8-1985

Diagnosis of Dyslexia: The Utility of the Boder Test of Reading-Spelling Patterns, a Representative Case Study Approach

Donna Montei
Western Michigan University

DIAGNOSIS OF DYSLEXIA: THE UTILITY OF THE BODER TEST OF READING-SPELLING PATTERNS, A REPRESENTATIVE CASE STUDY APPROACH

by

Donna Montei

A Dissertation
Submitted to the
Faculty of The Graduate College
in partial fulfillment of the
requirements for the
Degree of Doctor of Education
Department of Counseling and Personnel

Western Michigan University
Kalamazoo, Michigan
August 1985

DIAGNOSIS OF DYSLEXIA: THE UTILITY OF THE BODER TEST OF READING-SPELLING PATTERNS, A REPRESENTATIVE CASE STUDY APPROACH

Donna Montei, Ed.D.

Western Michigan University, 1985

The first purpose of the dissertation was to study the relationship between Boder test diagnosis (dysphonetic dyslexia) and hemisphere arousal with a representative subject. The relationship between standard methods of diagnosis and Boder diagnosis was studied with five additional subjects. The "dysphonetic" subject was measured with electroencephalogram biofeedback equipment and the Wechsler Intelligence Scale for Children-Revised (WISC-R) and demonstrated higher arousal in the left hemisphere than the right hemisphere. Four of the five other subjects were diagnosed differently by the Boder test from diagnoses obtained through standard psychological test batteries. The results suggest that the Boder typology constructs may be too broad to accurately diagnose individuals with varying combinations of strengths and weaknesses. The results do not support correspondence between electrophysiological hemisphere arousal patterns and reading-spelling patterns. The concluding chapter contains recommendations for future research.

8526117

Montei, Donna

DIAGNOSIS OF DYSLEXIA: THE UTILITY OF THE BODER TEST OF READING-SPELLING PATTERNS, A REPRESENTATIVE CASE STUDY APPROACH

Western Michigan University ED.D. 1985

University
Microfilms
International 300 N. Zeeb Road, Ann Arbor, MI 48106

ACKNOWLEDGMENTS

I wish to thank the following people for their time and wise assistance to me in completing this dissertation: Paul Graelich for his work, expertise, and counsel with both the Boder and the EEG biofeedback equipment; Tom VanDenAbell for his advice and use of the Boder test; Louise Haas of the Specific Language Disability Center for her time and referrals; Peg VanDam and Joe Chapel of the WMU Reading Clinic for their time and referrals; Dan Klainer, psychologist, for testing; Michael Ezzo for the loan of his original software program which allowed the data to be analyzed by the computer; Mary Wassink for referring a key subject; and Bob Hopkins, Bob Betz, Bob Brashear, and Joseph Morris, members of my committee, who gave their time and energy so generously. Thanks also to Greg Henson for his patience and help at many of the stages of this project.

Donna Montei

TABLE OF CONTENTS

Table of Contents--Continued

LIST OF TABLES

CHAPTER I

INTRODUCTION AND REVIEW OF THE LITERATURE

A 9-year-old boy named Derek (fictitious) appeared to be normal in every respect. He was alert, verbal, interested in his environment and in others, sociable, and also unusually artistic for his age. However, in the third grade Derek was still reading at a first grade level. His behavior showed some inconsistencies which puzzled his teacher. He would, for example, write a sentence (spelling poorly) as dictated by his teacher, and then he would be unable to read that same sentence. He seemed unable to sound out words or to increase his sight vocabulary. He was evaluated by a trained examiner and diagnosed as dyslexic. Tutoring was prescribed as treatment for the disorder. The tutoring in his case was aimed at teaching reading skills through multisensory integration techniques. After approximately one year of lessons, this boy was significantly improved in his skills and approach to reading and spelling. Derek is an example of a child suffering from dyslexia, and it is estimated that at least 10% of children are so afflicted today (Newton, 1970/1975).

The Committee on Dyslexia and World Illiteracy of the World Federation of Neurology defined dyslexia as "a disorder manifested by difficulty in learning to read despite conventional instruction, adequate intelligence and sociocultural opportunity. It is dependent upon fundamental cognitive disabilities which are frequently of constitutional origin" (Masland, 1978, p. 23).

Dyslexia was first described in 1895 by Hinshelwood (cited in Critchley, 1970), an eye surgeon, in an article on word blindness and visual memory. In response to the article, Morgan (cited in Critchley, 1970) published in 1896 a case study report about a 14-year-old student who was incapable of reading despite obvious intelligence. A few years later the syndrome was mentioned by Kerr (cited in Critchley, 1970) in an essay on schools. In 1900 and 1917 Hinshelwood (cited in Critchley, 1970) produced articles hypothesizing possible causes of the disorder, naming it congenital word blindness. He suggested deficiencies in the angular gyrus and in storage of visual images as possible neurological causes. According to Critchley (1970), the British are credited with first gathering and publishing information about these cases. Interest grew in other countries; and by 1909, McCready reviewed 41 cases from the literature.

Orton (1925) theorized that strephosymbolia (dyslexia) is due to a delay in development of normal hemisphere dominance for language. Orton (1931, 1937) believed this resulted in visual distortions and deficits in visual memory. His theory was supported by Bender (cited in Critchley, 1970), who described dyslexia as a disruption of the "gestalt function." Other researchers objected to this explanation and favored disruptions in association of visual stimuli with sound (Hermann, cited in Critchley, 1970) or disruption of sequential memory of verbal stimuli (Bakker, cited in Critchley, 1970; Bakker, 1972).

Tutoring using a variety of approaches either within the classroom or independent of the classroom is by far the most common treatment for dyslexia. A small population of those students with visual-spatial perceptual problems do not respond well to at least some methods of tutoring (Haas, 1985, personal communication). Occupational therapists also treat dyslexia by means of a variety of physical and multisensory techniques designed to intervene in the area of coordination and involvement of both hemispheres. To date, psychological treatment of dyslexia has focused on a few experiments employing hypnosis (Crasilneck & Hall, 1975) or electroencephalogram (EEG) biofeedback (Murphy & Cunningham, 1981; Murphy, Darwin, & Murphy, 1977). At the present time there is no standard psychological treatment for dyslexia. Although various treatments are successful with certain individuals, some issues about definition and diagnosis remain unresolved.

