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DYSNOMIA AND ITS RELATIONSHIP TO SUBTYPES OF READING DISABILITIES

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DYSNOMIA AND ITS RELATIONSHIP TO

SUBTYPES OF READING

DISABILITIES

by

Rebecca Hobgood Felton

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APPROVAL PAGE

This dissertation has been approved by the following committee of the faculty of the Graduate School at the University of North Carolina at Greensboro.

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ABSTRACT

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The purpose of this study was to investigate the relationship between dysnomia and subtypes of reading disabilities. Specifically, three research questions were addressed:

1. Does dysnomia, as indicated by performance on a battery of naming tests, differentiate between subtypes of reading disabilities?

2. How does word-retrieval performance of reading-disabled subjects compare to other groups (both disabled and average readers)?

3. If impaired, is this performance indicative of a developmental lag or a deficit?

The subjects were 41 students, ages 8 to 12, who were identified by their respective school systems as learning disabled and who had a deficit of at least 1.5 years in reading skills. Thirty-eight of the subjects were males and three were females. All of the subjects earned IQ scores of at least 85 on either the Performance or Verbal scales of the Wechsler Intelligence Scale for Children-Revised.

The subjects were categorized as to specific type of reading disability using the Boder Test of Reading-Spelling Patterns. In addition, a battery of naming tests were administered. These included the Boston Naming Test, the Rapid Automatized Naming Test, the Peabody Picture Vocabulary Test-Revised, and tests of verbal fluency.

Results of this study failed to confirm the existence of a differential relationship between dysnomia and some subtypes of reading disabilities but not others. Subjects in each subtype demonstrated significant word-retrieval problems in comparison both to established

norms as well as to other reading-disabled and average readers. In addition, the results indicated that the difficulties in word-retrieval demonstrated by reading-disabled children reflected a deficit rather than a maturational lag.

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CHAPTER I

INTRODUCTION

In 1896, the British Medical Journal published "A Case of Congenital Word-Blindness", in which W. P. Morgan described a 14 year-old boy, of above average abilities on nonreading tasks, who had a severe reading disability which had been basically impervious to remedial attempts. Morgan concluded that this boy's inability to read was congenital and due to defective development of the left angular gyrus. Since that time, numerous attempts have been made to define, describe, and determine the etiology of severe reading disability in persons with adequate intelligence, motivation, and educational and sociocultural opportunity. To date, researchers have agreed upon the labels appropriate for such reading problems but little else. "Developmental dyslexia" and "specific reading disability" are the currently accepted terms for use in referring to

> inexplicable failure to learn to read by a child whose intelligence level, oral language development, and sensory capacities appear to be fully adequate to permit the development of reading skills; who has the benefit of conventional instruction in reading; and who at the beginning of his schooling had normal motivation to learn to read. (Benton, p. 3).

The more general term, "learning disability", is also currently used to refer to a serious discrepancy between ability and achievement which is not commensurate with age or ability level and is determined not to be the result of inadequate educational experiences; mental retardation; emotional disturbance; visual, hearing or motor handicaps;

or environmental, cultural, or economic disadvantages. Learning disabilities may be manifest in one or more of the following areas: oral or written expression, listening comprehension, basic reading skills, spelling, reading comprehension, mathematical calculation or reasoning. Learning disabilities are typically operationally defined by the use of discrepancy formulas which quantify a student's deficit in a particular skill in relationship to age and level of intellectual ability when other possible causes have been ruled out. Therefore, "developmental dyslexia" and "specific reading disability" may be considered to be subsets of the more general category of "learning disability".

Debate concerning definitional issues has focused on the problems inherent in the preceding definitions (primarily ones of exclusion) and has led to the proposal of numerous methods for more accurately describing dyslexia with some researchers proposing a multifactor classification system of subtypes (Boder, 1973; Mattis, French & Rapin, 1975) and others suggesting a single deficit model (Vellutino, 1977).

For many years, theories concerning the etiology of developmental dyslexia focused primarily on dysfunction in visual-perceptual processing. In recent years, however, this focus has widened to include other possible causes with particular emphasis upon deficits in verbal processing (Vellutino, 1977). A related issue concerns whether the reading difficulties found in developmental dyslexia are due to an actual deficit or impairment of some set of abilities necessary for reading or due to a maturational lag in the development of such skills (Satz, Friel & Rudegair, 1974). Research into these and other aspects of dyslexia has produced conflicting results with various investigators citing evidence for and against all of the preceding points of view. According to Benton (1975), one of the major deficiencies of research in the area of developmental dyslexia has been the lack of adequate descriptions of the behavioral disability involved. Benton suggested that "changing the approach to define more homogeneous types of developmental dyslexia and determine the antecedents and correlates of each type might go far to eliminate the present morass of contradictory and inconsistent findings" (1975, p. 39).

One approach to determining more adequately the antecedents and correlates of different types of developmental dyslexia has involved searching for basic subprocesses which may be vital to the development of reading. One such subprocess which has recently been identified as important in proficient reading is that of naming or word-retrieval ability. Evidence from research and clinical experience in adult aphasia, acquired alexia, and developmental dyslexia (e.g., Denckla & Rudel, 1981; Luria, 1966; Wolf, 1982) has converged to point to the relationship between word-retrieval difficulties (developmental dysnomia) and some types of specific reading disability (developmental dyslexia) in children. As Wolf and Morris (1982) stated, "naming, which is learned early in development and is easily tested in various forms, offers an almost unparalleled opportunity to probe the cognitive and linguistic subprocesses of children who are experiencing early difficulty in learning to read" (p. 1). Although relatively few researchers have directly studied the relationship between dysnomia and dyslexia, the resulting research has shown promise in unraveling theoretical issues such as developmental lag versus an actual deficit, the existence of subtypes of dyslexia, and the relative importance of underlying linguistic problems in dyslexia. For example, studies by Wolf (1982) and Wolf and Morris (1982) highlighted the multioperation nature of the word-retrieval process and suggested that this allowed for specific subtypes of anomia which might be able to account for specific subtypes of dyslexia. Both the cross-sectional and the longitudinal studies of Wolf (1982) and Wolf and Morris (1982) suggested that there are qualitative as well as quantitative differences in the development of word-finding abilities across ages in groups of retarded and normal readers which lend support to the deficit model. The importance of linguistic processing in dyslexia was pointed to by Wolf's (1982) finding that performance on the more linguistically demanding naming tasks corresponded best to reading ability. In addition, the documentation of the existence of dysnomia in reading disabled children has implications for the prediction of reading disability (Wolf, 1982) as well as for remedial strategies, a largely unexplored area.

Although previous research in this area demonstrated that naming or word-retrieval difficulties can distinguish between disabled readers, normal readers, and children considered learning disabled in areas other than reading, the relationship between dysnomia and specific subtypes of reading disabilities had not previously been examined. If children with reading difficulties were categorized according to subgroups (as defined, for example, by Boder) and given a battery of tests designed to measure word-retrieval, what relationships and patterns would result? Would anomia differentially characterize some subtypes, but not all? If, as proposed by Boder (1973) and Mattis, French, and Rapin (1975), there are distinct and independent subtypes of dyslexia, then dysnomia should be correlated with the subtypes involving language dysfunction and not with the other subtypes. If Vellutino's (1977) proposal of an underlying deficit in verbal processing as basic to all dyslexia is correct, then dysnomia might be correlated with reading disability regardless of the subtypes. The issue of deficit versus developmental lag might also be clarified to some degree by looking at the quality of naming errors across various reading disability subgroups as well as across age groups.

CHAPTER II

REVIEW OF THE LITERATURE

Definitions

The issue of the proper method of identifying subjects to be classified as suffering from "developmental dyslexia" or "specific reading disability" remains unresolved. Definitions currently in use rely primarily on exclusionary criteria (e.g., unexplained reading failure not due to inadequate intelligence, language development, sensory capacity, reading instruction, or motivation). Such definitions developed as a means of distinguishing dyslexic children from the larger group of children who may be retarded readers for a variety of reasons (e.g., limited intelligence, sensory deficits, lack of motivation, poor reading instruction, emotional problems, etc.). While it is considered advisable in many respects to make such distinctions, Benton (1975) pointed out several shortcomings of the exclusionary type of definition. One prominent problem concerns the lack of adequate definitions for terms such as "conventional instruction", "normal motivation", and "adequate intelligence." Another problem with such definitions is the assumption that dyslexia is a homogeneous condition or a single syndrome in spite of evidence from both clinical observation and research studies to the contrary (e.g., Boder, 1973; Mattis, 1978). In addition, the specification of adequate intelligence, cultural background, and educational opportunity as necessary to the diagnosis of dyslexia eliminates a large number of children, some of whom should be included. As Rutter

(1978) indicated, studies have shown that a number of factors (e.g., low socioeconomic status, family size, cultural values) are associated with developmental dyslexia as well as with more general retardation.

After reviewing the current definitions and associated problems, Benton (1978) suggested measures to both broaden and narrow the categories of children studied in relation to specific reading disability. On the one hand, Benton recommended that "it may be desirable, given our present state of ignorance, to cast a wide net and study children with a wide variety of deficits including those whose clinical pictures do not meet strict criteria of specific reading disability" (1978, p. 460). In this way, researchers can avoid the possibility that the diagnostic category known as dyslexia be limited to an atypical subgroup. On the other hand, Benton strongly supported attempts to define more carefully specific subgroups within the more general category of dyslexia.

Subtyping

Currently there exist two major systems of classification of subtypes: one based on actual reading and spelling performance and one based on problems concomitant with dyslexia such as difficulties in oral language, memory, or perceptual-motor skills. Benton (1978) recommended the use and comparison of both such classifications and suggested that this type of research offers "a more refined assessment of reading performance than is usually made in neurological and neuropsychological studies of dyslexic children" (p. 458).

The methods of subtyping dyslexia proposed by Boder in 1973 and by Mattis, French and Rapin in 1975, exemplify the two basic categories of classification systems described by Benton (1978). The Mattis model is defined as a model of independent causal effects which attempts to subgroup dyslexic children according to associated clusters of deficits in higher cortical functions (Mattis, 1978). According to Mattis (1978), this model was based on clinical findings in adults which indicated that acquired alexia (inability to read following cerebral damage) may be caused by lesions in at least four separate locations in the brain; i.e., there is no single causal defect underlying acquired difficulty in reading. The model proposed by Mattis makes the assumption that because reading is a very complex process, difficulties in any of the subprocesses may cause problems in the development of reading. Support for this model was based primarily upon a study by Mattis, French and Rapin (1975) in which an extensive battery of neurological, neuropsychological and psychological tests were administered to 113 children referred by pediatric neurologists for evaluation of learning and/or behavior disorders. Of this group, 83 children (ages 8-18) were identified as dyslexic (based on the criteria of Full Scale IQ of 80 or above and two or more grades below level expected for age). The dyslexic group was further subdivided, based on the results of neurological examination, into brain-damaged dyslexic (N=53) and nonbrain-damaged dyslexic (N=29). In addition, a matched group of children diagnosed as brain-damaged but with adequate reading skills (N=30) was identified. The assumption was that many of the correlates of dyslexia previously identified in the literature were actually manifestations of central nervous system dysfunction and not necessarily related causally to dyslexia. Therefore, by disregarding the dysfunctions found in brain-damaged readers as well as non-brain-damaged readers, Mattis et al. (1975) identified three clusters of deficits presumed to be causally related to developmental dyslexia. These three syndromes included language disorder, articulatory and graphomotor dyscoordination, and visuospatial perceptual disorder. The language disorder group was the largest (39%) and included children with dysnomia and either a disorder of comprehension, imitative speech, or speech sound discrimination. The articulatory and graphomotor dyscoordination group (37%) had intact acoustosensory and receptive language processes but were deficient on a sound blending and graphomotor test. The visuospatial perceptual disorder group (16%) had Verbal IQ scores more than 10 points above Performance IQ, and difficulties on a test of visual retention and the Raven's Coloured Progressive Matrices (in comparison to their Performance IQ). These syndromes accounted for 90% of the 82 dyslexic children studied with no child falling into more than one category. Additional support for these subtypes was found in an unpublished, cross-validation study by Erenberg, Mattis, and French (Mattis, 1978) in which 163 school age children, ages 8 to 14, referred to a Center for Child Development, were identified as dyslexic. Using the Mattis, French, and Rapin (1975) criteria, 63% demonstrated the language disorder, 10% the articulatory and graphomotor dyscoordination, and 5% the visual-spatial perceptual disorder. Unlike the original Mattis, French and Rapin study, in the cross-validation study 9% of the dyslexics presented with two of the syndromes. Mattis suggested that differences between IQ levels for the two groups (lower mean IQ for the cross-validation study) may have been related to this finding and pointed out that the subjects presenting with two syndromes also had much lower IQ scores than the subjects in the original study. In the cross-validation study, the three syndromes taken independently accounted for 77% of the dyslexic children and Mattis concluded that "there appears to be sufficient data to submit that a dyslexia syndromes model which presumes several independent causual defects is a tenable working hypothesis to guide future research" (Mattis, 1978, p. 52).

The method of subclassification proposed by Boder (1971, 1973, 1976) represents an attempt to categorize subjects according to their actual spelling and reading patterns. Boder considered her method a diagnostic screening procedure, which assumes that developmental dyslexia is heterogeneous, and which differs from other diagnostic approaches by focusing on the interdependence of reading and spelling performance and taking into account the child's strengths and weaknesses. Using a set of tasks which was recently formalized and published as The Boder Test of Reading-Spelling Patterns (Boder & Jarrico, 1982), Boder's method assesses sight vocabulary, word analysis-synthesis skills, and spelling (including known, unknown, phonetic and nonphonetic words). According to Boder (1973), analysis of a child's ability to spell "unknown" and "known" words constitutes the crucial feature of the diagnostic screening procedure. Indeed, once it has been established that children are reading below their expected level, the distinction between the dysphonetic and dyseidetic subgroups is based on the ability to spell unknown words phonetically. That is, the dysphonetic children spell less than 50% of the unknown words correctly and dyseidetic children spell more than 50% of unknown words correctly. Analysis of ability to spell "known" words (i.e., words in the subject's sight vocabulary) provides information about the child's ability to revisualize words. Analysis of the spelling of "unknown" words reveals the child's ability to apply phonetic skills to words not in their sight vocabulary.

Boder's use of this procedure in a clinical setting led to the identification of three subtypes of dyslexia: dysphonetic dyslexia, dyseidetic dyslexia, and mixed dysphonetic-dyseidetic dyslexia (alexia). These subtypes accounted for virtually all of the dyslexic subjects while none of the patterns were found among good readers and spellers. Subjects classified as dysphonetic dyslexics have reading-spelling patterns which demonstrate a basic deficit in symbol-sound integration, which results in a lack of ability in phonetic analysis-synthesis skills. The dyseidetic dyslexia subgroup consists of subjects who demonstrate a deficit in the ability to perceive letters and words as visual gestalts. In the mixed dysphonetic-dyseidetic subgroup are those subjects whose reading-spelling patterns demonstrate deficits in both of the preceding abilities and who are essentially alexic (nonreaders). In addition, poor readers can be identified as having nonspecific reading retardation which involves a normal pattern of spelling but lower than expected reading level. Nonspecific reading retardation is presumed to reflect problems, not in central processing abilities, but in aspects of the student's environment (e.g., poor teaching, lack of family support) or emotional status (e.g., lack of motivation, serious emotional disturbance). The Boder test also identifies an undetermined subgroup which is defined as children with either dysphonetic or dyseidetic dyslexia whose reading disability has been partially remediated.

Using the procedures developed in her clinical practice, Boder (1982) studied a random sample of 107 dyslexic children (based on a diagnosis by exclusion) and found that 94% of those studied fell into one of the three categories. As in the Mattis, French and Rapin (1975) study, the largest percentage of subjects met the criteria for inclusion in the category related to deficits in central language processing. The results for each of the subtypes in the Boder study were as follows: dysphonetic-63%, dyseidetic-9%, mixed dysphonetic-dyseidetic-22%, and undetermined-6%. The combined results of four studies involving 420 subjects (Boder & Jarrico, 1982) produced the following subtype frequencies: dysphonetic-61.7%, dyseidetic-13.1%, mixed-18.6%, undetermined-6.6%. Several recently published studies (Aaron, 1978; Malatesha, 1981) as well as unpublished doctoral dissertations were cited by Boder and Jarrico (1982) as providing evidence supporting the reliability and validity of Boder's diagnostic screening procedure. The authors suggested that "The Boder Test offers a fresh point of departure for undertaking new studies on dyslexia and for re-evaluating the finds of earlier studies" (Boder & Jarrico, p. 108).

