS = 100 (G.E. 2.9)? At present, one needs to assume that a child who obtains a SS between the mean and +1 SD (i.e., $100 \leq X < 115$) is an "average" reader and a reasonable experimental control subject. (See p.90 for a discussion of the problems with the concept of "average" reader.) It seems important that future research test this assumption directly before it is hypothesized that the differences found between reading disabled and reading control groups reflect an actual divergence in underlying abilities.

To summarize, it was found that G.E.'s were not always consistent with the obtained SS's. This makes sense in light of both the weaknesses of G.E.'s and the nature of the achievement measure (i.e., S.E.M.). The use of SD units to define experimental groups appears to have the potential for

generating greater reliability and more representative samples.

Boder Test of Reading-Spelling Patterns (BTRSP). The BTRSP is an instrument designed to delineate reading subtypes (e.g., dysphonetic, dyseidetic, alexic, nonspecific reading disabled, and normal). Although it has been used extensively in previous research and the test manual and technical material appear sound, the instrument proved to be inaccurate and cumbersome. Specific problems encountered included: difficulty in distinguishing between "flash" and "untimed" word recognition (whether a word was recognized within one second or between two and ten seconds); unreliable, non-discriminatory subtype classifications; imprecise guidelines for scoring good phonetic equivalents (GFE's); and a lack of appreciation for differences in the development of phonetic decoding and spelling abilities. These problems resulted in inconsistent data which have questionable validity. For example, when a relative comparison of a child's decoding and spelling abilities was made, many "normal" readers were misclassified because they met 2 out of the 3 criteria for a dysphonetic reading pattern. This was due to the divergence of phoneme-grapheme (i.e., spelling) and grapheme-phoneme (i.e., decoding) abilities. Current reading theories, however, (Bookman, 1984; Chall, 1983; Gentry, 1984; Taylor & Taylor, 1983) predict this divergence in high achieving

children. The theories hypothesize that children are able to phonetically analyze (i.e., decode) words before they can phonetically construct (i.e., spell) them. The findings from the present study are consistent with this hypothesis as well. Thus, it appears as though the BTRSP does not take into account the different developmental patterns of decoding and spelling skills that have been identified.

Based on the present investigation, several suggestions for the improvement of the BTRSP are warranted. First, an automated presentation of reading lists with some type of electronic timing device would be helpful in eliminating the unreliability of manual administration. Second, more research should be devoted to establishing subtype criteria. While Boder and Jarrico's clinical data are impressive, the failure of the instrument to correctly classify almost 1/4 of normal readers, and its inability to subclassify any of the reading disabled children, indicate that a revision in criteria may be in order. Ideally, this revision would attempt to correlate independent characteristics not assessed with the BTRSP with the criteria to be utilized. Third, some provision needs to be made for children who are reading above grade level. Understandably, this was not a factor Boder and Jarrico took into consideration when developing their measure. However, if the BTRSP is going to have research utility it must be able to identify control groups as normal

readers, as well as dyslexic groups as dysphonetic, dyseidetic or alexic. Lastly, more stringent rules need to be set for the scoring of GFE's. Since this is the one parameter which separates dysphonetic and dyseidetic readers, accuracy in scoring is essential. In summary, the BTRSP appears to need revision before it can be considered a reliable assessment tool and used in research on subtyping dyslexic subjects.

An alternative method to identify reading subtypes uses multivariate statistical procedures (e.g., Q-type factor analysis and cluster analysis) on theoretically selected measures (Adams, 1985; Fisk & Rourke, 1979; Fletcher & Satz, 1985; Rourke, 1978, 1982; Satz & Morris, 1981). According to Adams (1985) and Fletcher and Satz (1985), this alternative has the advantage of eliminating human judgment when establishing typologies. They maintain that statistical methods provide an unbiased, systematic means of identifying unique groups of learning disabled children. However, Hooper and Boyd (1986) question whether statistically determined groupings are clinically meaningful (i.e., demonstrate unique sets of problems in the classroom). These authors also note that despite the use of multivariate statistical procedures, methodological decisions can still flaw group comparisons.

Another possible approach to identifying subtypes of dyslexic readers is on the basis of remediation strategies

(Gunnison et al., 1982; Hynd, 1986). These investigators note that many remediation strategies may be categorized (e.g., phonetic vs. whole word approach). Children are instructed based on the concept of 'teaching to the strength' or 'remediating the weakness.' It is likely, however, that children's strengths and weaknesses are determined by using different assessment tools and varying levels of inference. In addition, further screening to rule out concomitant problems (e.g., ADDH, borderline intelligence, etc.) and to assess the quantitative level of disability would still be necessary. Thus, it appears that the composition of naturally occurring remediation-based subtypes may result in heterogeneous samples of children.