The Problem of Diagnosis

Numerous attempts have been made to define and describe the etiology of reading disabilities. According to Felton (1983), writers have generally agreed that the term "learning disability" may be used to refer to a discrepancy between ability and achievement. Yet, other reasons for the discrepancy such as emotional disturbance, mental retardation, inadequate learning or sociocultural opportunity, and physical handicaps must be excluded from this determination. Agreement has been generally reached as to the interchangeability of the terms "dyslexia," "developmental dyslexia," and "specific reading disability"; these terms may be considered a subset of the category of "learning disability" (Felton, 1983).

Thus, definitions and diagnosis have been traditionally exclusionary in nature with the focus of what dyslexia is not. The exclusion process of defining the problem leaves out those individuals who may have dyslexia as well as other disadvantages or disabilities. The possibility that dyslexia is a specific dysfunction which may exist independently, or in combination with other dysfunctions, remained ignored by this diagnostic process. In recent years researchers have moved again toward defining what dyslexia is by isolating behavioral and neurological symptoms and syndromes.

Behavioral Symptomatology

Symptomatology includes variations in approaches to reading. The following examples of behavioral symptoms exhibited by dyslexic children may, or may not, appear with any one individual.

1. Inability to spell in writing, even when able to spell correctly orally.

2. Reversals, or unstable form perceptions, of letters and/or words in print.

3. Ability to write words followed by inability to read the same words.

4. Poor spelling with rote memory drill being of limited assistance.

5. Problems with handwriting.

6. Difficulty with clearly hearing, categorizing, and retrieving sounds.

7. Difficulty with sequencing of letters, sounds, or units of movement (Oliphant, 1978).

Physiological Symptomatology

Physiologically, dyslexia has been described as poor coordination between the right and left hemispheres of the brain. The normal transfer of visually perceived patterns (predominantly a right hemisphere function) to the left hemisphere for association with sound does not occur. In addition, some dyslexics seem to be able to sound out words phonetically but fail to read the word as a whole (considered predominantly a right hemisphere function). Birch and Belmont (1964) defined the phenomenon of dyslexia as a deficit in intersensory integration. In 1971, Satz, Rardin, and Ross hypothesized that the right hemisphere is doing an inordinate amount of processing to the detriment of verbal tasks, secondary to a maturational lag in the development of intercortical connections between hemispheres. Symmes and Rappaport (1972) noted that dyslexia is often associated with unusually advanced development of the brain's right hemisphere.

In 1967, Oettinger, Nekonishi, and Gill studied 19 individual cases of reading disabled children. They hypothesized that some individuals may have a form of subclinical epilepsy which is activated by the task of reading itself. They studied the electroencephalogram (EEG) recordings of their subjects and found five who exhibited epileptic spiking during a reading task. Although these results were not generalizable to a population of poor readers, these results may be viewed as an addition to the body of knowledge which demonstrated abnormal EEG recordings in some reading disabled youngsters.

In one study of normal children, EEG recordings were taken to study normal arousal activity in the brain. Results indicated that no consistent use of one hemisphere or another was associated with any of the tasks studied, suggesting that the ability to shift arousal throughout the brain is common to normals. A noteworthy exception occurred with one subject in the study. This child had "outgrown" a reading disability and her EEG record demonstrated that her attention tended to remain in one hemisphere (right), suggesting to the author that intercortical connections were underdeveloped in that child. It was possible that the subject had adapted to this abnormality by processing information with her right hemisphere while the left hemisphere remained underdeveloped (Metcalf, 1978). By the exclusion process of diagnosis this child would not have been considered learning disabled, as she would not have demonstrated a visible discrepancy between ability and achievement. Yet, an abnormality in brain wave functioning was discovered. The significance of this example lies in its support for diagnostic procedures which are specific, rather than exclusionary. Further, this finding suggests that this child's disability was the result of a specific physiological abnormality which could be measured.

Recent efforts have been made to measure electrophysiological differences between dyslexics and normals. Ayers and Torres (1973) confirmed that abnormal EEG recordings were present with their dyslexic subjects when compared to a normal control group. These findings were reported only in terms of normal or abnormal. The results were consistent with the findings of several previous research studies which had examined EEG recordings of learning disabled children who also demonstrated other problems or abnormalities. These results had also been reported as normal or abnormal (Cohn, cited in Ayers & Torres, 1973; Hughes, Leander, & Ketchum, cited in Ayers & Torres, 1973; Muehl, Knott, & Benton, 1965; Webb & Lawson, cited in Ayers & Torres, 1973). The purpose of the Ayers and Torres (1973) study was to determine if learning disability existed as a physiological abnormality when other disabilities were excluded. The findings support this hypothesis. In addition, when this study is examined in light of the earlier studies cited, the findings support the concept that learning disabilities may coexist with other dysfunctions or problems. By the exclusion process of diagnosis the other problems would have automatically ruled out learning disability.

Newton (1970/1975) compared EEG recordings of dyslexic children with those of normal children in order to discover specific differences. Differences in brain wave patterns indicated that the dyslexic group produced more slow wave activity in general than the normals. Secondly, the dyslexic group demonstrated no hemisphere dominance. Sklar, Hanley, and Simmons (1972) searched for some EEG spectral features that could be useful in diagnosing dyslexic children. Their results also suggest that the most prominent difference between dyslexics and normals is greater theta band (slow wave) activity in general. In addition, dyslexics in the study tended to show higher coherence between regions in the same hemisphere, while normals tended to be symmetrical across hemispheres. These results were replicated by Sklar, Hanley, and Simmons in 1973 and Hanley (cited in Boder & Jarrico, 1982)

Rebert, Wexler, and Sproul (1978) found an abundance of theta band activity in the left hemispheres of their dyslexic subjects, particularly over the angular gyrus. When measured during a reading task these children demonstrated a greater decline in left hemisphere arousal than in right hemisphere arousal. These recordings suggest some use of the left, but dependence on the right hemisphere, for language processing.

The implications of the neurological studies described above may be summarized as follows. Dyslexia is correlated to a lack of facility in shifting arousal levels in the brain. Abnormal EEG activity has been associated with subjects with learning disabilities and with dyslexia. The most common finding evidences more slow wave activity in general with a dyslexic population. High arousal in the right hemisphere and low arousal in the left hemisphere is found in many subjects, although not in all. The tendency to "rely" on one hemisphere mode of processing rather than to coordinate both hemispheres is reflected in the findings which indicate dyslexics show more coherence between regions of the same hemisphere than across hemispheres.