Etiology

In addition to clarifying issues of definition, attempts to delineate subtypes of dyslexia also address theoretical questions. According to Benton (1978), "the opinion of most professional workers is that endogenous factors, reflected in anomalies of central nervous system function, constitute the primary basis for specific reading retardation" (p. 465). Despite this agreement, numerous theoretical questions remain to be answered concerning the nature of the central nervous system anomalies responsible for developmental dyslexia. In a recent review, Vellutino (1977) listed four theories regarding the underlying deficit in dyslexia which are currently popular. These included the perceptual-deficit hypothesis, deficiencies in intersensory integration, dysfunctions in temporal-order perception, and deficiencies in verbal processing. Historically the most prevalent of these theories has been the perceptual-deficit theory which proposes a disability caused by visual-spatial confusion presumed to be the result of a neurological deficiency of some kind. The intersensory integration theory hypothesizes that reading disorders are caused by faulty integration of the various sensory systems. Proponents of the dysfunction in the perception of temporal order theory point to problems in the sequencing of verbal stimuli as a major cause of dyslexia. The verbal processing deficiency theory states that difficulties in one or more aspects of language underlie specific reading disabilities.

Studies such as those by Boder (1973) and Mattis, French and Rapin (1975) lend support to a multifactor theory of dyslexia, e.g., one encompassing both visual-perceptual and verbal processing components. However, Vellutino (1977) disagreed with this conclusion and presented evidence in support of verbal processing deficits as the basis for all dyslexia. In an extensive review of the literature supporting the other three theories, Vellutino (1977) pointing to the lack of control for factors such as experience with letters and words, differences in verbal-encoding abilities, and attention and memory requirements, concluded that deficits in verbal processing offered a better explanation of the findings. For example, in critiquing the perceptual-deficit theory, Vellutino stated that "poor readers' processing of visual material may be due not to their inability to stabilize visual-spatial relationships, but rather to their difficulty in establishing visual-verbal relationships" (1977, p. 337).

Developmental Lag vs. Deficit

In addition to the preceding questions regarding the nature of the central nervous system disability, there exist theoretical differences concerning whether the disabilities reflect a developmental lag or an actual deficit. According to Rourke (1976), proponents of the developmental lag theory (e.g., Satz) propose that a lag in brain maturation causes a delay in the acquisition of skills necessary for reading. In this model, in which no deficit or impairment exists, retarded readers function like younger normal readers and may eventually "catch up" on the delayed skills. The deficit theory (supported by Rourke, Wolf, Mattis, Denckla, etc.) hypothesizes a central nervous dysfunction or deficit underlying the failure to develop age-appropriate skills. While there is no expectation that children will "catch up", the deficit theory does allow for adaptation to or compensation for the deficit.

One of the major advocates of the developmental lag theory in the past has been Paul Satz (Satz, Friel & Rudegair, 1974). Satz et al. administered a battery of 20 tests to 120 white males (60 dyslexic and 60 control) and followed their progress from kindergarten to the end of second grade in an attempt to look at developmental precursors of dyslexia as well as changes in these developmental skills over time. Factor analysis identified four factors which were important in predicting reading ability: (a) Somatosensory-perceptual-mnemonic, (b) Teacher Evaluation, (c) Conceptual-Verbal, and (d) Fine Motor. The first factor, seen as a general measure of somatosensory-perceptual-mnemonic ability, was the most powerful. The tests included in the first factor which were most predictive (finger localization, alphabet recitation, and a recognition-discrimination task) were also the only tests on which the dyslexic children had "caught up" to controls by the end of the second grade. Satz et al. concluded that these tests were measures of simpler, earlier developing skills which are in a period of rapid growth during preschool. Since the dyslexic children "caught up" on these skills by the end of second grade but still showed lags in more complex skills, Satz et al. hypothesized that the nature of the developmental lag changes with the age of the child; i.e., for younger children the problem lies in visual-perception integration while for older children difficulty in language processing is more important. The fact that children in this study did make improvements over time on skills at least theoretically related to reading was used as evidence by Satz et al. (1974) for supporting the developmental lag model. However, a later study (Fletcher, Satz & Sholes, 1981), which focused on developmental changes on linguistic tasks related to reading, allowed for the possibility that some subtypes of reading disability may fit the deficit model better than the developmental lag model.

Support for the deficit theory has come from numerous researchers (e.g., Mattis, 1978; Rourke, 1976; Wolf & Morris, 1982). Results of the Wolf and Morris cross-sectional and longitudinal study pointed to a combination of "delay and gross aberrance in lexical organization" (1982, p. 6) for the dyslexic readers. Mattis (1978) stated that the finding that a 10-year-old dyslexic obtains the same raw score on some measure as most normal 7-year-olds does not imply that the dyslexic reads like a normal first grader. If this logic were correct, then the prediction could be made that the dyslexic would read like a normal second grader at age 11, a normal third grader at age 12, etc., when in reality this does not occur. Rourke (1976) reviewed the Satz et al. study in the light of seven possible ways in which performance over time on some dependent measure can be plotted on a graph, each of which can be interpreted as supporting the developmental lag or the deficit theory. Based on this type of analysis of the Satz et al. study as well as studies of his own, Rourke (1976) concluded that there is more support in general, across a number of dependent variables, for the deficit theory than for the developmental lag theory. Denckla (1979), in support of the contention that both maturational lags and deficits may contribute to reading disabilities, suggested that sequencing-phonological problems may be due to a developmental lag which leads to problems in reading when combined with additional problems such as attention deficit disorder, hearing loss, or inadequate instruction. However, according to Denckla, dysnomia reflects a difference in the quality not just the quantity of development and is therefore, due to a deficit rather than a lag. In summary, theoretical issues such as multifactor versus single factor and deficit versus developmental lag remain unresolved and may well benefit from research which more carefully delineates subgroups of dyslexia.

Dysnomia and Dyslexia

Many additional questions concerning dyslexia have grown out of clinical observations of children with developmental reading problems and adults with acquired difficulty in reading. One such fruitful question which has only recently begun to be systematically investigated is the relationship between dysonomia and dyslexia. Dysnomia, also referred to as word-finding, naming, word-retrieval, or reauditorization difficulty, was defined by Lerner (1971, p. 296) as a "difficulty in recalling or remembering words or the names of objects" and a "deficiency in remembering and expressing what words sound like." Dysnomia is at times used synonymously with the term anomia (acquired word-finding difficulties in adult aphasics), but is generally used to designate a less severe disorder which is developmental in nature. Wiig and Semel (1976) expanded on this concept by defining dysnomia as a reduction in verbal fluency as shown by reduced accuracy and speed of verbal association as well as reduced availability of verbal labels.

Clinical observations of this phenomenon in learning disabled children have been reported for a number of years. For example, Johnson and Myklebust, in 1964, described in detail the phenomenology of word-finding difficulties in children with various learning disabilities. However, these clinicians considered dysnomia to be but one form of a disorder of expressive language which affected oral but not silent reading. Dysnomic children were further described by Wiig and Semel (1976) as having problems in phoneme discrimination, sequencing and word-finding. For example, the dysnomic child may reverse phonemes within words and say "emeny" for "enemy". Word-finding problems may cause severe difficulties in recalling proper and concept names which can lead to frequent word substitutions, circumlocutions, and the use of stereotypes. These problems are particularly evident in the preschool child with dysnomia. Denckla pointed out that "the habit of circumlocution and of talking by slow associative approximations" (1979, p. 549) is often well-established in dysnomic children by kindergarten. In addition to affecting reading, dysnomia can have a serious effect on the child's social-emotional life and has been identified as one of the best established antecedents of stuttering. According to Wiig and Semel (1976), word-finding problems often decrease by the third grade but word substitutions may persist and be seen in reading, sentence repetition, copying and writing from dictation. Adolescents with dysnomia are characterized by the use of verbal paraphasias (word substitutions) as well as some word-finding and retrieval deficits.

Based on their observations, Wiig and Semel (1976) concluded that word-finding problems of children with a language disorder are similar to the verbal paraphasias of adult aphasics with left temporal, parieto-temporal, or parieto-occipital-temporal lesions. Indeed, much of what is assumed to be true about children with the language disorder of dysnomia has come from studies of adults with identifiable lesions. Agranowitz and McKeown (1963) described anomia and amnesic aphasia in adults as the inability to recall names, words, or other facts of language and pointed to lesions in the lower part of the junction between the temporal and the occipital lobes as the causative factor. Bannatyne (1971) referred to brain stimulation research which located a posterior ideational area of the brain (centered around the angular gyrus) which is associated with the following symptoms: inability to name objects (with intact inability to speak), misnaming with perseveration, distortion and repetition, and confusion of numbers while counting. More recently, Benson (1983) described four types of anomia associated with aphasia in adults and the neuroanatomy of each. Word-production anomia, in which the patient produces incorrect phonemes for the names of objects, has been associated with disturbances along the pathway which connects posterior with anterior language areas of the left cerebral cortex. Word-selection anomia, in which patients can describe the function of an object but cannot retrieve the specific label, has been traced to pathology of the posterior-inferior temporal lobe. A third type of anomia, semantic anomia, involves the inability to name or to point to an object when named and is related to pathology in the angular gyrus. Category- and modality- specific anomias represent situations in which the naming problem is limited to a specific category or modality and indicate a disconnection of a given sensory area from the angular gyrus of the left hemisphere.

Luria, in his work Higher Cortical Functions in Man (1966), described aphasic speech which lacks nouns and is primarily composed of auxiliary words such as conjunctions, prepositions and adverbs. In explanation of the processes underlying dysnomia, Luria suggested that the problem is caused by an inability to discover a required dominant word from within a set of related words of equal probability. Luria (1970) also stated that naming disorders can disrupt the entire speech system including reading and writing. These findings, as well as the frequent co-occurrence between alexia and anomia and the high correlation between naming and reading abilities in adults with cerebral damage, have focused attention on the possible relationships between reading and naming in children (Wolf, 1982).

Encouraged by such observations, researchers have been stimulated to pursue the relationship between developmental disorders of language (e.g., dysnomia) and dyslexia. Evidence for general deficiencies in verbal processing as well as naming problems in particular among dyslexics was reviewed by Vellutino (1977). Vellutino pointed to findings from clinical observations as well as studies of semantic, syntactic and phonological factors as supportive of the role of verbal processing deficiencies in dyslexia. In conclusion, Vellutino stated that "poor readers neither code (label) nor synthesize (chunk) information for effective storage and retrieval as readily as average readers because of problems in one or more aspects of language" (1977, p. 391).

The initial and most lengthy series of studies directly investigating the relationship between dysnomia and dyslexia was carried out by Martha Bridge Denckla and her associates. Beginning in 1972, Denckla followed up on reports of the coexistence of alexia and color anomia in adults with lesions by investigating color-naming defects in dyslexic boys. Five boys who were severely retarded readers were identified as having color anomia as well as other subtle word-finding difficulties. Denckla (1972) concluded that these boys' color-naming difficulties implied " a discrete dysfunction relevant to their dyslexia and there is a trend towards correlation between the persistence of the color-naming defect and severity of dyslexia" (p. 175). In 1976, Denckla and Rudel used the Oldfield-Wingfield Picture Naming Test to evaluate similarities between dyslexic children and aphasic adults. The authors (Denckla and Rudel, 1976a) hypothesized that dyslexic and nondyslexic groups of neurologically impaired children would show patterns of difficulty on picture-naming tasks similar to those reported for adults with left hemisphere, right hemisphere, or bilateral damage. The experimental subjects were

8- to 10-year-olds attending a special school for the neurologically impaired (i.e., diagnosis of minimal brain dysfunction-MBD). One group was dyslexic (N=10) and one group was nondyslexic (N=10) and included children with dyscalculia, attention deficit disorder, and handwriting problems. Controls were 120, 8- to 11-year-olds with 15 children of each sex at each age level. Results indicated significant differences among all three groups with the dyslexic subjects having the lowest number of correct responses and the longest response latencies. Dyslexic children scored similarly to aphasic adults both quantitatively (low scores) as well as qualitatively (type of naming errors). Nondyslexic brain-damaged children's errors involved figure-ground or part-whole confusions suggestive of adults with bilateral lesions. Denckla and Rudel concluded "that dyslexic MBD children resemble dysphasics in that they have linguistic retrieval problems, whereas nondyslexic MBD children are verbally competent but tend to fail due to faulty perception of the object pictures" (1976a, p. 14).

Following up on their findings indicating overall slowness of color- and object-naming in dyslexics, Denckla and Rudel questioned whether or not visual-verbal tasks (e.g., naming pictured objects, letters, numbers or colors) under pressure of time might be even more sensitive to differences between dyslexics and normals. To test this hypothesis, these authors devised such a task, the Rapid Automatized Naming Test, and evaluated the performance of normal children between the ages of 5 and 11. Their findings (Denckla & Rudel, 1974) indicated that normals named numbers and letters faster and objects slower even though object names were acquired earlier. Denckla and Rudel (1976b) then investigated the ability of their Rapid Automatized Naming Test (RAN) to differentiate dyslexia from other learning disabilities (i.e., nondyslexic brain-damaged children) as well as from normals. Experimental subjects (N=128), ages 7 to 11, from the researchers' private practice and two private schools, were divided into dyslexic (N=52) and nondyslexic (N=48) learning disabled (LD). These subjects were compared to the normals tested in the author's 1974 study. Since errors on the RAN task were infrequent for all groups, analysis was limited to differences in the speed of naming. The results indicated that normals were faster on all four categories (colors, objects, numbers, and letters) than both learning disabled groups and that nondyslexic LD subjects were faster than the dyslexics. The order of difficulty was the same for all groups with objects being the slowest, color naming being significantly slower than letter or numbers, and with no significant differences between letters and numbers. Denckla and Rudel concluded that the RAN was useful for differentiating between normals and learning disabled children as well as between types of learning disabled children. In discussing the possible nature of the processes involved in the RAN task, the authors stated that both adequate visual-verbal associations and automatization (rapid retrieval) are necessary and may not be easily separated in human subjects. Possible causes of deficits in these processes include poor attention, delays in visual-processing, poor speech encoding and slow verbal retrieval.

The possible role of poor speech versus slow verbal retrieval in dyslexia was investigated by Rudel, Denckla and Broman in 1978. In order to eliminate the vocal requirement, the authors devised a cancellation task in which subjects were required to rapidly cross out a target letter or triad of letters, a number or triad of numbers, or a geometric form (five subtests in all). While acknowledging that these modifications changed the task from recall to recognition as well as changing the attentional requirements, Rudel et al. (1978) hypothesized that if the crucial deficit was in speech rather than lexical access then eliminating the vocal requirement should eliminate group differences. Results showed significant differences between controls and nondyslexic LD children on three subtests and between controls and dyslexic LD children on only one subtest. Controls were faster than the LD children in each instance. The two LD groups differed significantly from each other only on the two triad subtests, with the dyslexics having slower performances. As a group, the dyslexics tended to be slow on the original RAN test and average on the cancellation test, a finding interpreted as indicating that vocal responding slowed response time more than increasing the letters to be processed from one to three. Rudel et al. concluded that speech may be an important but not essential factor in learning to read.

The next study in the Denckla series investigated the role of stimulus context in word-finding abilities. Rudel, Denckla, Broman, and Hirsch (1980), compared the performance of 202 normal children (ages 5 to 11) to previous studies of aphasics. While for aphasic adults naming problems are not modality specific, different tasks are of varying difficulty; e.g., sentence completion (using a noun) is easiest, naming a pictured object is more difficult, and naming an object following a verbal definition is most difficult. In order to determine whether or not the same sequence would apply to normal children, Rudel et al. (1980) gave their subjects three tasks similar to the ones given aphasics (i.e., naming to pictures, naming to description and sentence completion). In addition, naming objects following palpation was included in order to evaluate the importance of that sensory modality. Results indicated that, by age 11, accuracy of response did not depend upon condition. For younger children, as for aphasics, naming to definition was much more difficult than sentence completion. For all ages tested, completing a sentence with a noun was performed more rapidly than any of the other conditions. Other related findings were that girls made more rapid responses while boys named more objects but made more dysphasic-type errors (i.e., phonemic sequencing errors).