Identification of dyslexic subtypes is a necessary prerequisite for conducting meaningful research on the disorder. Since a reliable and valid measure to subtype readers does not exist, statistical and more clinically based methods may prove more useful.

Theoretical On the basis of the literature reviewed, it appears that most research on dyslexia has failed to integrate the available knowledge that relates to the cognitive processes involved in reading. As a result, many of the studies on dyslexia have two serious flaws which limit their interpretation. Briefly, these shortcomings relate to the failure of the research to recognize that: 1) reading

acquisition is a developmental process such that poor readers need to be compared with both CA and RA control groups; and 2) reading ability consists of a number of complex skills which may not be accurately measured by only one facet of reading activity (e.g., decoding).

Differences in Reading between Grades 2 and 4. The findings in the present investigation lend further support to the importance of integrating knowledge from current reading theory and studies examining dyslexia. Specifically, the findings suggested the presence of differences between second and fourth grade readers as well as two distinct reading "profiles." The data imply, for example, that reading decoding and reading comprehension skills are more interrelated in grade 2 than in grade 4. Although the data is correlational, it suggests that reading comprehension for second graders depends, to a large extent, on decoding abilities. This is further substantiated by the overall pattern of positive relationships between comprehension and VIQ, Boder RQ and Sequential processing. This hypothesis is congruent with several current reading theories (e.g., Chall, 1983; Samuels & Eisenberg, 1981; Taylor & Taylor, 1983) and is further supported by the overall pattern of positive relationships between comprehension and VIQ, Boder RQ and Sequential processing.

It is well documented that beginning readers focus

primarily on information pertaining to individual words (letter shape, phonetic sounds, etc.). This has been termed a "bottom-up" (Chall, 1983), "data-driven" (Samuels & Eisenberg, 1981), or "context-dependent" (Taylor & Taylor, 1983) approach to reading. Chall (1983) noted that to make progress in reading at this stage, the child must first concentrate on what the word looks and sounds like before attaching meaning to it. Similarly, Taylor and Taylor (1983) point out that beginning readers can only understand what they decode because many of the features of holistic word recognition used to aid reading fluency (e.g., familiarity, word contour, and contextual clues) have yet to be developed.

As more exposure to and competency with written text is achieved, "decoding skills" and "meaning skills" diverge (Chall, 1983; Samuels & Eisenberg, 1981; Taylor & Taylor, 1983). Adults may resort to pure "data-driven" reading when faced with an unfamiliar word; however, as reading proficiency increases, there is less dependence on the individual features of words and more reliance on global word features and context (Chall, 1983; Samuels & Eisenber, 1981; Taylor & Taylor, 1983). Thus, the relative dissociation between decoding and comprehension found in the fourth graders of the present investigation may be related to the well-documented "shift" which occurs with the development of reading skills. The negative relationships between reading

comprehension and sequential processing and GFEs which emerged in Grade 4 is also understandable within this framework. Most importantly, however, is the distinct differences in the relationship between these variables in Grade 2 and Grade 4. As mentioned, these variables are positively related in second grade and may play a significant role in the acquisition of beginning reading skills. In contrast, in fourth graders the relationships are negative. These data suggest that attention to phonetics and a sequential processing approach may hamper reading comprehension in that grade. Such information would be masked if subjects were collapsed over age or reading abilities. This finding further supports the need for Reading age control groups in dyslexia research as well as for experimental groups comprised of children narrowly defined reading abilities.

Another difference between Grade 2 and Grade 4 that emerged is the stronger positive relationship between VIQ and FSIQ and decoding in grade 2 than in grade 4. A possible explanation for this difference is that decoding may be the primary reading skill of second graders, while comprehension skills have relatively more importance in fourth graders. If this explanation is plausible, however, one might expect to see a complementary increase in the relationship between comprehension and VIQ and FSIQ in fourth grade (i.e., a

stronger positive relationship between these variables in fourth grade as compared to second grade). An examination of the data provides only partial support. There is a tendency for FSIQ, although not VIQ, to be more positively related to comprehension in fourth grade. In addition, there also appears to be a stronger positive relationship between PIQ and comprehension in fourth grade, although PIQ was not significantly correlated with reading skills in either grade. As FSIQ is a composite score, the increase in its relationship with reading comprehension in fourth grade may reflect the increase in the correlation between PIQ and comprehension.