The neurological studies described above were done with groups of dyslexics who were identified by means of the exclusionary diagnosis process. With the exception of one study which examined individual cases, the EEG records of the dyslexic groups were averaged and individual differences remain unexamined. In the Oettinger et al. (1967) study, 19 subjects were studied, and 5 individuals appeared to form a subset of the group, exhibiting a discrete syndrome. Inconsistencies in these data may be partially understood by considering subjects within subtypes of dyslexia.

Subtypes of Dyslexia

Researchers have attempted to subclassify behavioral syndromes of dyslexia in recent years. Boder in 1973 designated three subtypes, identified as dysphonetic, dyseidetic, and a mixed group exhibiting characteristics of both dysphonetic and dyseidetic groups. Mattis, French, and Rapin (1975) also identified three subtypes: one demonstrating a general language deficiency, a second exhibiting visual and visual-motor impairment, and a third showing sound-blending and graphomotor deficits. Pirozzolo (1979) reported two types of dyslexia: auditory-phonetic and visuo-spatial dyslexia. Similar behavioral syndromes were seen by these researchers: the dysphonetic, sound blending deficient, and auditory phonetic classifications correspond to one another, and the dyseidetic, visual-motor impaired, and visuo-spatial types also correspond.

Examination of the symptoms present within the Boder (1973) typology reveals the following characteristics:

1. Dysphonetic dyslexia is characterized by deficits in sound-symbol integration. These individuals seem to read globally and rely

on sight vocabulary. Their mistakes tend to be nonphonetic gestalt substitutions, such as "'whole' for 'full,' 'funny' for 'laugh,' and 'chicken' for 'duck'" (Rosenthal, 1973, p. 426).

2. Dyseidetic individuals can learn to read phonetically, yet have difficulty perceiving words as wholes or gestalts. Errors are phonetic, such as "'lisn' for 'listen,' 'sos' for 'sauce,' and 'laf' for 'laugh.' Sight vocabulary is underdeveloped. Reversals are common" (Rosenthal, 1973, p. 426).

3. Mixed dysphonetic-dyseidetic readers exhibit errors common to both patterns (Boder, 1973; Rosenthal, 1973).

Boder and Jarrico (1982) developed an instrument for subtyping dyslexics and diagnosis called the Boder Test of Reading- Spelling Patterns. (Hereafter the test will be called simply the Boder test.) The test claims to diagnose cognitive style of stimuli processing by analysis of patterns of errors and successes in reading and spelling (Nockleby, 1983). According to the authors of the test, the test "is based on the premise that the dyslexic reader has a characteristic pattern of cognitive strengths and weaknesses in two distinct components of the reading process: the visual gestalt function and the auditory analytic function" (Boder & Jarrico, p. 4). Depending on whether the subject spells or reads from sight or memory or whether the subject uses phonics, five diagnoses are possible. These are: normal, nonspecific reading disability, dysphonetic, dyseidetic, and mixed dysphonetic-dyseidetic.

Electrophysiological data have been obtained by researchers to search for differences between subtypes. Fried (cited in Boder &

Jarrico, 1982) and Fried et al. (cited in Boder & Jarrico, 1982) provided the first investigation of electrophysiological differences among children diagnosed by the Boder test. The results suggested that the dysphonetic subjects in the study did not develop normal auditory discrimination in the left hemisphere, while the dyseidetics appeared to demonstrate at least normal left hemisphere electrophysiological activity. In other words the dysphonetics demonstrated a low pattern of arousal in the left hemisphere while the dyseidetics showed at least normal arousal in the left hemisphere.

Rosenthal (cited in Boder & Jarrico, 1982) studied amplitude power in left and right hemispheres and found a significant difference between children diagnosed dysphonetic and dyseidetic. The dysphonetic group showed a greater tendency to rely on the right hemisphere and the dyseidetic a greater tendency to rely on the left hemisphere. However, these results were found with 4 out of 11 dyseidetic subjects and 4 out of 12 dysphonetic subjects. The two groups were significantly different, but not all the individuals within the groups demonstrated the same pattern of arousal.

In 1983 Nockleby investigated the Boder subtype of dysphonia in relation to measures of analytical-sequential information processing. The dysphonetics performed poorly on three tasks of analytic-sequential processing and normally on four tasks of gestalt-simultaneous processing, results which supported the subtype construct. Subjects in the study were diagnosed with the use of the Boder test.

Rankin (1984) studied the relationship between neuropsychological functioning and reading performance in dyslexics, as diagnosed by the Boder test. Nine of 11 subjects were assigned to Boder subgroups. Correspondence between inclusion in the Boder groups and neuropsychological diagnostic categories was 45%. Analysis of errors failed to reveal patterns in error types; all subjects made errors in all areas. The findings suggest "more combinations of abilities and disabilities exist within the dyslexic population than are covered by the" subtypes (abstract).

Telzrow (1983) studied neuropsychological and demographic features within Boder subtypes to search for consistency between the Boder and traditional neuropsychological constructs. The sample size was 30 students. The WISC-R, handedness, and average finger oscillation tests were used as comparison measures. Dysphonetic readers were found to have either higher performance IQs on the WISC-R or equivalent verbal and performance scores. None of the dysphonetics in the study had higher verbal scores. All of the normal readers (identified by the Boder test) had equivalent verbal and performance IQ scores. The dyseidetic group had equivalent verbal and performance IQ scores. Disproportionate results were obtained with the mixed dysphonetic-dyseidetic group in handedness and finger oscillation tests. Thus, some consistency was found with traditional testing methods for the dysphonetic and mixed dyslexic groups. Not all subjects within the groups demonstrated the same patterns with the exception of the dysphonetics, none of whom had a higher verbal than performance IQ.