Rudel, Denckla and Broman (1981) extended their investigation of the effects of varying stimulus context on word-finding ability to dyslexic and nondyslexic learning disabled children. The same tests as described in the previous study were administered to 20 controls, 21 dyslexics, and 21 nondyslexic learning disabled (NDLD) children (mean age of 11). In addition, the authors included a test requiring the subject to give the function of an object (i.e., verb rather than noun retrieval) and two measures of vocabulary (i.e., word recognition by the _Peabody Picture Vocabulary Test_, _PPVT_, and word definition by the Vocabulary Subtest of the _Wechsler Intelligence Scale for Children-Revised_, _WISC-R_). In addition to investigating the effects of varying stimulus context on word-finding ability, Rudel et al. attempted to assess the generality or specificity of the language disorder in dyslexic children as well as whether performance on language tasks differentiated between dyslexic and nondyslexic learning disabled children. As expected, the best readers (control group) performed best on every test and, as in previous studies, dyslexic subjects made more errors on the word-finding tasks than either the NDLD or the control group. Unlike either the control or the NDLD group, the dyslexic subjects experienced more difficulty with both of the auditory conditions than with the visual or the haptic conditions. For example, the auditory sentence completion task was significantly more difficult for dyslexics than controls but not for the NDLD. The authors suggested that the "simple syntactic and semantic constraints of this task, which made it the easiest one for young children in our previous study and for the NDLD group in this, were not as useful to dyslexic children" (Rudel et al., 1981, p. 142). Qualitative analysis of error types indicated that while all groups made dysphasic errors, the dyslexic group made more of this type and the NDLD responded more rapidly and made more perceptual errors (neither finding was significant, however). Dyslexics' word-finding difficulties were not aided by the instruction to name the function of the object, indicating that their difficulties in retrieval were not specific to nouns.

An unexpected finding of this study (Rudel et al., 1981) was the presence of language problems in both of the learning disabled groups. Both LD groups had scores on the PPVT and the WISC-R Vocabulary subtest which were significantly lower than the control group. In addition, stimulus context affected response accuracy for both LD groups so that their performance was like younger controls. Rudel et al. concluded that, at least by age 10, "the language impairment of dyslexia (cf. Vellutino, 1977) is nonspecific and includes deficits of word finding as well as of receptive and expressive vocabulary" (1981, p. 144). These findings also indicated that some but not all aspects of language difficulties can discriminate between dyslexic and NDLD children.

In a related study, German (1979) assessed the impact of stimulus context as well as word-frequency on the noun retrieval abilities of learning disabled children. German's LD group consisted of 30 males, ages 8 to 11, with an IQ of 90 or above who demonstrated deficits of at least 1.5 grades below normal on tests of reading recognition, spelling, and math (it was unclear whether these subjects had deficits in all or one or more of these areas). Word-finding measures used by German consisted of 20 high- and 20 low-frequency nouns presented in three contexts, i.e., naming to pictures, naming to open-ended sentences, and naming to description. Errors were checked for target-word comprehension by asking the child to point to pictures of the target word. Only those words which the child correctly identified in this manner but failed to retrieve were coded as word-finding errors. Results indicated that the learning disabled children as a group made significantly more errors than controls on the low-frequency words in the conditions requiring naming to open-ended sentences and naming to description. Using a post hoc analysis which categorized subjects according to their deviation from the mean of the control group, German determined that 43% of the LD group were classified as "poor retrievers." This finding was interpreted as indicating that the group differences were not due only to a small subgroup of the LD children producing a large number of errors. The order of difficulty, as measured by errors, for both LD and control groups, was as follows: naming to description, naming to open-ended sentences, and naming to pictures. This finding replicated, in part, the finding by Rudel, Denckla, Broman, and Hirsch (1980) that normal children (less than age 11) made more errors on naming to definition than naming to open-ended sentences. In the Rudel et al. study, however, the order of difficulty, as measured by errors, was naming to description, naming to pictures, naming to open-ended sentences, and naming to palpation. German (1979) concluded that her findings supported the hypothesis of underlying language problems in learning disabled children and pointed to the importance of investigating deficits in basic linguistic skills.

In an attempt to investigate the relative discriminative power of a variety of tasks, Denckla, Rudel and Broman (1981) examined the performance of a small group of dyslexic and nondyslexic learning disabled children (NDLD) on each of the tasks which these authors had previously investigated. In order to minimize differences (e.g., socioeconomic, biological, educational) all of the subjects were recruited from the learning disability population of one school and included only right-handed males, ages 8 to 10. Subjects were classified as dyslexic (N=10) or nondyslexic (N=10) on the basis of a multiple regression equation incorporating age, IQ and community IQ and reading grade level. All of the dyslexic boys were at least 1.5 years below expectation on a measure of oral reading and had a full scale IQ of 90 or above. The battery of tests given included the test of Rapid Automatized Naming, the Oldfield-Wingfield Picture Object Naming Test, a test of paired-associate learning of letter names for visually presented Braille dot patterns, a visual temporal-temporal/spatial matching task in which the subject matched a series of light flashes to either another pattern of lights or to a linear array of black dots, and a rapid cancellation of a visual target test. From the results of these tests, the authors selected six variables for entry into a linear discriminant function analysis, i.e., cancellation, naming, temporal-spatial matching, temporal-temporal matching, dysphasic errors, and perceptual errors. The best linear discriminant function, including total rapid-naming time, temporal-spatial pattern-matching and Oldfield-Wingfield picture-naming errors (perceptual or dysphasic), correctly classified 80% of each group. The dyslexic group was slower on the rapid-naming tests and made more dysphasic errors on the picture-naming test. In contrast, the NDLD group made more errors on the temporal-spatial patterns matching test and made more errors of a perceptual nature on the picture-naming test. Denckla et al. (1981) concluded that this study strongly supported the verbal deficit hypothesis of dyslexia in that the best discriminator between groups was the presence of dysphasic errors and slow "automatized" naming. The authors further suggested that, for future research, qualitative descriptions of error types provided the most powerful indication of dyslexia within a learning-disabled population.

Maryanne Wolf, a former student of Martha Denckla, has continued and expanded the investigation into the relationship between dyslexia and dysnomia. Wolf's basic premise is that "the word-finding process is near the heart of the speech/language process: Reading is a complex but language-based skill; therefore the retrieval process must play some part in reading and will affect reading acquisition, fluency, and failure" (1982, pp. 438-439). As the first step in the investigation of what is called the "duo-symbiosis between reading and language and between language and word-finding" (1982, p. 438), Wolf developed a model of word retrieval intended as a heuristic for subsequent research. Based on a review of pertinent literature from 1865 to 1962, Wolf concluded that a model of word retrieval should include the following components: perception, a conception operation, a lexicon with phonological and semantic classifications, a motor system, word frequency effects and the influence of the age of acquisition of words. Research from 1963 to 1980 suggested that the following additional components should be added to the model: attention, memory, rates of presentation and processing, developmental differences, and stimulus redundancy.

According to Wolf, the basic tenet of this model is that the word-finding process is multioperational in nature, which creates the likelihood that there are specific types of word-finding dysfunction. The possibility of specific subtypes of dysnomia and the evidence for subtypes of dyslexia is considered by Wolf to be further evidence for the relationship between naming and reading.

To investigate the proposed relationship between reading and naming, Wolf (1982) conducted a cross-sectional study of 64 subjects, 32 average and 32 poor readers in three age categories (6 to 7, 8 to 9, and 10 to 11 years old). A battery of tests, designed to include as many components of the model as possible, was administered to each subject. These included: The Peabody Picture Vocabulary Test (PPVT), the Gray Oral Reading Test, the Rapid Automatized Naming Test (RAN), the Boston Naming Test (BNT), the "F" Set Test (phonological retrieval), the Gates McGinitie Reading Test and visual reduction naming and reading tests.

The following three questions were addressed by this study: (a) Is there a relationship between naming and reading?, (b) Can a naming test differentiate between poor and average readers and between age groups?, (c) If poor and average readers perform differently on retrieval measures, are the differences developmental or qualitative? In answer to question number one, Wolf's results indicated a positive correlation between all of the reading and naming measures (significant at the .001 level). The Boston Naming Test showed the highest correlation with the reading measures which Wolf hypothesized was due to the fact that the BNT tapped the largest group of linguistic and cognitive processes. Wolf also proposed that the very high correlation between reading and the "F" set test was due to the fact that this test measures verbal fluency or automaticity of phonological processing which is important both in naming and in reading. Question number two was also answered in the affirmative by Wolf's data. Analysis of variance showed significant main effects of age for each of the word retrieval measures. For every test except the visual reduction naming test, there were significant differences between reading groups at the youngest age (6 to 7 years). For the middle age group (8 to 9 years) there were significant differences between reading groups on three retrieval measures (BNT, "F" set test, and RAN colors). Results for the 10- to 11-year old group were similar to those for the youngest group. In response to question number three, Wolf pointed to a number of indications that there are qualitative, not merely developmental, differences in lexical retrieval between good and poor readers. For example, while good readers showed orderly increments on all measures, poor readers demonstrated a gain from the youngest to the middle group but very little change from the middle to the oldest group. For all tests except for the visual reduction naming and RAN numbers tests, the oldest poor-reader group scored below the youngest good reader group.

Five major differences between good and poor readers emerged from the Wolf (1982) cross-sectional study. While poor and good readers' performance on the PPVT (receptive vocabulary) and the tip-of-the-tongue probes (probes designed to measure knowledge of the target word which cannot be retrieved) was similar, the poor readers were much less able to actually retrieve words. This discrepancy between tacit linguistic knowledge and the ability to retrieve it became more pronounced for the older poor readers. Poor readers were also deficient in phonological fluency and rapid naming of letters, both tasks which require automaticity in identifying and retrieving linguistic stimuli. A third finding concerned the lack of word frequency effects for poor readers who tended to name poorly throughout (contrary to previous results by Denckla and German). On all measures (retrieval and reading), poor readers started out significantly behind their peers, made a growth spurt and plateaued between the ages of 8 and 10. Within the poor reader group, there were significant response differences which Wolf interpreted as supporting the possibility of specific subgroups of dyslexia and dysnomia.

In order to investigate further the findings of the preceding cross-sectional study, Wolf and Morris (1982) are currently in the fourth year of a longitudinal study. Kindergarten students from three schools with different socioeconomic levels have been evaluated with the battery described in the cross-sectional study. Initial analysis of the data has been reported in regard to two basic questions: (a) Can naming measures administered in kindergarten differentiate between average and poor readers at the end of grade one?, and (b) Can a qualitative evaluation of naming errors give insight into the issue of pathology versus developmental lag? Using data on 91 monolingual subjects, all of the naming measures (except for the "Animal" set test) were able, at kindergarten, to differentiate poor from average readers. By grade one, only the expressive naming tests (RAN, BNT and Visual Reduction Naming) were able to significantly differentiate groups. Based on multiple regression analysis, the BNT was the best single predictor of oral reading as well as silent comprehension in the first grade. The BNT was useful not only in differentiating good from poor readers but was also useful in qualitatively evaluating the issue of pathology and developmental lag. Wolf and Morris illustrated the importance of qualitative analysis by the case study of a young boy, Tony, who had excellent receptive vocabulary and verbal fluency. On the RAN tasks Tony could not (in kindergarten) name many letters without singing the alphabet song or name numbers without counting from one to the target number. On the BNT, his quantitative score was only slightly below the mean but his responses were bizarre and showed little frequency effect. For example, Tony called a "pelican" a "gulp bird" and a "unicorn" a "screwhorse". When asked to read, Tony invented a story based on random letters and "read" word for word his made-up story. When errors on the BNT made by the reading disabled subjects were compared to those made by adult aphasics, there were numerous similarities. For example, both groups made semantic errors, gave phonological nonwords, and used circumlocutions. Wolf and Morris concluded that "it is only the combination of quantitative and qualitative measures of the subprocesses of naming that gives us a real means of comparison across development and types of pathology" (1982, p. 9).

In summary, research to date has demonstrated a strong relationship between dysnomia and dyslexia. Careful analysis, both quantitative and qualitative, of retrieval abilities offers rich insights into the nature of severe reading disabilities. Although there are indications that subtypes exist within the general categories of dyslexia and dysnomia, research into these two areas has not fully addressed this issue. All of the dysnomia/dyslexia studies reviewed have classified subjects as poor readers but have not divided the subjects into subgroups. Therefore, a logical next step in this investigation was to subtype reading disabilities and investigate the relationship of word retrieval to the various subtypes. By employing both quantitative and descriptive data analyses, the following questions were addressed:

1. Will tests of dysnomia differentiate between subtypes of dyslexia?

2. How does the word-retrieval performance of a group of reading disabled subjects compare to other reading disabled groups and average readers?

3. If impaired, is this performance indicative of a developmental lag or a deficit?

Current theories of dyslexia and dysnomia lend support to several hypotheses concerning these research questions. On the one hand, multifactor theories of dyslexia (e.g., Boder, 1973; Mattis, French & Rapin, 1975) predict that there are independent subgroups of dyslexia and that the largest subgroup is characterized by language dysfunction. If this theory is correct, it would be expected that naming, considered a basic language subprocess, would be impaired to a greater degree in this subgroup as compared to a subgroup involving visual dysfunction. On the other hand, the verbal deficit theory (Vellutino, 1977) proposes that language dysfunction might be distributed among all subgroups of dyslexia. In regard to question number three, current data suggests the existence of both developmental lag and aberrant patterns for different dependent measures (e.g., Rourke, 1976). At least two researchers (Wolf, 1982 and Denckla, 1979) have strongly contended that naming abilities in reading disabled subjects reflect a deficit rather than a developmental lag. By a careful subgrouping of a group of reading disabled children, using the Boder Test of Reading and Spelling Patterns, and both a qualitative and a quantitative analysis of these subjects' performance on a word-finding battery, these research questions were addressed.

CHAPTER III

METHODS OF PROCEDURE

Due to the nature of the variables involved (i.e., reading and language abilities) as well as the research questions raised, the study was nonexperimental and descriptive. As Kerlinger pointed out, "non-experimental research deals with variables that are by nature not manipulable" (1979, p. 119). Reading ability and language skill, the primary variables involved, were status variables which could not be manipulated in the manner of a true experiment. The relationships between reading abilities (or disabilities) and manifestations of language skills could, however, be systematically investigated in order to uncover the nature of hypothesized relations. Therefore, this study employed analysis of variance and multiple regression analysis to explore the relationships between subtypes of reading disabilities and language skills (i.e., naming). Although correlational data could not be used to prove causation, such data were considered relevant to causal hypotheses by exposing them to failure of confirmation (Campbell & Stanley, 1963). In addition, a qualitative analysis of subject's performance on selected language tests (e.g. error patterns) was carried out in order to provide a more accurate description of subtypes of reading disability as well as to generate hypotheses for future research.

Research Instruments

Boston Naming Test (Kaplan, Goodglass, & Weintraub, 1982)

This test consisted of 85 line drawings of objects of varying familiarity which the subject named orally. If the subject failed to name correctly, prompts (either phonological/first sound, or semantic/ brief "set" definition) were given. The Boston Naming Test was administered according to modifications of the original scoring which were made by Wolf (1982 and personal communications, 1983). Beginning with the first item, the subject was requested to name each picture as quickly as possible. Testing was discontinued when the subject made six consecutive errors. The final score was the number of pre-15-second (unprompted), correct responses. Norms were not available for this modified scoring procedure. Additional information was gathered in the following areas:

1. Latency - Using a stopwatch, the examiner checked off which of seven time categories the subject's response fell within (i.e., .5 seconds or under, 1.5 seconds, 2.5 seconds, 4 seconds, 7.5 seconds, 12.5 seconds or over 15 seconds). This procedure was used by Wolf (1982) and found to be preferable, due to time constraints, to taking exact measures for each of the test items. The latency score for each subject was an average of the time required for correct responses.

2. Tacit information - Using the TOT procedures described by Brown and McNeil (1966), if subjects could not recall a word they were asked how many syllables the word had, what the first sound was, or to give any sound they could remember.

3. Type of Word Associates - If the subject gave incorrect but target-related words, the errors were divided into three categories: semantic, visual, or phonological.

4. Type of prompt - If a subject could not name a picture after 15 seconds, the examiner gave, in random order, either a semantic prompt

or a phonological prompt. The examiner recorded which prompt elicited the correct response.

5. TOT's - If the subject, either spontaneously or after prompts, retrieved the correct word after 15 seconds, this was recorded as a successful TOT. If the subject did not find the correct word, this was recorded as an "attempted TOT."