The pattern of relationships found between Verbal, Performance, and Full Scale IQ measures is again consistent with the literature on reading development. Reading theorists (e.g., Chall, 1985; Ferry, 1985; Samuels & Eisenberg, 1981; Taylor & Taylor, 1983) describe a "shift" from purely data-driven reading to a more integrative style which relies heavily on context to derive meaning. Ferry (1985) and Taylor and Taylor (1983) specifically note that as familiarity with written text is developed, less and less information about individual words is processed. Word choice is based to a greater extent on holistic recognition, using the outer contours of the word and the context in which it is found to aid selection.

In a recent study, Solan (1987) found that the role of simultaneous and successive processing in reading varies at different developmental levels. His findings suggest that successive processing may be more important for the mastery of early decoding tasks, while simultaneous processing is more important for comprehension skills. The results of the present investigation provide partial support for this hypothesis. As stated above, sequential processing and comprehension are positively correlated in Grade 2 but negatively correlated in Grade 4. However, similar correlational changes did not occur for simultaneous processing. Holistic or simultaneous information processing is highly correlated with PIQ (Kaufman & Kaufman, 1983). Thus, it is understandable that PIQ and comprehension are more related in fourth grade than in second. One could expect that the positive relationship between these variables might continue to increase through the grades. Future research could test directly for developmental trends in the relationships between Sequential/Simultaneous processing, VIQ, PIQ, and FSIQ, and reading decoding and comprehension.

In the present investigation, simultaneous processing, as measured by the K-ABC, was not significantly related to comprehension in either second or fourth grade nor did an increase in the relationship between these variables emerge in Grade 4. This is puzzling in light of the strong

relationship between PIQ and K-ABC simultaneous processing (r = .65) in the present study and the results of past research in which a positive relationship between simultaneous processing and reading comprehension was found (Cummins & Das, 1977; Solan, 1987). One possible explanation is that fourth grade is seen as a transitional period for reading (Chall, 1983), a time when children "shift" from word analysis to meaning analysis. Hence, this transition may need to be more complete before a positive relationship between simultaneous processing and reading comprehension can be demonstrated. Indeed, the subjects in Cummins & Das' and Solan's studies were fifth and sixth graders. Lastly, it is possible that the lack of correlation between simultaneous processing and reading comprehension is a reflection of the instruments used to assess these abilities. Although the K-ABC is purported to measure processing styles, it is a quantitative instrument. Scores are based on the product produced by the child rather than the method he/she used to derive an answer. Thus, it is unknown how a child arrived at his/her solution. It could be that if a more process-oriented approach was employed (e.g., in the tradition of Piagetian tasks) the expected relationship would have emerged. This is an important issue to be considered in future research.

To summarize, the present investigation supports the

developmental nature of the reading process. Reading skills in second grade were more interrelated than they were in fourth grade. In addition, associated skills such as Sequential processing and GFEs exhibited a change in the direction of their relationships with reading comprehension in Grades 2 and 4. This suggests that there are not only quantitative but also qualitative differences between reading skills across ages (grades) and emphasizes the importance of narrowly defined groups of experimental and control subjects. Current theories of reading development also support this hypothesis.

More research is needed to determine the nature of the changing relationships between reading (both decoding and comprehension) and both simultaneous and successive processing, and VIQ, PIQ and FSIQ. Longitudinal studies which would systematically assess the developmental changes in reading skills for a group of children over a period of years and concurrently evaluate processing abilities, would be particularly useful. Research which tests for developmental trends in these variables would also be valuable.

The implications for research on dyslexia are clear. Past studies have primarily used CA controls groups for comparative purposes. However, because these groups are comprised of children with age-appropriate reading skills

which may be qualitatively different than the skills of children in reading disabled groups, they limit the degree to which interpretations can be made. As Backman, Mamen and Ferguson (1984) note, the differences found between a reading disabled and CA control group might be explained solely by the lower reading achievement in the disabled group. To improve the meaningfulness of the results, future research on dyslexia should utilize both CA and RA control groups. Including groups matched on reading level increases the power of the study by allowing the researcher to test hypotheses that dyslexic children perform at a lower level than or in a manner different from that predicted by their level of reading achievement (Backman, et al., 1984). Furthermore, qualitative comparisons could yield important information about the similarities and differences in the development of reading skills between the groups.