Questions as to the accuracy of diagnosis arise from the research comparing neuropsychological tests with the Boder test. In addition, although some electrophysiological work has been done on the Boder types, some inconsistencies occurred in at least one study. Thus, the question of accuracy of diagnosis of individuals is paramount. Two issues arise from the data. The first one relates to whether by diagnosing a subtype of dyslexia with the Boder test the psychologist is identifying a syndrome with both behavioral and neurological correlates or whether a pattern of errors or both has been identified. The second one relates to the assumption that the Boder test is measuring individuals consistently with other measures of an individual's language processing behavior. The studies to date have used group designs and have described a general trend which supports the Boder typology. However, studies of individual cases have not been done on the constructs underlying the test. It is hypothesized that the case study method is the most appropriate technique to provide data supporting or refuting current diagnostic practices.

Thus, the proposed research examined the following questions:

1. Does a single subject, diagnosed by the Boder test as dysphonetic, demonstrate the expected electrophysiological language processing pattern (right hemisphere more aroused than the left)?

2. Does the subtyping of children tested by more traditional methods compare favorably to the typing resulting from being tested by the Boder test?

Definitions of Terms

A number of terms need to be defined and explained for the purpose of describing this research.

Dyslexia: The term used to categorize a specific learning disability which has a neurological and/or cognitive component.

Brain waves: Electroencephalogram (EEG) patterns which reflect some electrical activity in the brain, classified here according to frequency from slowest to fastest:

Delta waves--1-4 cycles per second, associated with deep sleep.

Theta waves--4-8 cycles per second, associated with emotionally charged or creative imagery, reverie, day dreaming, and presleep stages of arousal.

Alpha waves--8-13 cycles per second, associated with relaxed alertness; one perceives or responds effortlessly.

Beta waves--13 or more cycles per second, associated with concentration or effort, cognitive struggling or anxiety about a problem or activity, a critical attitude or narrow focus of attention.

Filter: Equipment which responds to waves within a specific EEG band frequency in order to select information about electrical activity within the frequency band.

Arousal: An increase in frequency (EEG) associated with an increase in attention.

Amplitude: The measure of the area below the highest point of a brain wave; the slower waves thus have greater amplitude and decreased frequency. As wave amplitude increases, arousal and frequency decrease. Amplitude may also be substituted for power measure (Murphy & Cunningham, 1981).

Coherence: Consistency in EEG recordings between two or more electrode sites.

Electrode: Device attached to a subject's scalp which can pick up and transmit electrical signals produced by the brain.

10-20 System: A standardized method of locating standard electrode sites on an individual's scalp by the means of measuring dimensions of the head, finding percentages of those measures, and locating specific sites.

Importance of the Study

The findings of this study may be useful to neuropsychology in general. Neuropsychology has emerged as a specialty within psychology and has begun to bridge neurology and psychology, as the specialist may now make inferences about neurological functioning through a subject's performance on standardized tests. Within this context, the results of this study may be useful to those who study learning disabilities, those who make diagnoses of learning disabilities, and those who make recommendations for treatment--particularly in relation to subtype constructs. Those who consider use of the Boder test may find this study useful, because selection of tests is crucial to the kinds of questions that can be investigated through testing. A more thorough knowledge of what the examiner may expect from the test is helpful in making choices about the data gathered by the test.

A case study approach allows a comprehensive examination of individual(s). Thus, individual differences which could be lost in a group design are available for examination. As treatment for learning disabilities tends to be individualized in general practice, as do psychological evaluations of those suspected of having the disorder, the case study approach may be more applicable as well. The state of the art reflects no single standard of diagnosis nor a standard means of psychological treatment. Thus, findings may be useful in adding to the body of knowledge and finding standards.

These findings may provide the impetus for a larger study employing larger numbers of case studies and/or group designs studying the construct validity of the Boder test, particularly as it is applied to diagnosing individuals.

Finally, the issue of diagnosis is important because accurate diagnosis may make the difference between getting special services from the public schools, or not getting them. Expert diagnosis, usually psychological or neuropsychological, is a requirement for obtaining these services in many states. Further, an accurate and specific diagnosis is more useful for recommending specific treatment options which may be employed to help dyslexic students.

Limitations of the Study

The study is subject to various practical and theoretical limitations described as follows. The small number of available subjects limits generalizability to the population of poor readers. As the subjects were representative of the subset of dyslexia in terms of age and sex and fulfilled the requirements for diagnosis by exclusion, the results may be seen as having been specific to representative cases. Therefore, replication of representative case study research on the same variables may be undertaken to build generality in future research. Thus, the results may be seen within the context of a theory of dyslexia which is in the process of being formed. A series of replication studies and group studies would be necessary to establish generality to the population of dyslexics.

Intervention in the forms of psychological treatment or educational remediation are outside the scope of this study. Results are limited to their usefulness to the aspect of diagnosis only. However, the findings, while focused on this aspect, address theoretical constructs inherent in diagnostic procedures.

Findings of this study refer only to the construct validity of the subtypes used in the Boder test. The issue of reliability is outside the scope of this work. In addition, the design of this study included the study of the dyseidetic subtype construct and the mixed dysphonetic-dyseidetic construct on Question 2 only. Question 1 focused on the dysphonetic construct. The findings of Question 1 may be seen to have indirect relevance to all these constructs as they apply to the typology theory as a whole.

CHAPTER II

DESIGN AND METHOD

Some general issues of research design, particularly in choosing between single case designs and group designs, are valid issues for discussion in this particular study.

In 1979, Duane made the following comment in his summary of views regarding definitions of dyslexia:

> It would be a particularly useful kind of research which attempted to define the correlation among behavioral subtypes within a dyslexic population, their neurophysiologic and neuroanatomic characteristics, and implications of these characteristics for educational remedial strategy. . . . Note that I refer to an individual, just as the person providing the remedial instruction is an individual. We must be mindful that the behavioral data compiled thus far has dealt with groups of students, not individuals; thus, they provide us with some generalizations only. But it is the individual who must be remediated. Thus, there must be a major turnabout in the public attitude. (p. 60)

This article has described a critical shortcoming of traditional research methodology as it has been applied to the diagnosis and treatment of dyslexic individuals. No data exist on how these generalizations may or may not be useful in application to individuals. The fact that most research to date has employed group designs has yielded an assumption of generality. These assumptions remain untested with individuals.