Rapid Automatized Naming Tests (Denckla & Rudel, 1976, a, b)

Subjects were required to name, as rapidly as possible, items presented visually on a chart. Each chart contained five rows of ten stimuli from a category of five items; i.e., there were 50 randomized items on every chart. The color chart contained five colors (red, yellow, blue, black, and green). The letter chart contained five high frequency, lower case letters (o, a, s, d, p). The number chart contained five high frequency numbers (6, 4, 7, 9, 2). The object chart contained five common objects (key, scissors, umbrella, watch, and comb). The RAN tests were administered according to the author's instructions. All errors were noted on the examiner's sheet and the time required was recorded in seconds. Scores were recorded for total number of errors and time in seconds for each chart (e.g., number of errors and number of seconds for naming colors). Although not standardized, there were norms available for ages five through ten (see Appendix A).

"FAS" Set Test

The subject was asked to give as many words beginning with F, A, and S as possible, each within one minute. This test was designed to test the subject's ability to retrieve a specific letter/sound (i.e., phonological retrieval).

"Animal/Food" Set Test

The subject was asked to give as many animals or foods as possible, each within one minute. This test was designed to evaluate ability to retrieve items within a particular category (i.e., semantic retrieval).

For the "FAS" tests and the "Animal/Food" tests, the instructions were to name as many words as possible in one minute in each category. The score was the number of correct responses for each test. Each subject's responses were also tape-recorded so that error patterns and strategies could be analyzed. Experimental norms were available for the "FAS" tests only (see Appendix B).

Peabody Picture Vocabulary Test-Revised (Dunn & Dunn, 1981)

This test of hearing vocabulary included 175 items arranged in order of increasing difficulty. Each item consisted of four simple, black-and-white illustrations arranged in a multiple-choice format. The subject's task was to select the picture considered to illustrate best the meaning of a stimulus word presented orally by the examiner. The score reported was a standard score equivalent. Norms were available for ages 2 1/2 through 40. Split-half reliability data reported in the Peabody test manual, indicated coefficients which ranged from .67 to .88 on Form L and from .61 to .86 on Form M. Immediate retest alternate-forms reliability coefficients ranged from .73 to .91. Delayed retest alternate-forms reliability coefficients ranged from .52 to .90. The manual for this test cited as validity evidence several studies indicating the importance of vocabulary tests in predicting school success as well as the correlations between the Peabody and other vocabulary tests (median value = .71).

<u>The Boder Test of Reading-Spelling Patterns</u> (Boder & Jarrico, 1982)

This test consisted of an oral reading test, based on a series of graded word lists, and a written spelling test, based on the results of the reading test. The reading test used 13 graded word lists with half of the words being phonetic and half nonphonetic. The word lists had been graded for both reading and spelling from the preprimer through the adult level. For the reading test, the examiner presented words in two ways: flash and untimed. The examiner allowed not more than one second for the flash presentation and not more than ten seconds for the untimed presentation. Words read on flash presentation were considered to reflect words which were in the student's sight vocabulary. Following completion of the reading test, the examiner prepared a spelling test which consisted of known (sight vocabulary) and unknown words (not sight vocabulary). Based on the above procedures, the following scores were obtained for each child: reading level, reading age, reading quotient, known words correct, and unknown words correct. The reading level was broadly defined as the highest grade level at which the student read at least 50% of the word list on flash presentation. A more precise reading level was calculated by adding one-tenth of a year (0.1) to the reading level for each two words the student read flash beyond the required 10 (50%) at the reading level and one-tenth for each two words the student read flash at the next grade level. Reading age was calculated by adding 5 to the reading level. The reading quotient expressed the percentage of expected reading achievement attained by the reader and was based on a formula which included mental age, chronological age, and reading age (i.e., reading quotient = $\frac{2 \text{ x reading age x } 100}{\text{mental age \& chronological age}}$).

The scores for known and unknown words reflected a percentage of the total spelling lists which were spelled either correctly or as good phonetic equivalents. Using the guidelines outlined by Boder, each subject was assigned to one of the following categories: nonspecific reading retardation, dysphonetic, dyseidetic, mixed dysphonetic-dyseidetic, or undetermined.

Reliability and validity information were summarized in the _Boder_ test manual (Boder & Jarrico, 1982). One study, which investigated interrater reliability for identifying good phonetic equivalents, reported an intraclass correlation of .99. Test-retest reliability studies of both short-term (within two months) and long-term (after one year or more) retest situations indicated high test-retest reliability. Four independent validity studies involving 420 subjects found roughly the same proportions of the dyslexic subtypes within each sample. Correlations between the reading levels on the _Boder_ and two other standardized reading tests (the _Gray Oral_ and the _Wide Range Achievement Test_) were reported to be high (r = .74, .85, .91).

Sample

Subjects were recruited from the Greensboro City Schools, the Winston-Salem/Forsyth County Schools, and the Lexington City Schools systems. Administrative personnel in these systems identified students who had been diagnosed as learning disabled by the existing standards in North Carolina (see Appendix C) and who met the following criteria:

1. Ages 8 to 12.

2. Average intelligence (IQ of 85 or above on either the Performance or Verbal Scales of the _WISC-R_).

3. Reading level at least 1.5 years behind that expected for age and/or grade.

Parents of the subjects who met the above criteria were sent a letter (Appendix D) and a consent form (Appendix E) from their respective school system. The letter explained the purpose of the study as well as the responsibilities of the subjects and the investigator. For parents and subjects who wished to participate, a self-addressed, stamped envelope was included for their use. Upon receipt of the returned consent form, each subject's parents were contacted and appointments for the individual testing sessions were arranged.

Forty-six students were identified in this manner. Six of these students were subsequently omitted from the study due to failure to meet one or more of the specified criteria. In addition, one student who was referred to the Section of Neuropsychology for the evaluation of learning problems was also included in the sample. This subject was from the Davidson County School System and was determined to have met the preceding criteria. Therefore, the sample included a total of 41 subjects: 23 from the Winston-Salem/Forsyth County Schools system; 16 from the Greensboro City Schools system; 1 from the Lexington City Schools system; and 1 from the Davidson County Schools system. There were 3 females (7%) and 38 males (93%) in the sample. The predominance of males in this sample was expected and was consistent with numerous research reports of male/female ratios of approximately 4 to 1 in reading-disabled samples. Of the total sample, 9 were black (22%) and 32 of the subjects were white (78%). The subjects ranged in age from 8 to 12 with a mean age of 10. Grade level for the subjects ranged from second grade to sixth grade. Appendix F summarizes this information.

Additional data available from school records indicated that 23 of the subjects had repeated one grade and 4 subjects had repeated two grades. Thirty-four of the students were receiving learning disability services through a resource teacher while seven of the students were in self-contained learning disability classrooms. Scores on the Wechsler Intelligence Scale for Children-Revised were available for each of the subjects. For the group as a whole, Performance IQ's ranged from 84 to 124 with a mean of 99. Verbal scores ranged from 75 to 122 (mean = 100). Full scale IQ scores ranged from 81 to 117 with a mean of 96. Appendix G summarizes these data.

Data Collection and Scoring

All subjects were given individual appointments and were tested in the Outpatient testing offices of the Section of Neuropsychology, Bowman Gray School of Medicine. The researcher met with each student and his or her parent(s) or guardian(s) jointly to explain the research (see Appendix H) and to answer any questions. Following this joint session, each subject was given a battery of tests by a graduate student psychology technician. Two orders of testing were used. The tests were given in the following order to the first 23 subjects: Boder (Reading and Spelling), Boston Naming Test, Rapid Automatized Naming Test, Verbal Fluency, and the Peabody Picture Vocabulary Test. The final 18 subjects were given the tests in this order: Boston Naming Test, Rapid Automatized Naming Test, Verbal Fluency, Boder (Reading and Spelling), and the Peabody Picture Vocabulary Test. Possible order effects were assessed by comparing (using ANOVA) the performance of subjects in the two test conditions.

Scoring of each test was done by the psychology technician and checked by the researcher. In the case of the determination of good phonetic equivalents on the Boder, the technician and the researcher independently scored each item. For items on which there was a difference of opinion, a consensus was reached using the guidelines in the Boder manual.

Data Analysis

The major variables of interest in this study were subtype of reading disability as determined by The Boder Test of Reading-Spelling Patterns and naming ability as measured by a battery of naming tests identified in the literature as relevant to reading disabilities. As discussed in the literature review, the essential component of the subtype diagnosis was the spelling of unknown words, expressed as a percentage with a range of possible responses from 0 to 100%. According to the Boder criteria, subjects in the dysphonetic and mixed dysphonetic-dyseidetic groups scored below 50% and subjects in the undetermined and dyseidetic groups scored above 50%. Since it was not established that performance on this task constituted a dichotomy rather than a continuum, the subject's scores (expressed as percentages) were used as the dependent variable in the regression analyses. For the primary regression analysis, two measures from the naming tests (i.e., latency scores on the rapid automatized naming of letters and number of spontaneously correct responses on the Boston Naming Test) were fitted into a multiple regression model as the independent variables. These two measures were identified by Wolf (1982) as the best predictors of overall reading ability. Of interest in this analysis was whether or not naming scores would predict spelling of unknown words and, thereby, predict whether or not subjects fell into the categories designated as dysphonetic or mixed dysphonetic-dyseidetic. If, as Boder proposed, subjects in these particular categories had reading difficulties because of underlying language-processing problems, then it would be predicted that these subjects would also do poorly on naming tasks. Conversely, subjects in the dyseidetic and nonspecific categories, according to Boder, did not have a language component "base" for their deficit. If, on the other hand, language problems underly all subtypes of reading disability (as proposed by Vellutino, 1977), then poor performance on naming tests would be associated with all of the reader subtypes.

A second level of data analysis involved the entering of all of the naming test scores (BNT-correct responses and latency, RAN-errors and latency, FAS and Animal/Food generation tasks-number of correct responses) into a multiple regression analysis with score on the spelling of unknown words as the dependent variable. Since the number of subjects in relation to the number of variables was not sufficient to draw conclusions concerning statistical significance (Roscoe, 1969), this multiple regression was done as an initial attempt to describe the best predictors among the naming tests given. This analysis was considered to be important in replicating the preliminary work of Wolf (1982) and in providing the groundwork for further research.

Further descriptive evaluation of the data gathered involved a qualitative analysis of subjects' patterns of responses on the naming tests. As described by Wolf, (1982), errors on the BNT were classified in terms of perceptual, semantic, and phonological components. In addition, tip-of-the-tongue data were gathered on the BNT. The FAS and Animal/Food Generation Tests were analyzed in terms of differences in phonological (FAS Test) and semantic (Animal/Food) fluency as well as the subject's use of organizational strategies. The RAN test was qualitatively analyzed in terms of use of strategies (e.g., counting set to name numbers), order of difficulty, and errors. The qualitative data were analyzed by comparing the reading disabled subjects as a group to other reading disabled groups, to normals and to aphasics as reported in the literature (e.g., Wolf, 1982). In addition, the performance in each of these areas by subjects in each of the reading disability subtypes was described.

Although the spelling of unknown words was the most critical aspect of the Boder subtyping, additional information was included in the final decision concerning the category in which a subject was placed (e.g., degree of reading disability as expressed by the reading quotient). Therefore, the original analyses of the data were repeated utilizing the reader subtype categories. In order to assess differences between reading disability subtypes, subjects in the dysphonetic and mixed dysphonetic-dyseidetic subgroups (N=28) were combined into a language disability group and compared to subjects in the dyseidetic and nonspecific reading retardation groups (N=13). As was discussed previously, subjects in these latter two groups were defined by Boder as not having language-processing problems and were, therefore, not expected to have greater than average difficulty on the naming tasks. Subjects in the language disability group and the presumed nonlanguage disability group were then compared using ANOVA to determine if there were significant differences on age, IQ, reading quotient, and selected naming tests (Peabody Picture Vocabulary Test, BNT, RAN-latency scores only, and FAS and Animal/Food generation tasks).

To address more directly the developmental issues discussed previously, subjects were divided into age groups of 8- to 9-year-olds (N=7) and 10- to 11-year-olds (N=31). These two groups were then evaluated using ANOVA to determine if there were significant differences between group means on selected naming tests (i.e., BNT, latency on the RAN, and the FAS and Animal/Food generation tasks). Results were compared to data collected on these two age groups by Wolf (1982).

CHAPTER IV

RESULTS

Subtypes of Reading Disabilities

Based on the Boder Test of Reading-Spelling Patterns, all 41 subjects met the criteria for one of the reading disability subtypes. No subjects were classified as undetermined. Thirty-two subjects fell into one of the dyslexia categories with the largest number of subjects (N=15, 36%) being classified as dysphonetic. Four subjects (10%) met the criteria for the dyseidetic subtype and thirteen subjects (32%) were classified as mixed dysphonetic-dyseidetic. Nine subjects (22%) fell into the nonspecific reading retardation subtype. These percentages were somewhat different from those reported by Boder (1982). For example, in the four studies reported by Boder, the dysphonetic category comprised an average of 61.7% of the total. An additional 13.1% were classified as dyseidetic and 18.6% as mixed dysphonetic-dyseidetic. Only 6.6% of the total of 420 subjects were classified as undetermined and no subjects met the criteria for nonspecific reading retardation. One reason for these differences may have been that the criteria used for admission into the studies reported by Boder were apparently more stringent than those in the current study.

Reading levels for the entire sample ranged from preprimer to fifth grade with a mean grade level of second grade (2.58 average). This clearly represented an overall depressed achievement level for subjects whose mean age was 10 years and mean grade level was fourth grade-nine months. Subjects in the dysphonetic and the nonspecific subtypes had the highest reading levels (means = 3.41 and 3.32 respectively) while subjects in the dyseidetic and mixed groups had lower reading levels (means = 2.09 and 1.50 respectively).

Reading quotients for the group as a whole ranged from a low of 50 to a high of 95 (mean = 71.80). As would be expected, since the reading quotient was based in part upon the reading level, subjects in the dysphonetic and nonspecific subtypes had the highest reading quotients (means = 79.27 and 79.11 respectively). Subjects in the dyseidetic subgroups earned a mean score of 71.00 while subjects in the mixed group achieved a mean score of only 57.84.

Scores (expressed as percents) on the spelling of known words ranged from 20% to 100% for the entire sample (mean = 60%). The non-specific reading retardation group spelled 83% of the known words correctly, reflecting essentially a normal spelling pattern. Both the dysphonetic and the mixed subgroups spelled 56% of the known words correctly while the dyseidetic group spelled only 45% of these words correctly. A histogram showing the distribution of these scores is shown in Figure 1.

Scores on the spelling of unknown words ranged from 0% to 100% for the entire sample (mean = 47%). The nonspecific reading retardation subgroup spelled an average of 71% of the unknown words correctly (or as good phonetic equivalents), again essentially a normal pattern. The dysphonetic and mixed subgroups spelled less than 50% of unknown words correctly or as good phonetic equivalents (mean = 32% and 25% respectively). Subjects in the dyseidetic group each spelled 60% of the unknown words adequately. Figure 2 shows a histogram of these scores and was interpreted as supporting the continuous nature of this measure. Visual inspection of both histograms suggests that, based on these samples, a cutoff score of 70 would have been more appropriate than the score of 50 designated in the Boder manual. See Appendix I for raw scores on the Boder.

Measures of Naming Ability

Boston Naming Test (BNT)

For the entire sample, the number of spontaneously correct responses ranged from 21 to 49 (mean = 37). Subjects in the nonspecific, mixed, and the dysphonetic subgroups all had means equal to 37 on this measure while subjects in the dyseidetic group had a mean of 36. Errors on the BNT ranged from 8 to 18 (mean = 14) for the entire sample. Dysphonetic subjects had the lowest number of errors (mean = 12) while mixed (mean = 13), nonspecific (mean = 14) and dyseidetic subjects (mean = 15) earned scores in that order. The average latency (expressed in seconds) per response ranged from .50 seconds to 2.61 seconds for the entire group (mean = 1.30). Nonspecific and dyseidetic subjects (means = .96 and 1.06 respectively) had the lowest average latencies while dysphonetic and mixed subjects had the highest average latencies (means = 1.36 and 1.52 respectively). See Appendix J for these results.