Variability in Reading Skills. Backman et al. (1984) point out that an unresolved problem in reading studies is the inconsistency in how groups are matched on reading abilities. They go on to state that "...reading is not a unitary phenomenon that can be assessed unambiguously [and that]...matching even normal children on a single aspect of reading does not ensure that they will be equivalent in all other areas" (p. 564). This concept appears to be particularly relevant to the results of the present

investigation which seemed to reveal three distinct reading groups in both grades. Each group was characterized by unique comprehension/decoding patterns: a) both scores between SS 100 and 114 and less than 11 points apart ("flat average readers"); b) both scores above 114 and less than 11 points apart ("flat above average readers"); and c) both scores above 100 but more than 11 points apart ("split readers"). Upon further descriptive evaluation of spelling, IQ, and mental processing scores, several hypothese about these reading groups can be proposed.

The "flat average" and "flat above average" groups exhibited remarkably similar reading and spelling patterns. Both groups tended to make phonetic mispronunciations of phonetically irregular words (e.g., roof for rough). Very few gestalt substitutions (i.e., replacing an unknown word with a known word which has a similar contour) were noted. Furthermore, both groups were able to either spell correctly or produce good phonetic equivalents (GFEs) of over 50% of the words they read. Thus, the "flat average" and "flat above average" groups appear differ quantitatively but not qualitatively. The probable explanation for this qualitative difference is the significant discrepancy between the groups on FSIQ. The "flat above average" group obtained a FSIQ 1 SD higher than the "flat average" group. It is likely, therefore, that differences found between these two reading

groups reflect their divergent intellectual abilities.

In contrast to the "flat" groups, the "split" group showed a significant discrepancy between comprehension and decoding abilities. All children in this group showed higher comprehension than decoding abilities. A descriptive analysis of the "split" pattern revealed that the children appeared to have difficulty sounding out unknown words. As a group, they tended to make more gestalt substitutions (e.g. charter for character) and bizarre guesses (e.g., writer for artist). These children also demonstrated weaker phonetic synthesis skills on a spelling task. They were frequently unable to spell or render GFEs of words they had read. In fact, 14 of 16 children met two out of the three criteria for the dysphonetic subtype on the BTRSP. Their ability to read words above grade level, however, distinguished them from Boder's dysphonetic dyslexic reader. Hence, "split" readers appear to lack phonetic abilities comparable to their comprehension abilities.

Some investigators (Smith, 1985; Taylor & Taylor, 1983) might argue that the inconsistency in reading skills found in "split" readers is a reflection of an instructional emphasis on reading for meaning. Two aspects of the present investigation would argue against that explanation. First, all three reading groups were self-selected from the same schools and classrooms. Thus, if the "split" reading pattern

was related to instructional practices one could expect this pattern to emerge in all the children sampled. Secondly, reading instruction differs significantly in grades 2 and 4. Nevertheless, the "split" pattern is present in both grades. Thus, it is argued that a "split" reading pattern does not result from an instructional bias towards comprehension.

Another unique feature of the "split" reading group may help explain the differences between this group and the "flat" reading groups. Although none of the three groups differed on their mean MPC, in the majority of "split" readers, there was a significant discrepancy (at least 15 points) between MPC and FSIQ, favoring the latter. Based on this finding, one can hypothesize that children with "split" reading profiles may have weaker information processing abilities. The fact that the "split" and "flat above average" groups had comparable FSIQ scores and that the latter group did NOT show such a pronounced discrepancy between intelligence and processing abilities, lends some support to this hypothesis. Nevertheless, more research is needed before a more definitive statement can be made.

The emergence of two distinct reading profiles (i.e., "flat" and "split") raises an important theoretical and methodological question: Is it possible to measure reading ability through the administration of a broad reading achievement test (e.g., K-TEA, PIAT, etc.)? Backman, et al.

(1984) recently stated that to fully assess reading ability a complex reading battery would be required which encompassed both the lower and higher order skills (e.g., letter-sound recognition, gestalt comprehension, etc.). However, it is still questionable whether a composite score is useful for deriving matched samples. It appears that by quantifying reading skills, important and distinctive qualitative information is concealed. More descriptive case studies with carefully matched control subjects would be informative in this regard.