A clear advantage to representative case study, as it has been employed for this study, is that it may fulfill a deductive function. The single case study may address the question of application of generalizations and subtype constructs to individuals. This aspect of research has been most fully discussed by Shontz (cited in Herson & Barlow, 1977). He proposed the use of representative case study designs in a deductive manner to test previously established hypotheses with individuals who may be considered representative of a particular group. The fact that a subject may possess some common characteristics of subjects within the population allows some support for generality to be inferred.

Since the 1950s, group designs have been most often used in the study of psychology and human behavior. Prior to this time case studies were common. Weaknesses in these case study approaches had included inadequate definitions of variables. The group approaches sought to control variables as well as yield generalizations. An exception to this history has occurred in the study of physiological psychology which has continued to employ single case experimental and correlational designs as the traditional mode of study (Herson & Barlow, 1977).

Group designs with no-treatment controls have one distinct advantage--generality across clients. Disadvantages include (a) that the results would be presented in terms of group means and intersubject variability, and (b) that this kind of study is seldom practical in terms of the time and money required to collect large numbers of homogeneous subjects, pay therapists, and deal with large amounts of data. If one subject reacts in a unique way, the design does not allow flexibility for studying this variability (Herson & Barlow, 1977). Probably the strongest criticism of group designs has come from Bergin and Strupp (cited in Herson & Barlow, 1977). These authors accused researchers of an overemphasis upon methodology which was constricting "fruitful inquiry" (p. 440). They were particularly concerned with an emphasis on statistical analysis which they saw as a fixation within the profession. They proposed experimental single case designs for the purpose of isolating mechanisms of change within the therapeutic process. According to Herson and Barlow, the philosophy underlying their proposal had come full circle in the history of research methodology, as in the mid 1800s the study of the individual in physiology was flourishing. The wisdom of employing varieties of single case and group designs to a problem to serve both inductive and deductive functions of gathering information is evident. For example, variables may first be isolated through single case research. These variables may be tested with groups to obtain information about the frequency and generality of these variables (the inductive function), and then these constructs may be tested deductively with individuals to search for validity of direct application of same.

The major advantages to single case studies are: (a) ability to isolate specific therapeutic mechanisms within a treatment, and (b) isolation of these variables makes it possible to combine them in a treatment "package" (Herson & Barlow, 1977). Although this particular study does not address treatment issues, advantages of single case study exist in regard to isolating variables of theoretical constructs. These variables may then be combined toward the development of a theory of diagnosis.

The study described as follows was approved by the Western Michigan University Human Subjects Review Committee in March of 1984.

The study was comprised of two parts. The first part involved the study of a 9-year-old male subject's electrophysiological arousal pattern, other relevant test data, and results obtained with the Boder. This arousal pattern was compared to the expected pattern as predicted by the Boder subtype classification. This subject is identified as Subject F.

The second part of the study involved the study of five male subjects, aged 9 through 11, who had been tested, evaluated, and diagnosed as exhibiting dyslexia. These children were then tested by a different examiner with the Boder Test of Reading and Spelling Patterns. The resulting Boder diagnosis was then compared to the diagnosis resulting from the first evaluation in each case. These subjects are identified here as Subjects A, B, C, D, and E.

Subject F had been evaluated by a neuropsychologist a year before participation in this study. The diagnosis from the evaluation was dyslexia. The subject received individualized instruction in his school for approximately one academic year. As part of the present study this subject was tested by a psychologist with the following measures:

Wechsler Intelligence Scale for Children-Revised (WISC-R)

Woodcock Reading Mastery Tests, Form A

Wide Range Achievement Test (WRAT)

The subject was then tested with the Boder test by the examiner selected for the study. The Boder diagnosis was dysphonetic dyslexia.

Subject F was then evaluated by EEG equipment with the following method. Electrode sites chosen were those sites over the occipital and temporal lobes studied by Sklar et al. (1972). These were Occipital One (O1) and Temporal Three (T3) over the left hemisphere and Occipital Two (O2) and Temporal Four (T4) over the right hemisphere. These sites were located on the subject through the 10-20 system of electrode placement. Gold electrodes were attached to the scalp with Collodion and filled with electrode cream. A gold ground electrode clip was attached to each ear.

Signals from the electrodes were amplified and monitored through Medical Associates EEG biofeedback equipment. The equipment was interfaced with an Apple IIE computer system with eight channel acquisition capacity. Electronic data were digitalized by the computer with the aid of software written by Ezzo (1984).

Six channels were used. Channel 1 measured center frequency within the alpha band for the left hemisphere. Channel 2 measured center frequency for the alpha band for the right hemisphere. Channel 3 measured alpha amplitude in the left hemisphere. Channel 4 measured alpha amplitude in the right hemisphere. Channel 5 measured center frequency (filtered from .5-40Hz) for the left hemisphere. Channel 6 measured center frequency for the right hemisphere (filtered from .5-40 Hz).

The equipment was arranged as follows. To obtain data for the left and right hemispheres, the electrode signals from the subject were amplified by two ANL 100 preamplifiers set on DC mode. The signals were then amplified by two ANL 100 postamplifiers which transferred the signals to AC mode. To obtain data for alpha frequency for the left and right hemispheres, the raw signal was filtered through two EEG 500 (8-13 Hz) filters. The filtered frequency signals were converted to voltage by an EEG 550 frequency to voltage converter. This signal was put out through the auxiliary setting to the analogue to digital converter (ANL 940) which changed the signal to direct current mode. The digitalized signal was then processed through the DIG 600 computer interface module to the Apple IIE computer.

To obtain data on alpha amplitude for each hemisphere, connections were made from the alpha filters directly to the analogue digital converter (ANL 940) and processed in alternating current mode to the DIG 600 computer interface module and then to the Apple IIE.

To obtain data for center frequency for each hemisphere the electrical signals were monitored from the postamplifiers through the two ANL 142 wide filters (.5-40 Hz). The filtered signals were then sent through two ANL 300 dual threshold comparators set at .01 volts. This signal was digitalized through a One Shot (DIG 150) before being sent to the DIG 600 computer interface module and the Apple IIE.

Data were taken with the subject in eyes open and eyes closed phases in five 20-minute sessions at the same times (6:00-6:30 p.m.) on Thursdays and Fridays only. Within that period of time a stable pattern of functioning was observed. Data from each channel were reported in means. The means were then compared to analyze arousal levels in each hemisphere. These levels were then compared with the expected pattern of EEG arousal for dysphonetic dyslexics as reported by Fried (cited in Boder & Jarrico, 1982), Fried et al. (cited in Boder & Jarrico, 1982), and by Rosenthal (cited in Boder & Jarrico, 1982).