An analysis of the errors made on the BNT indicated that, for all of the reader subgroups, the largest number of errors were of the semantic type; i.e., responses related by function, context, or set membership to the target words. The second largest category of errors for each of the Boder subgroups was comprised of phonological errors, i.e.,

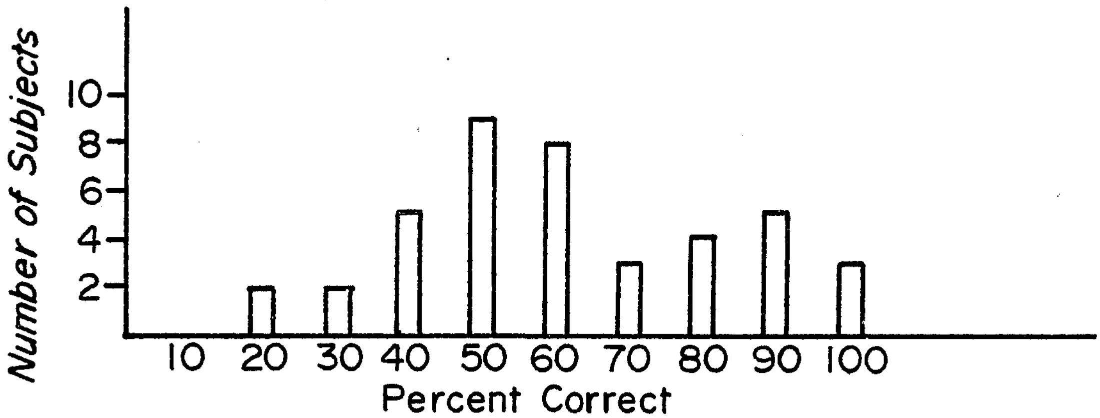

Figure 1 Histogram of Scores on Spelling of Known Words

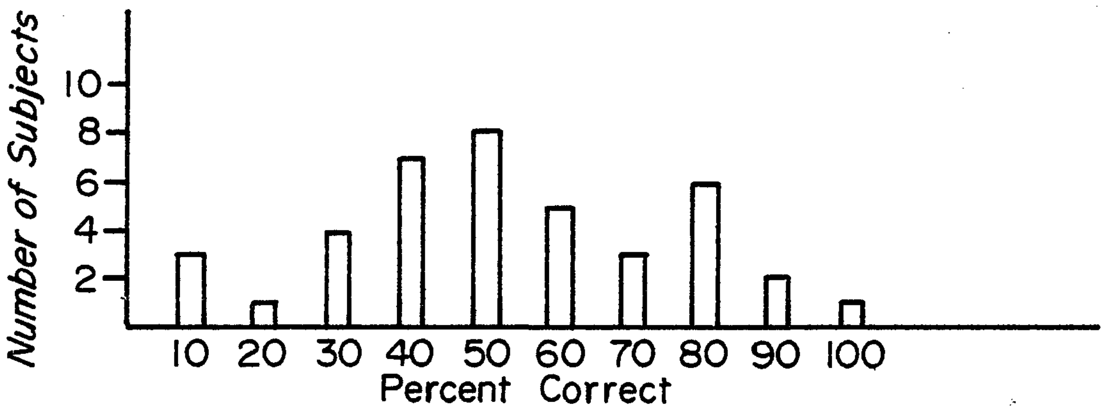

Figure 2 Histogram of Scores on Spelling of Unknown Words

responses linguistically similar to the target words. The smallest category included perceptual errors, i.e., responses based on visual similarity to the target words. In addition, a number of subjects gave responses which were circumlocutions (i.e., descriptions of the function of the target word) as well as responses which were combinations of the other error types. See Tables 1 and 2 for these results and examples of each error type.

In comparison to Wolf's (1982) data, subjects in this study demonstrated a somewhat different pattern of errors. For both groups of subjects, semantic errors represented the largest category of error types. However, the second largest group of error types for Wolf's subjects were responses based on visual similarity (perceptual) with phonological errors being less common. Wolf compared her subjects' response patterns to adult aphasics whose largest group of errors were phonological nonword responses. Error patterns of subjects in this study more closely resembled those of adult aphasics in that phonological responses comprised the second largest category of errors.

Table 1

Number of Errors by Category on the Boston Naming Test

	Category of Error		
Reader Subtype	Semantic	Perceptual	Phonological
Dysphonetic	80(50%)	23(14%)	58(36%)
Mixed	89(62%)	15(10%)	40(28%)
Dyseidetic	24(59%)	7(17%)	10(24%)
Nonspecific	59(59%)	14(14%)	27(27%)

Table 2

Examples of Errors on the Boston Naming Test

	Target	Child's Response
1. Semantically Related	accordion	keyboard
	muzzle	leash, mouth, harness
	harmonica	instrument
	globe	map
2. Phonologically Related	dominoes	dynomoes
	escalator	excellator
	funnel	figgle
	rhinocerous	rhinocerpot
3. Perceptually Related	stilts	crutches
	asparagus	thornes
	dominoes	blocks, dice
4. Circumlocution	noose	hanger-choker-knot
	yoke	oxen-holder
	muzzle	bite-holder
5. Combination	abacus	abicounter
	unicorn	hornican
	rhinocerous	ridonosaur

When performance on the BNT by poor readers was compared to that of average readers (Wolf, 1982), significant differences were found in favor of the average readers across several age groups. Subjects in the present study earned scores (number correct) on the BNT which were even lower than those reported for Wolf's poor reader groups. As in the Wolf study, subjects in the 8- to 9-year-old as well as the 10- to 11-year-old poor reader groups earned lower scores on the BNT than those earned by the 6- to 7-year-old average readers. See Table 3 and Figure 3 for these results.

The ability of subjects to respond to prompts or to tip-of-the-tongue probes was generally low. Semantic prompts were particularly unhelpful in soliciting the correct answer. Only one subject retrieved a target word following a semantic prompt. While phonemic cues were more helpful as prompts, the number of correct responses following such cues was generally low. The range was from 0 to 4 with only one subject in the nonspecific group making 4 correct responses following phonemic prompts and 15 subjects making no such responses. Correct responses to tip-of-the-tongue probes were also very infrequent (5 correct responses following a total of 146 tip-of-the-tongue probes). Although accurate retrieval following tip-of-the-tongue probes was uncommon, 31 subjects were able to demonstrate tacit knowledge of the target words. For example, many subjects were able to give accurate information concerning the beginning sounds, sounds contained in the word, or the number of syllables in the words.

Table 3

Group Means on Boston Naming Test

	Age		
Group	6-7 (SD)	8-9 (SD)	10-11 (SD)
Average Readers [a]	54.82 (6.57)	58.27 (4.71)	66.40 (4.99)
Poor Readers [b]	32.82 (8.76)	48.80 (8.63)	50.36 (8.58)
Poor Readers [c]	-----	33.29 (8.07)	37.42 (5.25)

[a] Wolf, 1982
[b] Wolf, 1982
[c] Felton, 1983

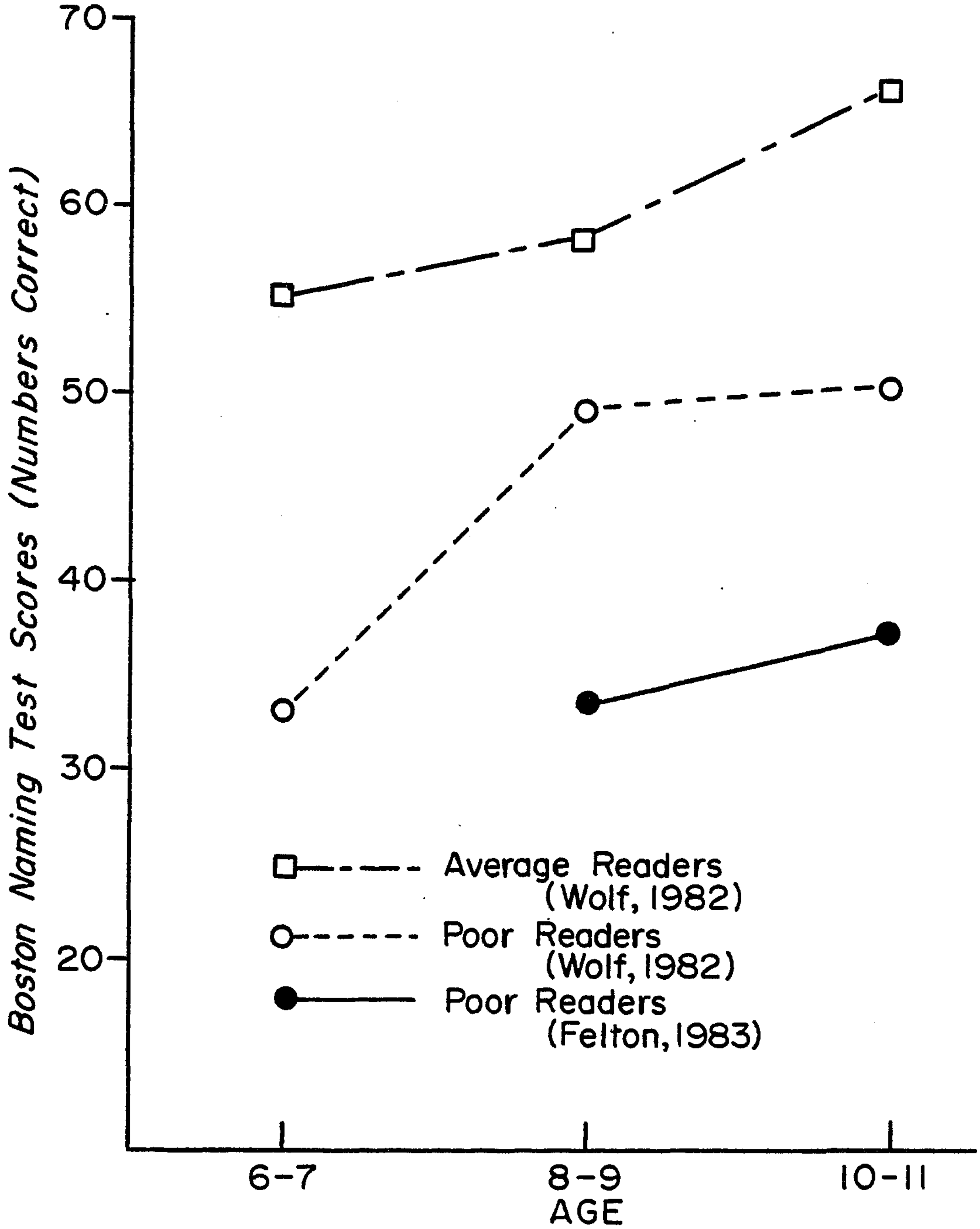

Figure 3 Comparison of BNT Scores of Poor Readers and Average Readers

Rapid Automatized Naming Tests (RAN)

Scores (latency and errors) on the RAN were gathered separately for each of the subtests, i.e., colors, numbers, objects and letters. For the entire sample, the mean latency score on colors was 52.63 seconds with a range of 30 seconds to 123 seconds. The group mean latency score on numbers was 33.92 seconds with a range of 20 seconds to 70 seconds. On object naming, the entire group's latency scores ranged from 40 seconds to 127 seconds with a mean of 68.78 seconds. Latencies for letter naming ranged from 20 seconds to 89 seconds (mean = 37.73). Thus, the order of difficulty (as measured by time required to name) for the four categories was objects (the most time consuming), colors, letters and numbers. This replicated the order of difficulty for normal and learning disabled subjects as reported by Denckla (1976b). See Appendix K for latency and error raw scores.

In 1977, Denckla defined slow performance on the RAN as 1.5 standard deviations longer than the average time required, for a child's age group, to name items. Using this criterion, 12 subjects (30%) were slow on color naming, 20 (50%) were slow on number naming, 15 (36%) were slow on object naming and 30 (73%) were slow on letter naming. Subjects with slow performance were fairly evenly distributed within each of the Boder subgroups.

Also, as reported by Denckla, errors on all naming tasks were low (range from 0 to 13) with most subjects making no more than four errors on any one subtests. Errors that were made involved reversals of letters (e.g., b for d), substitutions of items related to the target but not included in the test (e.g., brush for comb, orange for yellow), and substitutions of one item in the set for another (e.g., umbrella for watch). Several subjects became very agitated and/or very active during the RAN tests. One subject almost hyperventilated and another rocked so hard that he nearly fell out of his chair. A strategy used by a number of subjects involved pointing to each object or tapping as they named items. One subject actually moved his hands to demonstrate the use of each object as they were named.

Wolf (1982) administered the colors, and letters, and numbers sections of the RAN to average and poor readers and found significantly shorter latencies for the average reader group on all subtests (with the exception of numbers for the 8- to 9-year olds). When subjects in the current study were compared to Wolf's, their latency scores were very comparable to her poor readers in the 8- to 9-year-old group as well as in the 10- to 11-year-old group. See Table 4 for these results.

Verbal Fluency Tests

On the linguistic fluency tests (naming words beginning with F, A, or S), the subjects as a whole named an average of 21 items (range = 9 to 34). On the semantic fluency tests (naming animals and foods), the entire group named an average of 28 items (range 16 to 47). These results reflected the expected semantic-linguistic difference reported by other researchers (e.g., Wolf, 1982). Raw scores are reported in Appendix L.

When scores on the FAS test were compared to published norms (Gaddes & Crockett, 1975), only in the dysphonetic group did a majority (60%) of the subjects have scores greater than one standard deviation below the mean for their age. In the mixed dysphonetic-dyseidetic group, 46% of the subjects had scores greater than one standard deviation below the mean. The number of subjects scoring more than one standard deviation below the mean was much lower for the dyseidetic and the nonspecific groups (i.e., 25% and 22%). For all of the subgroups, the remaining subjects scored within one standard deviation of the mean with no subject earning a score greater than one standard deviation above the mean.

Table 4

Group Means on Rapid Automatized Naming - Latency

	Age					
Group	6-7	(*SD*)	8-9	(*SD*)	10-11	(*SD*)
Average Readers [a]						
Colors	46.82	(6.71)	41.27	(5.12)	36.00	(5.21)
Numbers	35.64	(7.15)	31.64	(9.24)	21.50	(4.28)
Letters	30.91	(5.43)	23.82	(3.19)	21.90	(3.14)
Poor Readers [b]						
Colors	60.09	(11.40)	50.60	(10.80)	46.82	(8.10)
Numbers	52.00	(7.46)	35.10	(15.13)	28.73	(4.17)
Letters	58.64	(16.32)	35.30	(6.22)	30.00	(3.13)
Poor Readers [c]						
Colors	-----		49.43	(6.19)	53.36	(19.17)
Numbers	-----		32.43	(2.99)	33.65	(11.68)
Objects	-----		70.00	(18.65)	69.48	(21.65)
Letters	-----		36.14	(8.40)	37.84	(14.74)

[a] Wolf, 1982
[b] Wolf, 1982
[c] Felton, 1983

In 1982, Wolf administered the F and animal portions of the verbal fluency tests and found that the poor readers scored significantly lower on both tests than did the average readers. Wolf noted that subjects in the 10- to 11-year-old group earned lower scores than the 6-to 7-year-old average readers and that little progress was noted from the 8-9 to the 10- to 11-year-old poor reader groups. Subjects in the current study were compared to Wolf's 8-9 and 10- to 11-year-old groups. The 8- to 9-year-olds scored lower on both the F and Animal tests than did Wolf's subjects. The 10- to 11-year-olds scored slightly higher on the Animal test and lower on the F test when compared to Wolf's subjects. Both 8-9- and 10-11-year-olds in the current study earned scores on both verbal fluency tests which were lower than the youngest (ages 6-7) of Wolf's average reader groups. These findings are summarized in Table 5 and Figures 4 and 5.