A second and related question pertains to how "average reader" is defined. In the present investigation, the group of "flat average" readers seem to fit the concept most closely since they have standard reading and intelligence scores within ± 1 SD of test means. However, if IQ was controlled for, the "flat above average" group could be considered average readers as well (i.e., average for their level of intelligence). Similarly, if only a measure of decoding was used to assess reading skill, the "split" group would also appear average. Thus the results raise the question as to the meaningfulness of the concept of "average reader" and speak to the need for a clear delineation of the term (i.e., SS range and abilities assessed).

The implications of the different reading patterns found in the present investigation for research on dyslexia are

profound. As previously noted, both CA and RA control groups are needed to further the interpretation of experimental findings. However, it is clear that there may be significant variability ("split" vs. "flat") within normal readers as well. This, in turn, emphasizes the need to adequately assess a range of reading skills. A failure to do so could result in unknown differences within experimental and control groups. Thus, it appears that not only are CA and RA controls needed in dyslexia research, but that careful attention should be paid to how reading skills are assessed and to the different types of readers in so-called "normal" samples.

Clinical

The Intelligence Test Controversy. The question of how intelligence should be measured has generated a plethora of research and stimulated clinical debate. For approximately 30 years, however, the psychometrically sound WISC-R has been accepted as the standard for use with children (Anastasi, 1984; Mann, 1984). With the publication of the K-ABC in 1983, the question as to how intelligence should be measured was reopened. The reader is referred to the Journal of Special Education (Vol. 18, No.31, 1984) for a comprehensive treatment of the current issues.

In the present investigation, the K-ABC was chosen as a measure of simultaneous and successive (sequential)

processing, but was not used as a measure of intelligence. Because of this, data on both the WISC-R and K-ABC as well as on measures of reading achievement were concurrently gathered. Hence, the findings relating these two measures may be applicable to the ongoing debate on the usefulness of the K-ABC as a measure of intelligence.

An examination of the correlations between the summary scores of the WISC-R (i.e., VIQ, PIQ, & FSIQ) and the K-ABC (i.e., simultaneous and sequential processing scores and MPC) raise some interesting points. The overall measures of "intelligence" on the WISC-R and K-ABC are FSIQ and MPC, respectively. However, these two scores share only 39.6% common variance. Furthermore, the correlations amongst the other scores, particularly VIQ and the K-ABC scales, suggests less common variance. The exceptions to this are the relationships between PIQ and the simultaneous scale and the MPC. These measures share approximately the same amount of common variance (between 40% and 42%). This data is somewhat consistent with the statistics reported by Kaufman and Kaufman (1983). However, there is a trend in the present study for weaker relationships between the K-ABC and WISC-R, particularly between VIQ and both MPC and simultaneous processing. Other investigators have found a similar dissociation in verbally bright children (McCallum, Karnes & Edwards, 1984; Naglieri & Anderson, 1985). This research

will be discussed below.

An analysis of WISC-R and K-ABC scores and the scatter plot of MPC and FSIQ revealed more discrepancy between the measures than was suggested from correlational data. Based on the time interval between the tests' standardizations, one would expect FSIQ to be approximately 3 standard score points higher than MPC (Kaufman & Kaufman, 1983; Kamphaus & Reynolds, 1987). However, even when this adjustment was made, a significant discrepancy remained between the K-ABC MPC and WISC-R FSIQ. There are several possible explanations for this phenomenon. The first is regression to the mean. As the mean FSIQ of the sample was 121, one would expect subjects to score closer to a standardized test mean when tested on additional measures.

Alternately, the discrepancy between FSIQ and MPC could be the result of experimental bias. As was previously mentioned, the present investigation did not set out to evaluate the relationship between the WISC-R and K-ABC. Thus, the methodology did not take into consideration counterbalancing the administration of the instruments. The WISC-R was given first to all the subjects and followed, after a short rest period, by the K-ABC. As a result, one possible explanation for lower MPC scores could be fatigue.

The last viable explanation of the discrepancy between FSIQ and MPC could be related to the characteristics of the

sample. Since children were self-selected for a reading study, it is not surprising that many had superior VIQs, indicative of highly developed verbal reasoning and expressive abilities. In general, it was these children (i.e., those with superior VIQs) who demonstrated the largest discrepancies between FSIQ and MPC. Because the K-ABC was designed to minimize the need for verbal input (Kaufman & Kaufman, 1983), it may not tap the strength of children who have relatively strong verbal problem solving abilities.

Although experimental bias cannot be overlooked as a possible contributor to the discrepancy found between MPC and FSIQ, evidence from other investigations appear to support the latter explanation. McCallum, Karnes, and Edwards (1984) found that the K-ABC yielded lower scores than either the Stanford-Binet or the WISC-R for a group of gifted children. These investigators concluded that the K-ABC mental processing scales may be limited in their capacity to assess highly developed verbal skills.