Instrumentation

The Boder Test of Reading-Spelling Patterns is based on two cognitive functions, according to the manual: the visual gestalt function and the auditory analytic function. The visual gestalt function "underlies the ability to develop a sight vocabulary through visual perception and memory for whole words; the auditory analytic function underlies the ability to develop phonic word-analysis skills" (p. 4). The diagnostic purposes of the test are

> (1) to differentiate specific reading disability, or developmental dyslexia, from nonspecific reading disability through reading and spelling performance alone; (2) to classify dyslexic readers into one of three subtypes on the basis of their reading-spelling patterns, each of which has its own prognostic and remedial implications; and (3) to provide guidelines for the remediation of all four reading disability subtypes identified by the test—the nonspecific subtype and the three dyslexic ones. (Boder & Jarrico, 1982, p. 5)

Subject F was also tested with the Wechsler Intelligence Scale for Children--Revised (WISC-R) for the purpose of examining specific cognitive strengths and weaknesses. The same subject was administered the Wide Range Achievement Test (WRAT) to determine grade level performance in reading, spelling, and math. This subject was also administered the Woodcock Reading Mastery Tests, Form A, to obtain more specific information on the subject's strengths and weaknesses as they approach the task of reading.

Subjects A, B, and C (all 9-year-old boys) were tested and diagnosed by the Specific Language Disabilities Center. Subjects D and E were given test batteries by an examiner at the Reading Clinic of Western Michigan University. Results appear in the Appendix. All subjects were then administered the Boder Test of Reading-Spelling Patterns by the same examiner who was not affiliated with either treatment institution.

CHAPTER III

RESULTS

Results obtained from a study of six dyslexic children are presented here in two parts. The first section explicates the extensive case analysis of Subject F, which includes data on cortical arousal as measured through EEG equipment. The second section is an analysis of five additional subjects, whose previous evaluations were compared to their diagnoses obtained with the Boder test and who were not analyzed as to hemisphere arousal.

Representative Case Study (Including EEG) Results

The dysphonetic subject (F) failed to exhibit the expected arousal pattern of dysphonia: right hemisphere more aroused than left. On the contrary, this subject demonstrated the opposite pattern. Left and right arousals were compared in three ways: frequency within the alpha band (Channels 1 and 2, respectively); amplitude within the alpha band (Channels 3 and 4, respectively); and center frequency for the left and right hemispheres (Channels 5 and 6, respectively).

Shown in Table 1 are the means obtained on the six channels by Subject F.

The results contained in Table 1 may be summarized by comparing left hemisphere functioning with right hemisphere functioning. As evidenced in Table 1, alpha frequency comparisons throughout all five

Table 1

Means Obtained on the Six Channels by Subject F

	Channel					
	1 left	2 right	3 left	4 right	5 left	6 right
Session 1						
Period 1: Eyes open	10.83	10.17	12.83	12.08	11.29	10.54
Period 2: Eyes closed	9.63	9.46	30.71	28.29	9.79	9.25
Session 2						
Period 1: Eyes open	11.29	10.67	12.25	10.21	11.42	10.67
Period 2: Eyes closed	9.92	9.25	30.38	29.71	0.00	0.00[a]
Session 3						
Period 1: Eyes open	10.46	10.08	11.17	11.33	6.25	5.88
Period 2: Eyes closed	9.71	9.38	22.21	28.79	9.63	9.33
Session 4						
Period 1: Eyes open	10.17	10.00	8.13	11.17	10.42	9.96
Period 2: Eyes closed	9.75	9.13	13.13	18.83	9.75	9.08
Session 5						
Period 1: Eyes open	10.04	9.87	13.17	12.92	10.04	9.92
Period 2: Eyes closed	9.58	9.04	25.00	24.58	9.46	8.96

[a]Electrical connection lost.

sessions demonstrated that this subject's left hemisphere is more highly aroused than the right hemisphere in both eyes open and eyes closed phases within the alpha band. When center frequency of total electrical activity is examined in each hemisphere, the left hemisphere shows more arousal than the right in all sessions and all phases.

Slow wave activity measured by alpha amplitude readings on Channels 3 and 4 indicated some slow wave activity in both hemispheres. During Sessions 1, 2, and 5 the subject produced more slow wave activity in the left hemisphere in both eyes open and eyes closed phases. During Sessions 3 and 4 more slow wave activity occurred in the right hemisphere than in the left in both eyes open and eyes closed phases. Inconsistent readings occurred on measures of average amplitude within the alpha band as described. In the left hemisphere the subject showed more activity in general in Sessions 1, 2, and 5 in both frequency and amplitude. Speed of waves and size of waves were both higher in the left hemisphere than in the right. In Sessions 3 and 4 speed of waves within the alpha band was higher in the left than right; on these same sessions, size of waves was higher in the right than the left.

Frequency measures which demonstrated a consistent pattern of higher left hemisphere arousal than right are inconsistent with the expected direction of arousal. Considerable slow wave activity was most notable with this subject during the eyes closed phases in Sessions 1, 2, 3, and 5 in both hemispheres. Slow wave activity was observed by comparing center frequency measures with alpha frequency measures. Whenever the center frequency measure is lower than the alpha frequency measure, the Medical Associates EEG equipment was picking up and averaging in theta wave or lower wave activity.

Results on the WISC-R showed a nonsignificant difference between verbal and performance scores with the verbal score higher than the performance. Unusually low subtest scores were obtained in arithmetic, digit span, and coding. These low scores are related to learning disability, sometimes called the "acid test" by some examiners (Haas, 1985, personal communication). They may indicate difficulty with attention and concentration, difficulty with short term memory, and difficulty with associating symbols (necessary to reading). These difficulties may reflect deficits in both the verbal analytical cognitive component and the visual-spatial cognitive component. This subject appears to rely on above average abilities to discriminate the essential aspects of problems, good judgment, and good family and sociocultural learning to function in most situations. He functions at a below average level in ability to analyze and synthesize verbal information, in nonverbal reasoning, in ability to see sequences of movements or events holistically, and in ability to see holistically parts into wholes.