Table 5

Group Means on Animal and F Tests

	Age		
Group	6-7 (SD)	8-9 (SD)	10-11 (SD)
Animal Test			
Average Readers [a]	15.36 (3.61)	18.18 (5.91)	19.50 (3.31)
Poor Readers [b]	8.18 (3.28)	14.80 (3.80)	14.45 (4.11)
Poor Readers [c]	-----	12.71 (3.82)	15.13 (3.61)
F Test			
Average Readers [a]	10.09 (2.70)	12.00 (3.03)	16.10 (3.54)
Poor Readers [b]	4.81 (3.22)	8.00 (3.27)	9.64 (3.36)
Poor Readers [c]	-----	5.71 (2.29)	7.52 (3.48)

[a] Wolf, 1982
[b] Wolf, 1982
[c] Felton, 1983

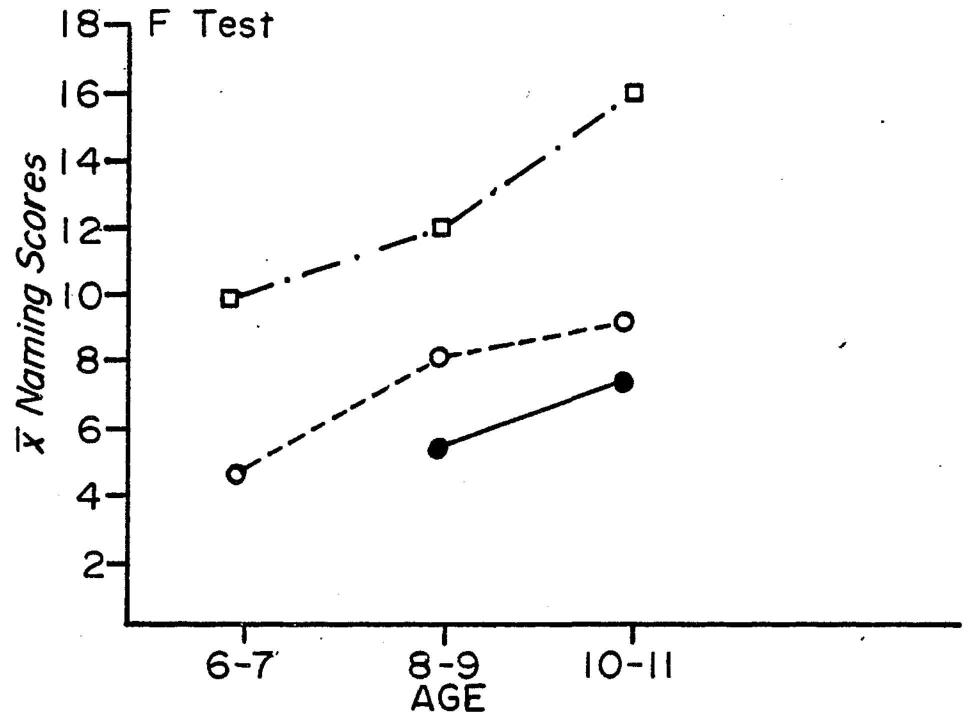

Figure 4 Comparison of F Test Scores of Poor Readers and Average Readers

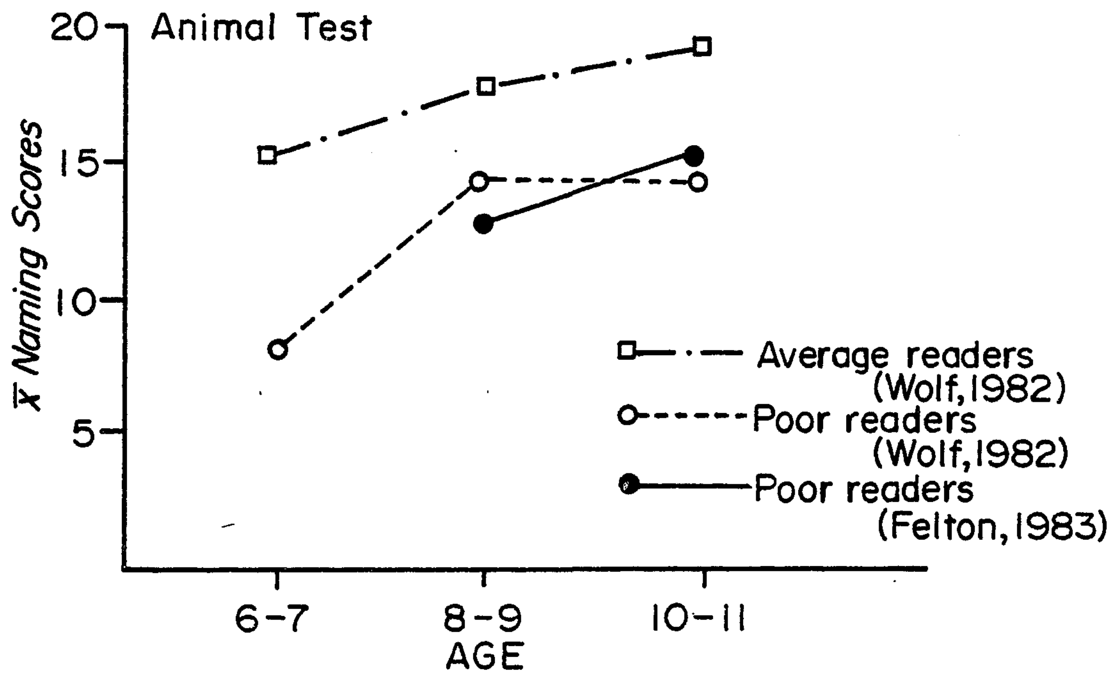

Figure 5 Comparison of Animal Test Scores of Poor Readers and Average Readers

The majority of subjects in all of the Boder subgroups employed some strategies on both the semantic (animal/food) and the linguistic (FAS) portions of the verbal fluency tests. The most common strategies on the animal/food tests involved chunking items according to one of several categories, e.g., breakfast foods, foods used in sandwiches, wild animals, farm animals, fruits, vegetables, etc. On the FAS tests, subjects tended to group words beginning with the same two letters, e.g., a string of "fr" words. Many subjects in each subgroup were unable to name items for the entire 60 seconds and would frequently have long periods of silence followed by a word or two and silence again. One dysphonetic subject who became overly active during the tests was able to name very few items in any of the categories. Only in the mixed dysphonetic-dyseidetic group did any subjects give a number of incorrect reponses. For example, one subject in the mixed group gave the word "are" for the A category and proceeded to switch to words beginning with "r" for the remainder of the test. Another subject in this group gave "V" words for the F category and still another gave "O" words for the A category. In general, the mixed group (composed of the lowest functioning readers) appeared to have the most difficulty in utilizing appropriate organizational strategies and in applying adequate auditory discrimination skills to the verbal fluency tasks.

Peabody Picture Vocabulary Test-Revised (PPVT-R)

The mean standard score equivalent on the PPVT-R for the entire group was 92.54 with a range from 75 to 121. According to the PPVT-R manual, these scores ranged from moderately low to moderately high and fell within two standard deviations (plus or minus) of the mean for the PPVT-R.

Correlations

In order to evaluate the construct validity of variables important to this study, several correlations were calculated. The number of items correct on the BNT was positively correlated with scores on the PPVT-R (.54) and verbal IQ scores (.37). This measure, however, was not correlated with the Reading Quotient (.08). Conversely, latency on the letter subtest of the RAN was not highly correlated with the PPVT-R (.14) or Verbal IQ scores (.11) but was inversely correlated with the Reading Quotient (-.63). Number correct on the BNT and latency on the RAN letters, the two measures used in the primary regression, were not correlated (-.02).

Order Effects

Subjects who received test order number one (N=23) were compared to those receiving test order number two (N=18) on nine naming measures. When analyses of variance were used to test for differences between groups, none of the differences was found to be significant (all p's $>$ .10). See Table 6 for these results.

Regression Analyses

The multiple regression analysis using number correct on the Boston Naming Test and latency on letter naming of the Rapid Automatized Naming Test to predict percentage correct on the spelling of unknown words indicated that there was no linear relationship between these variables. The multiple R was .0246 with a multiple R^2 equal to only .0006 indicating that almost none of the variance in the spelling of unknown words was explained by performance on the BNT or the letter naming test of the RAN. The formal results of this analysis are presented in Table 7.

Table 6

Analyses of Variance Comparing Test Order One to Test Order Two

Variables	Source	Sum of Squares[a]	Mean Square	*F*	*p*
BNT-correct	Between	17.18	17.18	.43	.514
	Within	1548.87	39.71		
BNT-latency	Between	.31	.31	1.58	.216
	Within	7.75	.20		
RAN-colors	Between	80.92	80.92	.28	.600
	Within	11336.59	290.68		
RAN-numbers	Between	.01	.01	.00	.99
	Within	4386.77	112.48		
RAN-objects	Between	697.97	697.97	1.69	.200
	Within	16071.05	412.08		
RAN-letters	Between	13.88	13.86	.07	.788
	Within	7432.19	190.57		
FAS test	Between	43.78	43.78	1.03	.315
	Within	1651.98	42.36		
Animal/Food	Between	236.36	236.36	6.20	.017
	Within	1486.86	38.12		

[a] *df* for Between Groups = 1
df for Within Groups = 39

Table 7

Test for Significance of BNT and RAN-letters

in Predicting Unknown Words

Sum of Squares		df	Mean Square	F Ratio	p
Regression	13.42	2	6.71	.01	.99
Residual	22225.60	38	584.88		

The second multiple regression analysis involved the prediction of unknown words (percentage correct) using the following naming test scores: BNT-number correct and latency, RAN-latency and errors for colors, numbers, objects and letters, and the FAS and animal/food generation tests. As in the previous regression, the results indicated no significant linear relationship. The multiple R was .6179 with a multiple R^2 equal to .3819 and $p=.21$. See Table 8.

Table 8

Test for Significance of all Naming Tests

in Predicting Unknown Words

Sum of Squares		df	Mean Square	F Ratio	p
Regression	8492.20	12	707.68	1.441	.21
Residual	13746.82	28	490.96		

Analyses of Variance

Boder subtypes

Subjects were divided into two groups according to Boder subtype (i.e., language disability-dysphonetic and mixed subtypes and nonlanguage disability-dyseidetic and nonspecific subtypes). One-way analyses of variance were carried out to determine whether or not there were significant differences between these two groups on a variety of naming measures, i.e., PPVT, BNT-number correct and latency, RAN-latency, FAS and animal/food generation tasks. In addition, possible differences in age, IQ, and reading quotient were assessed in the same manner. In order to decrease the chances of making a Type I error, the preset significance level of .05 was divided by the number of variables tested (14) and determined to be .004. Using this criterion, the only significant difference found between the language disability and nonlanguage disability groups was on the latency measure of The Boston Naming Test. Subjects in the language disability group took significantly (p=.002) longer to name items on this test than did the subjects in the nonlanguage disability group. P values for the other variables ranged from .19 to .99. See Tables 9 and 10. Using Levene's Test for Equal Variances (Levene, 1960), it was determined that there were no significant differences between variances on any of the variables tested. This information is summarized in Table 11.

Age

For this analysis subjects were divided into two groups: 8- and 9-year-olds (N=7) and 10- and 11-year-olds (N=31). Using analysis of variance, these two groups were compared on the BNT-number correct and latency on each of the RAN tests, and the FAS and Animal/Food generation tests. As before, the preset significance level (.05) was divided by the number of ANOVA's to be done (8) and determined to be .006. Using this standard, there were no significant age group differences. Differences

Table 9

Analyses of Variance Comparing Language to Nonlanguage Disability Groups on Naming Tests

Variable	Source	Sum of Squares[a]	Mean Square	*F*	*p*
PPVT	Between	101.54	101.54	.74	.393
	Within	5316.66	136.32		
BNT-correct	Between	.26	.26	.01	.936
	Within	1565.79	40.15		
BNT-latency	Between	1.75	1.75	10.82	.002
	Within	6.31	.16		
RAN-colors	Between	501.95	501.95	1.79	.188
	Within	10915.56	279.89		
RAN-numbers	Between	5.44	5.44	.05	.826
	Within	4381.34	112.34		
RAN-objects	Between	390.15	390.15	.93	.341
	Within	16378.88	419.97		
RAN-letters	Between	79.17	79.17	.42	.521
	Within	7366.88	188.89		
FAS test	Between	21.85	21.85	.51	.479
	Within	1673.91	42.92		
Animal/Food	Between	.27	.27	.01	.937
	Within	1722.95	44.18		

[a] *df* for Between Groups = 1
df for Within Groups = 39

Table 10

Analyses of Variance Comparing Language to Nonlanguage Disability Groups on Age, IQ, and Reading Quotient

Variable	Source	Sum of Squares[a]	Mean Square	*F*	*p*
Age	Between	1.47	1.47	1.70	.199
	Within	33.69	.86		
Verbal IQ	Between	1.59	1.69	.02	.893
	Within	3393.92	87.02		
Performance IQ	Between	124.48	124.48	1.26	.268
	Within	3857.03	98.90		
Full Scale IQ	Between	36.59	36.59	.60	.442
	Within	2369.60	60.76		
Reading Quotient	Between	472.33	472.33	3.41	.072
	Within	5399.18	138.44		

[a] *df* for Between Groups = 1
df for Within Groups = 39

Table 11

Levene's Test for Equal Variances: Language and Nonlanguage Disability Groups Compared on Naming, IQ, Age, and Reading Quotient

Variable	*F* Value	*p* Value
BNT-Correct	.18	.671
BNT-latency	1.89	.178
RAN-colors	1.60	.213
RAN-numbers	.02	.894
RAN-objects	.01	.929
RAN-letters	1.38	.248
FAS test	.14	.713
Animal/Food test	.02	.875
Age	.06	.815
Verbal IQ	.02	.890
Performance IQ	.15	.700
Full Scale IQ	.21	.652
Reading Quotient	2.04	.160

in latency on the BNT approached significance (.020) with the older age group being slower than the younger group. These results are summarized in Table 12.

Table 12

Analyses of Variance Comparing 8- to 9-Year-Olds to 10- to 11-Year-Olds on Naming Tests

Variables	Source	Sum of Squares[a]	Mean Square	F	p
BNT-correct	Between	97.58	97.58	2.89	.098
	Within	1216.98	33.80		
BNT-latency	Between	1.12	1.12	5.87	.020
	Within	6.84	.19		
RAN-colors	Between	88.03	88.03	.28	.599
	Within	11256.81	2.69		
RAN-numbers	Between	8.45	8.45	.07	.788
	Within	4144.81	115.13		
RAN-objects	Between	1.52	1.52	.00	.954
	Within	16147.74	448.55		
RAN-letters	Between	16.42	16.42	.09	.772
	Within	6941.05	192.81		
FAS test	Between	196.52	196.52	4.94	.032
	Within	1430.98	39.75		
Animal/Food	Between	134.72	134.72	3.41	.073
	Within	1422.86	39.52		

[a] df for Between Groups = 1
df for Within Groups = 36

CHAPTER V

DISCUSSION

The stated purpose of this research was to examine the relationship between language disorder, as indexed by dysnomia, and subtypes of reading disabilities. The specific question was whether dysnomia differentially characterized some types of reading problems but not others. The initial approach to investigating this question, involved the prediction of the subjects' scores on the spelling of unknown words (expressed as percentages). As discussed previously, this score was crucial in the determination of whether a subject met the criteria for a non-language-based reading disability (i.e., nonspecific reading retardation or dyseidetic dyslexia) or for a language-based disability (i.e., dysphonetic or mixed dysphonetic-dyseidetic dyslexia). Two multiple regressions (the first utilizing latency scores on the RAN-letter naming test and number correct on the BNT, and the second entering BNT-number correct and latency, RAN-latency and errors for all subtests, and the FAS and animal/food generation tests) were carried out with spelling of unknown words as the dependent variable. In both of these analyses, the results indicated no significant linear relationships (p's = .99 and .21) between the measures of word-retrieval and one crucial aspect of the subtyping.

Recognizing that the reading disability subtype classifications included more than the score on spelling of unknown words, a further attempt to investigate the relationship between dysnomia and subtypes was carried out using the actual categories. Subjects in the nonlanguage disability group (nonspecific reading retardation and dyseidetic) were compared to those in the language and nonlanguage disability groups (dysphonetic and mixed) on a variety of naming measures. Using analyses of variance, subjects in the language and nonlanguage disability groups were significantly different on only one naming measure, i.e., latency on the BNT. Subjects in the language group took significantly longer to name items than did subjects in the nonlanguage disability group. Since this finding was not predicted in advance, further research will be necessary before any conclusions are drawn concerning its significance.

In general, therefore, this study failed to confirm the differential relationship of dysnomia with some, but not other, subtypes of reading disabilities. Given the size of the p values involved (i.e., .99 and .21), this finding was considered unambiguous at least in regard to the specific instruments used to measure dysnomia and reading subtypes. In view of the finding that subjects classified according to the Boder subtypes did not differ significantly on the majority of the naming measures, the question was then raised concerning the subjects' actual performance on the naming tests as well as the construct validity of the naming measures.

The number correct on the BNT was positively correlated with the PPVT-R and Verbal IQ. This measure was not, however, correlated with the reading quotient, a measure of the severity of the reading disability which included reading level and IQ. Latency on the letter subtest of the RAN was highly inversely correlated with the reading quotient but not with the PPVT-R or Verbal IQ. In addition, RAN-letters (latency) and BNT (number correct) were not correlated with each other. These correlations suggest that the BNT and RAN do validly measure different aspects of reading and language skill--the BNT appears to reflect general verbal ability (especially vocabulary), while the RAN relates specifically to reading ability, with intelligence controlled for.