Naglieri and Anderson (1985) also reported that the K-ABC underestimates the intellectual functioning of gifted children. These researchers used an older sample (5th and 6th graders) and concluded that, "...the reason for the lower K-ABC scores appears to be the result of a limited K-ABC ceiling at the upper ages for high functioning children" (Naglieri & Anderson, 1985, p. 179). Naglieri and Anderson

also noted the failure of the K-ABC to significantly relate to VIQ and commented on the weakness of the K-ABC to adequately assess verbal abilities. In the present investigation, subjects were younger children who did not ceiling out on K-ABC subtests. This suggests that the primary explanation (i.e., limited ceiling of the K-ABC) proposed by Naglieri and Anderson to account for the discrepancy between FSIQ and MPC may not be sufficient. More likely, the hypothesis that the K-ABC is insensitive to the above average verbal abilities of these children has more explanatory power.

Kaufman and McLean (1987) and Kamphaus and Reynolds (1987) recently proposed that a comparison of the WISC-R and the K-ABC needs to take into account the factor analytic solution of the two instruments. These authors note a three factor solution: Verbal Comprehension/Achievement; Perceptual Organization/Simultaneous Processing; and Freedom from Distractibility/Sequential Processing. The data presented by these investigators, however, suggest that the factors may not be independent. A small although significant correlation was found to exist between the Verbal Comprehension /Achievement factor and the other two, indicating that there are some shared abilities (Kaufman & McLean, 1987; Kamphaus & Reynolds, 1987). As Kamphaus and Reynolds (1987) point out, this should be expected as the K-

ABC Achievement scale was intended to reflect scholastic achievement which requires sequential and simultaneous processing. It appears that the three factor solution separates verbal from nonverbal abilities, and further specifies an attentional factor. This pattern, however, is in contrast to the theoretical position taken by Luria (1966) and others (e.g., Das, Kirby, & Jarman, 1975; 1979). These researchers argue that simultaneous and successive (sequential) processing are operative in both verbal and nonverbal problem solving tasks.

A three factor solution (i.e., verbal, nonverbal and attentional) does not seem productive or consistent with the original purposes of the K-ABC. If one accepts the theoretical underpinnings of the K-ABC as proposed by Kaufman and Kaufman (1983), then simultaneous and sequential (successive) processing are basic mental functions. This is consistent with current thinking in the cognitive information processing literature (Das, 1984 a & b; Goetz & Hall, 1984; Sternberg, 1984, 1980). For example, Das (1984a&b) proposes that simultaneous and successive processing abilities coupled with planning and strategy formation skills form the fundamental basis for human intelligence. Other theorists support similar hypotheses (Goetz & Hall, 1984; Sternberg, 1984, 1980). The K-ABC encounters difficulties when it is given the status of an "intelligence test" in the more

traditional sense (i.e., Verbal). Although there is some debate as to its success (Das, 1984; Goetz & Hall, 1984; Sattler, 1988; Sternberg, 1984), the K-ABC mental processing scales purport to measure more "basic" abilities; i.e., the scales attempt to define intelligence by measuring the cognitive processes which underlie performance.

In summary, the K-ABC appears to underestimate the level of intellectual functioning in children who have exceptional verbal skills. In contrast, the results of this study indicate a strong correspondence between PIQ and the K-ABC, particularly the simultaneous processing scale. McCallum et al. (1984) found similar results. However, in both studies these measures demonstrated only a small relationship to achievement scores. Thus, the question remains: How appropriate is the K-ABC as a measure of intelligence? It is beyond the scope of this paper to fully debate this issue. As noted above, the answer to this question is heavily dependent upon how one chooses to define the construct of intelligence. Nevertheless, based on the results of this study, it appears that the K-ABC may not be an appropriate measure of intelligence for verbally superior children. Unlike the K-ABC, the WISC-R has the latitude to assess both verbal and non-verbal abilities. Although the WISC-R may be biased towards verbally based skills, these are the skills which correspond most highly with achievement. If the

purpose of intellectual testing is to predict scholastic achievement, then it appears as though the WISC-R is the more appropriate instrument when assessing highly verbal children. Kaufman and McLean (1987), McCallum et al. (1984), and Naglieri and Anderson (1985) all draw similar conclusions. In contrast, the K-ABC may be the instrument of choice when assessing reading disabled, language disordered or culturally different (e.g., Native Americans, Mexicans, etc.) children.