The subject's scores were at grade level on the WRAT in reading and spelling and one year below grade level in arithmetic. On the Woodcock the subject was again reading at grade level; areas of adequacy were found in letter identification, word attack, and word comprehension. Mild weaknesses were found in word identification and passage comprehension, with these results consistent with the subject's cognitive style as measured by the WISC-R. Weaknesses in concentration and analyzing and synthesizing information are also reflected in weaknesses in passage comprehension. Word identification weaknesses may reflect weaknesses in attention and symbol integration. Difficulty with seeing wholes from parts was also reflected in the subject's difficulty with word identification.

These results, when examined with the subject's EEG patterns of arousal, also show consistency. General reliance on left hemisphere processing was found on the EEG and also on the WISC-R (verbal was higher than performance). Difficulties with attention and concentration were reflected in theta waves and high amplitude readings in the left hemisphere. Slow wave activity present in the right hemisphere may be correlated to the subject's slow psychomotor speed and symbol integration as seen in the coding subtest on the WISC-R. Below average performances in picture arrangement, block design, and object assembly on the WISC-R, suggestive of holistic visual processing, were reflected in the subject's general lower arousal in the right hemisphere.

The subject's performance on the Boder test suggested that the subject would have relied on right hemisphere processing, would have a higher ability to process information holistically than verbally, would have strengths in word identification and deficits in sound-symbol integration, and would have deficits in verbal analytical processing.

Based on the electrophysiological data on the subject, as compared to the Boder results, a diagnosis of dyseidetic would be appropriate. However, that diagnosis would have ignored specific deficits which appear to operate in both hemispheres. For example, the Boder typology is limited to arousal patterns of reliance on one hemisphere type of processing over another.

At least in the case of this subject, the Boder test appears to have inaccurately isolated the general cognitive style of the subject and focused on one aspect of deficiency operating within a spectrum of strengths and weaknesses.

Comparisons of Prior Evaluations With the Boder Test With Five Subjects

An examination of the data on individuals who had been diagnosed previously by comprehensive test batteries and then diagnosed by the Boder test showed differences in four out of five cases. Four of the subjects received a different diagnosis from the Boder test than the expected diagnosis based on the previous testing.

Subject A was diagnosed by the Specific Learning Disabilities Center as auditory and visually dyslexic. The Boder test diagnosed Subject A as mixed dysphonetic-dyseidetic dyslexic.

Subject B was diagnosed by the Specific Learning Disabilities Center as auditory and visually dyslexic. The Boder test diagnosed the same subject as having a nonspecific reading disability.

Subject C was diagnosed by the Specific Learning Disabilities Center as visually dyslexic. According to the Boder test, this subject would be diagnosed with nonspecific reading disability.

Subject D was diagnosed by the Western Michigan University Reading Clinic as exhibiting both mild auditory and visual processing problems as well as attention deficit disorder. The Boder classification was dyseidetic dyslexia.

Subject E was diagnosed by the Western Michigan University Reading Clinic as showing mild auditory processing problems. The Boder diagnosis was nonspecific reading disability.

CHAPTER IV

DISCUSSION

In this chapter the questions investigated by the study, the results obtained from the study, the meaning of the results, their application to the constructs underlying the Boder test, and conclusions as to the utility of the test for diagnosing individuals are presented. In addition, the strengths and weaknesses of this type of investigation are discussed. Theoretical and practical implications of this study are offered as well as directions for future research.

Research Questions

Two questions were investigated concerning the construct validity of the Boder Test of Reading and Spelling Patterns. They were:

1. Will a single subject, diagnosed by the Boder test as dysphonetic, demonstrate the expected electrophysiological language processing pattern (right hemisphere more aroused than the left)?

2. How will the subtyping of children tested by more traditional methods compare to the typing resulting from the Boder test?

Results

Data obtained on Question 1 failed to show the expected arousal pattern. A diagnosis of dysphonetic dyslexia should have yielded an electrophysiological pattern of high right hemisphere arousal and low left hemisphere arousal. The subject manifested the opposite arousal pattern. Secondly, slow wave activity was measured in both hemispheres, indicating weaknesses in both the auditory analytic and visual spatial functions. Consistency was seen between the subject's electrophysiological functioning and performances on the WISC-R. Performances on the Woodcock Reading Mastery Tests provided support for correlating WISC-R performance with electrophysiological data. These data were not disconfirmed by the subject's performance on the Wide Range Achievement Test.

Data obtained on Question 2 failed to show consistency between diagnoses obtained from comprehensive neuropsychological and educational cest batteries and diagnoses obtained from the Boder Test of Reading and Spelling Patterns on four of five subjects.

Subject E demonstrated a discrepancy between his achievement level (see Appendix A) and grade in school. The Reading Clinic battery suggests a deficit in the auditory capacity on three of four measures. This would be expected to be targeted by the Boder test as dysphonetic dyslexia. Nonspecific reading disability is the Boder result. Subject D's reading disability, as measured comprehensively by the WMU Reading Clinic, was considered a combination of a minimal auditory deficiency and attention deficit disorder and not considered dyslexic. Yet, according to the Boder test, this individual showed strengths in auditory processing and was clearly in the dyseidetic dyslexic category. Subject C, who was diagnosed as visual dyslexic by the Specific Learning Disabilities Center received the Boder diagnosis of nonspecific reading disability. Subject B, who exhibited visual and auditory dyslexia in his prior testing, received the diagnosis of nonspecific reading disability. Subjects B and C were tested with many of the same instruments at the same institution and were diagnosed differently. The Boder test picked up no difference. In addition, Subject C was classified clearly as having a specific reading disability (visual dyslexia) which should have shown up as dyseidetic on the Boder test.

Subject A, the exception, demonstrated severe auditory and visual dyslexia on the prior testing, a diagnosis which is comparable to the Boder diagnosis of mixed dysphonetic-dyseidetic dyslexia. Achievement levels measured three grade levels lower than grade placement with this subject. Subject B, who also exhibited auditory and visual dyslexia in his prior testing, received the Boder diagnosis of nonspecific reading disability. This difference raises the possibility that a less severe disorder of the same kind may not be picked up by the Boder test. On the other hand, this individual's difficulties are severe enough that it would be difficult not to pick them up. Questions may be raised as to differences in this criterion of severity between the Boder test and other measures in determining the diagnosis.