These findings failed to confirm the results obtained by the Wolf and Morris (1982) longitudinal study in which the BNT (errors and latency) was the best single predictor of oral reading performance as well as silent comprehension in grade one. In a cross-sectional study, Wolf (1982) also found the BNT (number correct) to be the naming test which was most highly correlated with several measures of reading. Wolf hypothesized that this finding was due to the requirement on the BNT for more cognitive and linguistic processes than are required in the other naming tests. Differences between the present study and the Wolf data were also found in regard to the correlations between other naming tests and measures of reading. For example, Wolf found latency on the RAN-color, number and letter tests to be highly inversely correlated (r's from -.59 to -.77) with tests of reading. With the exception of latency on letter naming ($r = -.63$) correlations between the RAN tests and reading quotient were lower in this study (r's from -.21 to -.48). Thus, the present study confirmed the relationship of measures of speed in naming to reading ability but failed to confirm such a relationship for the number of items correctly answered on the BNT. Differences between the Wolf studies and the present study may have been due to differences in the age of the subjects (Wolf's studies included many more young children) or differences in the instruments used to measure reading level.

Clearly, the subjects in this study had significant and noteworthy deficits. Overall, only two subjects (in the dysphonetic group) had normal scores on all of the six basic naming measures (i.e., BNT-number correct, RAN-latency, and linguistic fluency). All of the other subjects had scores two standard deviations or more away from the mean (indicating poor performance) on at least one naming test. (For this assessment, norms on the BNT were used which reflected a slightly different administration procedure). Of the subjects who scored below the norm on at least one naming test, for all but one subject the low scores included either the number correct on the BNT or latency on the RAN-letter naming test. For 15 subjects, both of these measures were included in their low scores. The majority of subjects in both the language and nonlanguage disability groups earned scores at least three standard deviations away from the mean, in the deficient direction.

Additional evidence for word-retrieval problems in both the language and nonlanguage-deficit groups was found in an analysis of errors on the BNT. Subjects in each of the Boder subtypes demonstrated the same types of errors and the same order of occurrence of those errors. In this respect, subjects in this study, as compared to Wolf's (1982), more closely resembled adult aphasics in making a preponderance of phonological errors. In further comparison to performances on naming tests reported by Wolf (1982), subjects in the present study earned significantly lower scores than the average readers and, in some cases, lower scores than the reading disabled subjects. As in the Wolf study, subjects (ages 8-12) earned lower scores on the BNT, RAN-latency, F and animal fluency tests than did the youngest (ages 6-7) average readers.

A related issue addressed by this study concerned the nature of the retrieval problems found in the disabled readers. Specifically, the question was posed as to whether the naming problems constituted a maturational lag or an actual deficit. Wolf (1982) addressed this issue in a cross-sectional study and concluded that the pattern of scores on naming tests across ages 6 to 11 indicated qualitatively different development as opposed to merely a maturational lag. When subjects in the present study were divided into age groups comparable to Wolf's two older groups (i.e., 8- to 9- and 10- to 11-year-olds) and performance on namingtests compared, the results were quite similar. That is, subjects showed very little improvement from ages 8-9 to 10-11 and scores for both of these age groups were below those recorded by Wolf for the 6- to 7-year-old average readers. Further support for the appropriateness of deficit model was found by comparing the graphs in Tables 3, 4, and 5 to the paradigms proposed by Rourke (1976). These graphs, which compared the performance of average readers to poor readers on naming tasks, closely resembled the type 5 paradigm identified by Rourke as indicative of a deficit rather than a developmental lag. In this paradigm, between-group differences become particularly pronounced at some point in the developmental scheme and, beyond that point, reading disabled subjects fall progressively farther behind normal readers. Therefore, the findings of this study supported the deficit hypothesis and suggested that, for many reading disabled children, naming skills fail to develop normally rather than merely developing more slowly.

Inspection of the data concerning the subjects' tacit knowledge of vocabulary (i.e., tip-of-the-tongue responses and the Peabody Picture

Vocabulary Test-Revised) indicated better performance in these areas than on the timed retrieval tests. For example, the majority of subjects were able to correctly identify aspects of many target words and indicated their general knowledge of items in spite of an inability to retrieve the specific label. Scores on the _PPVT-R_ for all subjects, fell within two standard deviations of the mean and were, therefore, less deviant than many of the naming scores. This data supported the finding by Wolf (1982) that reading disabled subjects were similar to the average readers on measures of tacit knowledge of vocabulary.

CHAPTER VI

CONCLUSIONS AND RECOMMENDATIONS

This research addressed the following three questions:

1. Does dysnomia, as indicated by performance on a battery of naming tests, differentiate between subtypes of reading disability?

2. How does word-retrieval performance of reading disabled subjects compare to other groups (both disabled and average readers)?

3. If impaired, is this performance indicative of a developmental lag or a deficit?

In regard to the first two questions, the naming-test battery clearly did not differentiate between the reading disability subtypes as diagnosed by the Boder test. Subjects in each subtype demonstrated significant word-retrieval problems in comparison both to established norms as well as to other reading disabled and average readers. Only one naming test (latency on the BNT) discriminated between language and nonlanguage disability groups. These findings are in contrast to studies by Mattis and his colleagues (e.g., Mattis, 1978) in which dysnomia characterized only 39% to 63% of reading disabled subjects. Since the single naming test used by Mattis measured only errors and not latency, differences in these findings may have due to the greater sensitivity of the naming battery used in the present study. An alternative explanation could be that the Boder test did not accurately subtype children and that subjects identified as having nonlanguage-based disabilities were incorrectly classified.

Given that there may be alternative explanations, the findings as they stand offer support for the verbal processing deficiency theory proposed by Vellutino (1977) in which difficulties in one or more aspects of language underlie all reading disabilities. These data are also suggestive of the findings reported by Rudel (1981) in which learning disabled subjects both with and without reading deficits performed more poorly on tests of naming than did non-learning disabled subjects. Of particular interest is the finding that subjects identified by the Boder test as having nonspecific reading disability (i.e., reading problems due not to dyslexia but to a variety of other primarily environmental factors) demonstrated equally as poor performance on the naming tests as did the dyslexia groups.

The potential importance of the automaticity or speed of retrieval, as emphasized by Denckla (1979), was also suggested by this study. Speed of naming on the Boston Naming Test was the only naming measure that differentiated between subjects in the language versus the non-language groups. This outcome, standing alone as a post-hoc finding, is only suggestive. In addition, latency scores on the RAN-naming tasks were inversely correlated with the reading quotient, a measure of the discrepancy between a person's expected and actual reading level. That is, the slower subjects on the naming tasks also had the lowest reading levels in relation to their expected achievement levels. For this sample of learning disabled subjects, speed of retrieval rather than accuracy was the more important factor.

Data concerning question number three is somewhat limited due to the cross-sectional nature of the study, the lack of younger subjects, and the sample size. However, in partial replication of the study by Wolf (1982), these data suggest that the difficulties in word-retrieval demonstrated by reading disabled children reflected a deficit rather than a maturational lag.

In conclusion, the results of this study confirmed the relationship of dysnomia to reading disability but failed to confirm a differential relationship with particular subtypes. While many questions remain concerning this relationship, the importance of dysnomia as a factor in reading disabilities--both in treatment and prevention--has been further emphasized. While not implying that dysnomia is the cause of all reading problems, this study did lend some support to Denckla's contention that "a serious dysnomia is sufficient to predict long-lasting, 'hard-to-learn' dyslexia" (1979, p. 553). The mechanisms by which dysnomia affects reading acquisition and development remain to be explored.

Numerous questions raised by this study deserve further research. One major issue which should be addressed concerns the possible effect of attentional factors on word-retrieval skills. The importance of attentional factors in naming has been emphasized previously (e.g., Denckla & Rudel, 1976b; and Rudel, in press), but has not been controlled for in studies like the present one. In addition, the relationship between many aspects of memory (e.g., strategies such as "chunking" and initial labeling) and dysnomia should be systematically explored.

The remedial implications of dysnomia have not been systematically investigated. Several questions need to be addressed in this regard.

For example, is the encoding process deficient in dysnomic children or is the problem primarily one of retrieval from the memory store? If encoding is part of the problem, what teaching methods can be used to enhance this process? Once an item has been stored in memory, what techniques (e.g., cueing and overlearning) can be used to aid in rapid retrieval of the item. If remediation of dysnomia is begun early and pursued systematically, will the development of reading skills be enhanced?

The validity of the Boder Test as a tool for subtyping reading disabilities remains an issue. Studies comparing the Boder to other methods of subtyping as well as measures of stability over time and relationship to teaching methods remain to be explored. Longitudinal research involving larger numbers of children (e.g., the study by Wolf and Morris which is currently underway) will be necessary to address more clearly the issue of developmental lag versus deficit. The major finding of this study, that dysnomia characterized all subtypes of reading disability, needs to be replicated with other subtyping methods and with larger groups of children studied over time.

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APPENDIX A

RAPID AUTOMATIZED NAMING AGE NORMS

Color	5	6	7	8	9	10
Males (mean)	76	59	56.3	54.7	46.5	42.3
(mean & 1 SD)	109	76	67.0	62.0	58.0	50.0
Females (mean)	65	57	52.4	49.0	40.4	41.1
(mean & 1 SD)	82	74	61.0	60.0	47.0	47.0
Numbers						
Males and Females (mean)	61	45	34	31	26	24
(mean & 1 SD)	87	61	41	37	34	28
Use Objects						
Males and Females (mean)	85	71	70	62	48	50
(mean & 1 SD)	104	92	94	75	59	61
Small Letters						
Males and Females (mean)	56	43	33	31	25	24
(mean & 1 SD)	79	62	40	38	30	26

APPENDIX B

LINGUISTIC FLUENCY AGE NORMS

	Female			Male			Total		
Age	*N*	mean	*SD*	*N*	mean	*SD*	*N*	mean	*SD*
6	30	4.6	5.0	22	4.1	4.1	52	4.4	4.6
7	24	16.0	7.3	27	14.1	6.5	51	15.0	6.9
8	23	23.1	5.7	25	22.5	7.7	48	22.8	6.8
9	30	25.0	7.3	23	22.6	6.4	53	24.0	6.9
10	25	27.4	7.1	25	23.8	8.2	50	25.6	7.8
11	22	31.1	6.8	22	28.2	8.1	44	29.7	7.6
12	13	32.0	6.8	13	29.4	8.1	26	30.7	7.4
13	12	37.3	5.8	17	28.8	8.3	29	32.3	8.4

APPENDIX C

SPECIFIC LEARNING DISABILITIES: THE DIAGNOSTIC PROCESS GUIDELINES

I. Definition of Specific Learning Disabilities

A pupil who has a specific learning disability is one who has a severe discrepancy between ability and achievement and has been determined by a multidisciplinary team not to be achieving commensurate with his/her age and ability levels. The lack of achievement is found when the pupil is provided with learning experiences appropriate for his/her age and ability levels in one or more of the following areas: oral expression, listening comprehension, written expression, basic reading skills, spelling, reading comprehension, mathematical calculation, or mathematical reasoning. The term does not include pupils whose severe discrepancy between ability and achievement is primarily the result of a visual, hearing, or motor handicap; mental retardation; emotional disturbance; or environmental, cultural, or economic disadvantage.

II. The Diagnostic Process

The diagnosis of a potential pupil with specific learning disabilities involves four essential steps: (1) Determining the pupil's current intellectual functioning. (2) The calculation of an expected grade level functioning based upon the results of an intelligence test. (3) Determining the amount of discrepancy from the expected academic performance and current academic performance. (4) Accounting for the achievement discrepancy by utilizing an item analysis to indicate specific processing or other deficits. All four steps have to be completed before the pupil can be described as having specific learning disabilities.

III. Step 1: What is the pupil's current intellectual functioning?

An individually administered, norm relevant intelligence test shall be administered to all potential specific learning disability pupils (Screening tests of intelligence are excluded from use, i.e., Slosson Inelligence Test and PPVT).

<u>Step 2: The Calculation of an expected grade level functioning based upon the results of an intelligence test.</u>

(a) Obtain the intelligence test score. (IQ)

1. Use Full Scale IQ Score if discrepancy between Verbal IQ Score and Performance IQ Score is 10 or less.

2. Use Verbal IQ Score if discrepancy between Verbal IQ Score and Performance IQ Score is 11 or more. The Verbal Scale Score is an indicator of academic performance.

3. Performance Score should only be used if there is an identified language disability and if the Performance Score represents the student's actual in-school functioning.

(b) Obtain the Student's chronological age. (CA)

(c) Substitute that information in the following formula:

$$\frac{IQ}{100} \times (C.A. - 5.5) = \text{Expected Grade Achievement}$$

(d) Convert chronological age and approximate school entry age (5.5 or 5½ years) to months.

(e) Example: If the obtained IQ is 110 and the student's chronological age is 12-0:

$$\frac{110}{100} \times (144 - 66) = \text{Expected Grade Achievement}$$

$$\frac{110}{100} \times 78 = \text{Expected Grade Achievement}$$

$$1.1 \times 78 = \text{Expected Grade Achievement}$$

$$85.8 \div 12 = 7 \text{ years, } 1.8 \text{ months}$$

$$7 \text{ years, } 2 \text{ months} = \text{Expected Grade Achievement}$$

<u>Step 3: Determine the amount of discrepancy from the expected academic performance and current academic performance.</u>

(a) Obtain current achievement test scores in any of the achievement areas under consideration.

(b) Subtract the Expected Grade Achievement Score from the Current Grade Achievement Score.

(c) Compare that difference score to the Degree of Severity Index utilizing the student's current grade placement.

(d) Define the pupil's achievement level as falling within the Mild, Moderate, or Severe level of discrepancy, as follows:

MILD	• In Kindergarten: At Grade level to 6 months behind • In Grade 1: At Grade Level to 8 months behind • In Grades 2 & 3: At Grade Level to 10 months behind • In Grades 4-6: At Grade Level to 20 months behind • In Grades 7-12: At Greade Level to 30 months behind
MODERATE	• In Kindergarten: 6 to 10 months behind • In Grade 1: 8 to 15 months behind • In Grades 2 & 3: 10 to 20 months behind • In Grades 4-6: 20 to 30 months behind • In Grades 7-12: 30 to 40 months behind
SEVERE	• In Kindergarten: 10 or more months behind • In Grade 1: 15 or more months behind • In Grades 2 & 3: 20 or more months behind • In Grades 4-6: 30 or more months behind • In Grades 7-12: 40 or more months behind

APPENDIX D

LETTER OF EXPLANATION TO PARENTS

Dear _________________________:

The Winston-Salem/Forsyth County School system has agreed to assist the Bowman Gray School of Medicine in Winston-Salem in conducting an important research study of children with a specific learning disability in reading. The purpose of this study is to learn more about how these children learn compared to children with adequate reading skills. The study is being jointly sponsored by the Section of Neuropsychology, Bowman Gray School of Medicine and the Psychology Department of the University of North Carolina at Greensboro.

Since your child ________________________ has been classified as having a specific learning disability affecting reading, he/she would be eligible to participate in this study if you are interested. Each child who participates will receive a battery of psychological and educational tests (at no cost to you) designed to determine individual strengths and weaknesses. The testing will take approximately one and one-half hours and will be done at the Bowman Gray School of Medicine in Winston-Salem. Whenever possible, you will be requested to transport your child to the testing session, but alternative travel arrangements could be made if necessary. Bowman Gray will provide $25.00 reimbursement to cover travel cost and some compensation for the time involved.

For some of the students involved in the initial testing, there will be a further opportunity for additional testing at Bowman Gray and at the University of North Carolina at Greensboro. This additional testing will involve a neurological evaluation as well as a measurement of brain functioning during specific learning tasks. More information on this follow-up testing will be sent to you after the initial testing is completed. If you choose for your child to participate in the initial testing, this does not obligate you to have him/her to participate in the additional follow-up testing.

Potential benefits to you and your child include more specific information about your child's learning disability and recommendations for management and remediation which can be shared with your child's teachers upon your request. It is also anticipated the information gained from this research study will improve the understanding of learning problems as well as make earlier and more accurate diagnosis of learning disabilities possible.