At present, more research is needed to understand the nature of the relationship between traditional, verbally based measures of intelligence (e.g., WISC-R) and the processing oriented scales of the K-ABC. Further delineation of the uses of the K-ABC (e.g., in what populations and for what purposes) is important. As simultaneous and successive (sequential) processing are theoretically purported to underlie both verbal and nonverbal tasks, future research may benefit from the use of statistical regression and causal modelling to test the components more directly.

General Conclusions

In conclusion, several points deserve reiteration. The first concerns a cautionary statement about the generalizability of the results. It is important to note that the characteristics of the sample were, in some ways, unique. The subjects were all drawn from a small University town in Northwestern Ohio. Recruitment was based on

voluntary self-selection in response to a letter describing a reading study. Thus, it is likely that the sample was biased towards children from professional families who have a strong investment in education. Indeed, the sample exhibited above average intelligence and achievement. With this in mind, it is likely that the generalizability of the results to lower functioning and/or urban children or to children from white and blue collar families may be limited. Furthermore, results are based on small samples (i.e., 15 to 33). Thus the susceptibility to chance findings must be kept in mind when interpreting the results.

Despite the limitations outlined above, the implications of the current findings for dyslexia research, need to be reemphasized. Clinical research which attempts to study naturally occurring phenomena like dyslexia, involves a complex set of problems. Methodologies which appear feasible on paper prove difficult, if not impossible, to carry-out. This was clearly illustrated by the obstacles encountered while executing the original proposal. Nevertheless, forthcoming research on dyslexia may produce more meaningful findings if a number of basic guidelines are followed. On the basis of the literature on reading development and dyslexia, and the results of the present investigation, the following guidelines are suggested:

1) separation of "pure" and "compound" dyslexic

groups;

2) further break-down of "pure" and compound" groups, by statistical techniques or clinical information (e.g., remediational strategies), into homogeneous subtypes;
3) the use of at least two different measures of reading ability (e.g., decoding and comprehension) to determine reading level, with careful attention paid to the variability which occurs in "normal" readers (i.e., "split" vs. "flat" profiles);
4) quantifying the level of reading disability in dyslexia as between -2 SD and -1 SD below the mean of a standardized instrument of reading achievement for both areas assessed;
5) use of at least two comparison groups - one matched on IQ and CA and one matched on IQ and RA. Further comparison groups which might prove informative include: matched CA groups with higher IQs; matched CA groups with reading disabilities between -1 SD and the mean; matched CA and RA groups with different reading patterns (i.e., "split" vs. "flat" readers); etc.;
6) defining "average" reading ability for CA and RA comparison groups as between the mean and +1 SD

on both measures of reading achievement. Although these guidelines are rudimentary and somewhat imprecise, they do reflect our current understanding of dyslexia and reading, and the state of our assessment instruments. Careful adherence to these guidelines will help advance our knowledge and, in turn, provide the necessary information for revising and perfecting the guidelines.

Lastly, the different types of reading patterns uncovered in this investigation possess both theoretical and practical interest. From a theoretical standpoint, the "split" reader in many ways parallels the dysphonetic dyslexic reader (e.g., relatively poor phonetic analysis/synthesis skills) and it may only be the former readers superior verbal intelligence which allows them to obtain average reading scores and differentiates them from dyslexic readers. Future research comparing these two groups could address this directly, produce insight into the nature of their problems, and suggest potentially useful remediation strategies. Practically, the appearance of different reading profiles in so-called "normal" readers raises the issue of teaching approaches with these children; that it, is it necessary to provide a "split" reader with remedial phonics? In general, the appearance of the "split" readers is an empirical reminder as to the complexity of the reading process and further emphasizes the need to carefully assess

more than one reading ability both for research and educational purposes.

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APPENDIX A

Scoring criteria for BTRSP

Reader subtype	known words % spelled correct	unknown words % of good phonetic equivalents	Reading Quotient
Normal	> 50	> 50	≥ 100
Dysphonetic	≤ 50	≤ 50	≥ 67
Dyseidetic	≤ 50	≥ 50	≤ 80

Taken from: Boder & Jarrico (1982). The Boder Test of Reading-Spelling Patterns Manual, New York: Grune & Stratton, p. 38.

APPENDIX B

Recruitment. All subjects were recruited from Elementary schools in Northwestern Ohio. Letters introducing and explaining the study as well as a consent form to be signed and returned were sent home to the parents of both randomly selected second and fourth graders and to pre-identified Learning Disabled (LD) fourth graders. This pre-identification of LD students was based on the school psychologists' recommendations. After parental consent had been obtained, the students' primary teacher completed a SNAP on each potential subject. Only students who obtain a SNAP score within normal limits were eligible for further screening.

Screening for controls. Both second and fourth graders who obtain non-significant scores on the SNAP were seen for a two-hour screening session. During this time, each potential subject was individually administered, in order, the two K-TEA reading subtests and the BTRSP. A ten minute rest period separated the administration of the tests. Prior to testing, some time was spent with the children building rapport, explaining the procedures, and obtaining informed consent. Children who scored at or above grade level on both K-TEA subtests were considered potential subjects. Screening was discontinued as soon as the child failed to meet one of

the criteria outlined above. Regardless of their performance, children were given a set of stickers to acknowledge their participation.

APPENDIX C

Dear Parents,

My name is Arlene Staubsinger and I am a graduate student at Bowling Green State University. I am writing to you to ask for your help with a project on reading that involves second and fourth graders. I will be looking at comprehension and word recognition in children with average and below average reading skills. Your child has been selected because of his/her average to above average reading ability. I hope you will allow your child to take part in this project.

Let me explain further what the project will involve for your child. The first time I meet with your child, i will ask him/her to do many different tasks. Some of the tasks will involve reading paragraphs and answering questions, others putting together puzzles, and others remembering sequences of words, numbers or pictures. Children generally find these tasks fun and challenging. Throughout the time we spend together, rest breaks will be included during which the child can go to the bathroom, stretch, relax, etc. A small snack will be available at these times. I estimate that the first part of this project will last between one and one and a half hours. At the end of this meeting, some children will be asked to return, at a later date, for a second meeting. Those children who will not participate further will receive a small gift (stickers and an "honor" certificate) for their time and help.

The second meeting will be very similar to the first. Again, the child will be asked to do several different tasks. Rest breaks will be taken at various times throughout our time together. This meeting should be about the same length or somewhat shorter than our first. At the end of this meeting, your child will receive a $5 gift certificate to a bookstore and an honor diploma for participation in the project.

I anticipate working with the children in the Psychology Building on the Bowling Green campus. Meeting times are flexible and I will work with children after school and/or on weekends and school holidays. Of course, parents' time preferences will be honored. Travel arrangements, including reimbursement can be made.

Participation in the project is completely voluntary. None of the tasks involve physical exertion or present any

risk to your child. You or your child may withdraw at any time. All results will be coded and separated from name rosters to insure confidentiality. The school will not have access to any individual child's results. Because of the nature of the project, however, I will need your permission to have his/her teacher complete a very brief rating scale of behavior. This information will be coded as well and used solely for research purposes.

The attached consent form outlines the rights of the children who participate. If you are willing to have your child participate, please complete and sign the form and return it to me in the stamped, self-addressed envelope I have enclosed. At the beginning of the first session, the project will be carefully explained to your child and he/she will be asked to sign a comparable consent form. He/she has the right to decline to participate at that time.

Many parents find that they have additional questions about the project that they would like to discuss before agreeing to their child's participation. If you feel this way, I encourage you to call me at 372-2301 and leave your name and telephone number so that I may contact you and answer any questions you may still have about my project. To protect your confidentiality, I am unable to call you first.

I really appreciate the attention and consideration you have given my request. I consider the time and efforts your child will be devoting to the project a valuable contribution. I am happy to be able to give him/her a small gift to express my gratitude.

Again, if you have any questions about the project or would like to discuss it with me in further detail, please do not hesitate to call me at the above telephone number. I look forward to hearing from you soon.

Sincerely yours,

Arlene B. Staubsinger, M.A.

CONSENT FORM

I have read the attached letter in which the nature of the project is explained. I understand that all information is confidential and that any questions about the project will be answered by Ms. Staubsinger. I understand that either I or my child is free to withdraw consent and to discontinue participation in the project at any time.

I ---Will ---Will not allow my son/daughter to participate in the project with Arlene Staubsinger.

Parent's signature

Child's name

Date

Grade

Phone number

TO BE FILLED OUT AT THE TIME OF THE FIRST SESSION

I have been told about what I will have to do during these meetings. I know that I can stope if I want to and that my answers will be kept secret. I want to take part.

Child's signature

Date

Researcher's signature