The children will lose some time from school during the testing at Bowman Gray. Your school will cooperate with you in regard to school work missed by your child. All test results will be kept strictly confidential and will only be shared at your request. The staff at Bowman Gray has several years experience in making children feel comfortable and helping them to actually enjoy the testing procedures.

Page 2

If you are willing for your child to participate in this study, please sign the consent form and return it in the enclosed envelope to Bowman Gray School of Medicine in Winston-Salem. If you have questions, or would like to discuss the study further, please contact Ms. Rebecca Felton or Dr. Frank Wood at (919) 748-4117. If you would like to have your child participate but transportation or scheduling is a problem, please call Ms. Rebecca Felton to see if something can be arranged for you. You may call collect; Bowman Gray will pay for the call. Thank you for your cooperation.

Sincerely,

/jj

Enclosures

APPENDIX E

CONSENT FORM

I have read and understand the attached letter and give permission for ________________________ to participate in the research project which will include psychological and educational testing at Bowman Gray School of Medicine (including tests of memory, attention, reading, and spelling).

I also understand that my child may be selected to participate in further testing at Bowman Gray School of Medicine and University of North Carolina at Greensboro. If so, I will be contacted and given further information and will be under no obligation to participate unless I so choose.

I also grant permission for Bowman Gray School of Medicine to obtain the results of standardized tests contained in my child's school records.

I understand that my child may withdraw from this project at any time with no adverse consequences.

If you are interested in having your child participate but transportation or scheduling is a problem, please call Ms. Rebecca Felton at 919-748-4117 to see if something can be arranged for you. You may call collect. Bowman Gray Hospital will pay for the call.

Signed ____________________________ Address ________________________

Date ______________________________ ________________________

Child's Name _______________________ ________________________

Zip Code

School ____________________________ Telephone: Work ________________

Home ________________

Please indicate the best time for someone to contact you concerning an appointment. ____

____

APPENDIX F

SAMPLE DATA: AGE, SEX, RACE, GRADE

Subject	Age	Sex	Race	Grade-Months
28	8.67	M	W	2-9
35	8.75	F	W	2-9
17	9.08	M	W	3-9
43	9.33	M	W	2-9
44	9.58	M	W	2-9
20	9.83	M	W	4-9
39	9.92	M	W	3-9
06	10.17	M	W	4-9
32	10.42	M	W	3-9
36	10.50	M	B	4-9
08	10.50	M	W	2-9
40	10.50	M	W	4-9
04	10.58	M	W	3-9
45	10.65	M	W	5-9
12	10.67	M	W	4-9
47	10.83	M	W	5-9
01	10.83	M	W	4-9
10	10.83	M	B	5-9
26	10.92	F	W	4-9
09	10.92	M	W	5-9
27	10.92	M	W	4-9
13	11.00	F	W	4-9
25	11.00	M	B	4-9
30	11.08	M	W	4-9
33	11.17	M	W	5-9
37	11.25	M	B	4-9
05	11.42	M	B	4-9
42	11.42	M	B	5-9
29	11.42	M	W	4-9
03	11.58	M	W	4-9
14	11.58	M	B	5-9
16	11.58	M	W	5-9
38	11.67	M	W	5-9
18	11.67	M	W	5-9
24	11.75	M	W	5-9
11	11.83	M	W	4-9
23	11.92	M	W	5-9
07	11.92	M	W	4-9
46	12.17	M	B	4-9
41	12.25	M	B	4-9
21	12.83	M	W	6-9
N = 41	mean = 10.81			mean = 4-9

APPENDIX G

WECHSLER VERBAL, PERFORMANCE AND FULL SCALE SCORES

Subject	Verbal IQ	Performance IQ	Full Scale IQ
01	94	112	102
03	75	91	81
04	101	87	93
05	92	109	100
06	92	101	96
07	88	104	95
08	88	87	91
09	117	111	116
10	92	102	96
11	94	91	91
12	98	84	93
13	86	100	91
14	91	93	91
16	90	124	105
17	102	92	97
18	91	96	88
20	84	104	81
21	94	102	97
23	86	118	101
24	105	98	101
25	102	93	98
26	88	106	96
27	122	106	117
28	94	91	91
29	107	111	109
30	97	101	99
32	98	90	93
33	101	86	92
35	88	109	98
36	96	86	90
37	87	98	81
38	102	109	105
39	108	105	107
40	90	90	89
41	84	121	101
42	90	98	92
43	111	93	102
44	98	100	103
45	91	95	92
46	94	87	92
47	102	104	102
N = 41	mean = 95.36	mean = 99.63	mean = 96.46
	SD = 9.21	*SD* = 9.98	*SD* = 7.76

APPENDIX H

EXPLANATION TO SUBJECTS

The following explanation is made to the child (in the presence of his/her parent's) prior to the testing session:

We are part of a medical school--Bowman Gray School of Medicine. Medical Schools do a number of different things, like train people to be doctors. They also do something called "research" which is what we are doing here. Research is when you have a question about something and you try to figure out the answer. Our question is this--"What is there about the way a person's brain works that makes reading and spelling easy for some people and hard for others?" The reason we want to know this is so we can help teachers do a better job of teaching their students.

When you are in a research study you have a special name--you're called a "subject." Since we couldn't do our research without subjects, we want to thank you and your (Mother/Dad/parents) for taking the time to come and help us find the answer to our question. To thank you, we will send to your house, a check for $25.00. You and your (Mother/Dad/parents) can decide how you will divide that up. You should receive your check in the mail in a couple of weeks.

While I am talking to your (Mother/Dad/parents) you will be working with my assistant, Miss Rose Huntzinger. She will ask you to do several different things. Some are things you're used to doing in school; for example, reading and spelling words. Other are things you usually don't do in school; for example, seeing how fast you can press a counter with your finger, naming some pictures of things, and remembering some things. All of these will help us learn how different parts of your brain are working. Do you have any questions?

APPENDIX I

RAW SCORES ON THE BODER TEST OF READING-SPELLING PATTERNS

Subject	Reading Level	Reading Quotient	Known* Words	Unknown* Words
Nonspecific				
03	3.50	81	70	50
05	4.30	81	70	70
24	3.75	74	100	70
32	1.70	67	100	70
33	4.45	88	70	70
35	0.70	66	100	70
36	4.45	95	90	100
39	2.60	74	90	80
47	4.40	86	60	60
N = 9	mean = 3.32	79.11	83.33	71.11
	SD = 1.36	9.73	15.81	13.64
Dysphonetic				
01	3.30	76	90	40
09	4.35	81	50	30
10	3.25	78	80	30
13	3.35	79	20	50
14	3.35	75	40	0
16	3.60	72	60	10
17	2.55	84	80	10
23	3.65	72	60	30
25	3.30	76	40	50
26	3.40	79	60	40
28	1.40	77	80	40
42	5.40	95	60	40
43	2.40	79	50	30
45	4.60	94	50	30
46	3.25	72	30	50
N = 15	mean = 3.41	79.27	56.67	32.00
	SD = .97	7.05	19.88	15.21

*Percentage Correct

Subject	Reading Level	Reading Quotient	Known* Words	Unknown* Words
Dyseidetic				
12	1.45	64	50	60
18	2.25	65	50	60
20	2.20	76	30	60
44	2.45	79	50	60
N = 4	mean = 2.09	71.00	45.00	60.00
	SD = .44	7.62	10.00	0.00
Mixed				
04	.30	50	40	20
06	.30	53	60	40
07	1.40	55	50	40
08	0.00	51	40	50
11	2.35	62	50	40
21	3.35	66	60	30
27	2.60	64	80	30
29	2.45	62	50	0
30	1.35	58	60	20
37	1.30	62	40	0
38	1.50	54	90	40
40	1.35	64	20	0
41	1.25	51	90	20
N = 13	mean = 1.50	57.84	56.15	25.38
	SD = .98	5.74	20.63	17.13
Total Group				
N = 41	mean = 2.65	71.63	61.22	41.20
	SD = 1.33	12.12	21.82	23.58

APPENDIX J

RAW SCORES ON THE BOSTON NAMING TEST

Subjects	Spontaneously Correct Responses	Errors	Average Latency* per Response	Number Correct with Prompts	Number of Prompts
Nonspecific					
03	42	13	1.02	1	8
05	33	18	0.80	0	13
24	45	12	1.08	2	11
32	35	12	0.84	4	17
33	41	17	1.23	1	10
35	21	12	0.90	2	7
36	43	14	1.02	0	11
39	35	12	1.26	5	20
47	37	12	0.50	0	0
N = 9	mean = 36.89	13.56	0.96	1.67	10.78
	SD = 7.25	2.35	.23	1.80	5.78
Dysphonetic					
01	32	10	0.89	0	4
09	41	11	1.10	0	4
10	32	17	1.39	2	24
13	31	16	2.61	4	21
14	35	8	1.19	0	6
16	40	11	1.35	2	10
17	38	12	1.43	1	11
23	43	14	1.50	2	13
25	49	8	1.42	3	15
26	24	10	1.52	0	7
28	26	10	0.54	0	8
42	33	16	1.97	2	5
43	46	13	0.78	0	3
45	36	15	1.76	0	1
46	42	15	0.98	0	5
N = 15	mean = 36.53	12.40	1.36	1.07	9.13
	SD = 7.10	2.97	.51	1.33	6.66

*Seconds

Subjects		Spontaneously Correct Responses	Errors	Average Latency* per Response	Number Correct with Prompts	Number of Prompts
Dyseidetic						
12		37	13	1.01	1	10
18		40	14	1.55	2	7
20		34	16	0.96	1	26
44		33	16	0.73	2	11
N = 4	mean =	36.00	14.75	1.06	1.50	13.50
	SD =	3.16	1.50	.35	.58	8.50
Mixed						
04		33	17	2.03	1	12
06		34	16	1.97	2	26
07		34	15	1.50	3	13
08		36	11	1.42	0	10
11		38	13	0.68	0	3
21		46	13	1.28	1	15
27		41	17	1.88	1	8
29		35	14	1.44	0	6
30		36	14	1.44	2	11
37		38	12	1.49	1	12
38		48	10	2.00	2	14
40		38	13	1.33	0	6
41		25	8	1.33	1	11
N = 13	mean =	37.08	13.31	1.52	1.08	11.31
	SD =	5.81	2.65	.37	.95	5.62
Total Sample						
N = 41	mean =	36.73	13.17	1.30	1.24	10.61
	SD =	6.26	2.64	.45	1.28	6.24

APPENDIX K

LATENCY* AND NUMBER OF ERRORS ON THE RAPID AUTOMATIZED NAMING TASK

Subjects	COLORS Latency	COLORS Errors	NUMBERS Latency	NUMBERS Errors	OBJECTS Latency	OBJECTS Errors	LETTERS Latency	LETTERS Errors
Nonspecific								
03	50	3	32	0	71	1	31	1
05	44	2	24	0	42	0	22	0
24	52	5	25	0	63	4	31	0
32	66	1	41	1	62	1	45	4
33	47	1	29	0	68	1	30	0
35	45	1	29	2	67	0	31	1
36	67	0	32	0	91	0	32	1
39	45	1	32	0	77	2	37	0
47	74	0	37	1	76	2	44	1
N = 9 mean =	54.44	1.56	31.22	0.44	68.56	1.22	33.67	0.89
SD =	11.41	1.59	5.38	0.73	13.32	1.30	7.24	1.27
Dysphonetic								
01	66	1	34	2	52	3	30	2
09	33	2	27	2	51	1	31	0
10	58	2	40	1	69	1	42	9
13	44	0	31	0	66	0	27	0
14	36	1	21	0	65	3	31	1
16	57	1	28	0	48	0	34	4
17	45	1	31	2	55	1	26	1
23	30	0	26	1	43	0	25	1
25	44	3	26	0	58	0	29	2
26	38	0	25	0	49	0	25	0
28	56	0	36	1	59	1	52	4
42	36	0	26	1	40	0	24	1
43	56	2	37	0	75	1	40	1
45	50	0	20	0	59	1	20	0
46	47	2	39	0	58	0	27	1
N = 15 mean =	46.40	1.00	29.80	0.67	56.47	0.80	30.87	1.80
SD =	10.61	1.00	6.27	0.82	9.69	0.01	8.26	2.37

*Time in total seconds.

Subjects		COLORS Latency	COLORS Errors	NUMBERS Latency	NUMBERS Errors	OBJECTS Latency	OBJECTS Errors	LETTERS Latency	LETTERS Errors
Dyseidetic									
12		123	2	70	1	116	0	64	3
18		39	2	35	1	63	3	30	1
20		56	0	30	0	106	4	31	0
44		43	0	32	0	51	1	36	1
N = 4	mean =	65.25	1.00	41.75	0.50	84.00	2.00	40.25	1.25
	SD =	39.18	1.16	18.95	0.58	31.82	1.83	16.05	6.26
Mixed									
04		59	4	36	0	67	2	48	2
06		52	0	36	0	77	2	52	1
07		43	1	37	1	62	5	37	0
08		80	3	74	2	96	6	89	0
11		33	0	27	0	51	2	35	0
21		52	2	34	0	47	2	37	2
27		48	3	31	0	84	3	49	1
29		45	1	32	2	127	9	34	2
30		42	0	31	0	69	4	43	2
37		85	0	39	1	71	0	37	0
38		70	1	40	0	103	5	68	1
40		43	0	31	0	62	0	34	0
41		59	0	48	1	71	4	57	2
N = 13	mean =	54.69	1.15	38.15	0.54	78.46	3.46	47.69	1.00
	SD =	15.52	1.41	12.01	0.78	23.42	2.40	16.14	0.91
Total Sample									
N = 41	mean =	52.63		33.92		68.78		37.73	
	SD =	16.89		10.47		20.47		13.64	

APPENDIX L

RAW SCORES ON VERBAL FLUENCY TESTS

Subjects		LINGUISTIC F	A	S	Total	SEMANTIC Animals	Foods	Total
Nonspecific								
03		5	5	9	19	18	21	39
05		9	5	16	30	19	16	35
24		12	10	8	30	15	19	34
32		3	6	9	18	17	13	30
33		6	8	7	21	6	13	19
35		5	5	7	17	14	15	29
36		10	9	8	27	12	15	27
39		4	6	4	14	13	8	21
47		2	6	10	18	15	8	23
N = 9	mean =	6.22	6.67	8.67	21.56	14.33	14.22	28.56
	SD =	3.38	1.87	3.24	5.94	3.87	4.38	6.75
Dysphonetic								
01		8	4	8	20	15	10	25
09		11	6	8	25	14	17	31
10		3	4	2	9	15	14	29
13		3	6	14	23	16	16	32
14		10	12	11	33	17	22	39
16		5	6	8	19	24	23	47
17		7	2	7	16	13	15	28
23		4	7	6	17	14	14	28
25		12	3	6	21	15	8	23
26		6	6	15	27	12	17	29
28		6	2	5	13	6	14	20
42		13	7	11	31	16	18	34
43		3	4	11	18	19	12	31
45		11	7	8	26	17	14	31
46		8	4	7	19	13	11	24
N = 15	mean =	7.33	5.33	8.47	21.13	15.07	15.00	30.07
	SD =	3.44	2.53	3.42	6.50	3.84	4.09	6.62

Subjects		LINGUISTIC F	A	S	Total	SEMANTIC Animals	Foods	Total
Dyseidetic								
12		10	6	9	25	19	18	37
18		10	10	14	34	15	15	30
20		5	3	8	16	12	11	23
44		10	4	9	23	12	12	24
N = 4	mean =	8.75	5.75	10.00	24.50	14.50	14.00	28.50
	SD =	2.50	3.10	2.71	7.42	3.32	3.16	6.46
Mixed								
04		3	3	4	10	14	10	24
06		3	3	9	15	12	11	23
07		8	4	5	17	10	14	24
08		10	5	8	23	17	11	28
11		12	9	9	30	21	14	35
21		7	7	12	26	13	15	28
27		10	6	12	28	19	18	37
29		4	9	4	17	18	20	38
30		4	2	6	12	10	17	27
37		12	8	10	30	13	12	25
38		8	5	15	28	10	6	16
40		6	4	7	17	14	17	31
41		6	4	5	15	9	8	17
N = 13	mean =	7.15	5.31	8.15	20.62	13.85	13.31	27.15
	SD =	3.18	2.32	3.44	7.12	3.85	4.11	6.84
Total Group								
N = 41	mean =	7.17	5.66	8.56	21.39	14.46	14.20	28.66
	SD =	6.40	2.36	3.25	6.51	3.70	4.00	6.56