Discussion of Results

The Boder test purports to elicit, from reading and spelling performance alone, an analysis of the individual's cognitive style of processing information. The two constructs upon which the test is based are the verbal or auditory analytical cognitive component (left hemisphere) and the visual spatial cognitive component (right hemisphere). The authors believe that certain kinds of errors are made by individuals with deficits in either one or both areas. An individual with a deficit in auditory analytic processing would have difficulty with phonics and rely on holistic word recognition and sight vocabulary; an individual with a deficit in visual-spatial processing would exhibit a dependence on phonics, exhibit reversals and an underdeveloped sight vocabulary. Individuals with deficits in both types of processing would exhibit errors of both kinds.

To date, methods of diagnosis have involved several components. The most common is an exclusionary component. Another is an indirect neuropsychological component whereby neurological functioning is inferred by performances on standardized tests. The typology approach (exemplified by the Boder typology and the Boder test) which has developed out of the neuropsychological data is another component. More recently, studies of electroencephalograph (EEG) functioning with dyslexic or learning disabled subjects which have attempted to isolate patterns of EEG functioning which may be used as predictors of behavioral functioning are introducing the neurological component.

In a sense, each area has a "piece of the elephant." The neurological-electrophysiological area has the most specific and quantifiable data on the subject but lacks correlation with behavioral aspects of cognition. The neuropsychological area has developed standards of cognition and behaviors related to aspects of cognition which are related to known brain functioning; yet, neurological functioning may only be inferred from these standards. The typology theorists have specific information on how dyslexics perform in educational tasks in relation to their more normal peers in regard to some very general constructs, but may lack methods of identifying the underlying neurological deficits operating for individuals.

The study of Subject F explored cognition, typology, and electrophysiological data with one individual. The fact that this subject did not fit the expected typology does not exclude the value of typology theory. Rather, it does point up some weaknesses in the concept. From data presented in Chapter II, it is suggested that more combinations of individual strengths and weaknesses exist than are covered by the typology constructs, a conclusion which was reached in the Rankin (1984) study. Further, this individual's performance opposes the constructs underlying the Boder test, suggesting the possibility that the test does not measure what it purports to measure. Support for this conclusion may be found in the students examined for Question 2. The efficacy of determining cognitive style through reading and spelling behavior patterns may be doubtful. The test authors purport to be able to determine this with the Boder test and thus are assuming a causal relationship between cognitive style and learning adaptation.

The results of this investigation cannot be used to make generalizations across the population of learning disabled people or across the subset population of dyslexics. The possibility exists that due to the small number of individuals studied a unique and atypical result was obtained.

The results of Question 2 contain some limitations. The study of individual cases does not allow constructs within tests to be compared to the Boder test mathematically. The batteries differed from individual to individual, although there were similarities. Evaluations and conclusions were compared rather than tests. The subjectivity and clinical judgment of the examiners (who were different from the examiner who used the Boder test) may explain differences in conclusions to some extent. The fact that comprehensive batteries were used in the prior testings lends weight to their validity, on the other hand. (More samples of behavior were available to those examiners with which to make their judgments.) The issue of criterion of severity is raised by the difference between results seen in Subjects A and B. Yet, a severe disability which was considered specific (Subject C) was not considered specific by the Boder test. And a mild disorder (Subject D) was considered specific by the Boder test. Thus, severity as a criterion fails to explain these differences. That possibility that severity may not be a useful explanation is further supported by the extensive Subject F study. The subject was clearly diagnosed as dysphonetic-dyslexic by the Boder. Yet, in terms of his grade level performance in reading and spelling, the subject would not be considered severely dyslexic or reading disabled.

The test manual appears to be misleading to potential users of the test in the following area. By stating that cognitive style can be determined from reading-spelling patterns and by using the term dyslexia on the diagnostic categories, the inference is made that a neurological deficit can be discovered and diagnosed with the test. The test is not a test of underlying causes of a reading disability but of error patterns in reading and spelling. The possibility exists that inadequate educational experience and opportunity may produce in a given subject equally poor approaches to reading and spelling when no neurological deficit exists. The test results would imply the same kind of remediation for the educationally disadvantaged child as for the neurologically impaired child. The recommended treatment could fall anywhere on a continuum from helpful to harmful. In the example of Subject F, a treatment prescribed to deal with his "dysphonia" would have possibly ignored weaknesses in visual perceptual and visual motor areas. The potential for harm resides in a delay or denial of a needed and appropriate treatment.

The distinctions between nonspecific reading disorder and the dyslexias may be misleading, confusing, or even unnecessary. As seen in the comparisons for Study Question 2, three of the five children fell into the nonspecific reading disability category. The Boder test appears to be too gross a measure to detect the strengths and weaknesses detected by the test batteries. For these three individuals, no specific or useful implications for remediation or other treatments would have been generated. The test batteries isolated some areas of strengths and weaknesses that could be useful to tutors in each of these cases. The case may be made that the Boder should not be used alone and that comprehensive batteries are still needed.

The usefulness of the dyslexic categories of diagnosis is questionable. Since the emphasis on the test is reading-spelling behavior, why not eliminate the term dyslexia entirely and concentrate on refining standards for these behaviors alone (through test-retest research)? As seen in this study, little correspondence occurred between the diagnostic results on the Boder and the determinations made from the traditional comprehensive batteries. The test may be more useful to professionals if the standards were reported in terms of behaviors rather than diagnostic categories. For the purposes of the uses of this test, diagnostic categories may be unnecessary.

The results question the typology constructs used by the Boder test as they compare to typology constructs used by examiners in general practice (visual and auditory dyslexia) in at least two tutoring institutions. Very little correspondence was seen. The need for more research comparing the Boder with traditional tests clearly exists.

The point may be made that more consistency would have been expected as per the Boder test manual than was seen. Variability in tests given, settings for the tests, and examiners may in part account for the discrepancy in diagnoses. The same examiner administered the Boder in the same setting with each subject at the same time of day, between noon and 1:00 p.m. If variability of conditions was the deciding factor in the inconsistency of diagnostic results, the variability must be ascribed to the prior testings rather than the Boder testing. Procedures of testing and diagnosing with the Boder test were consistent across all subjects tested. If a correspondence between the means of diagnosis employed by the other examiners and the Boder typology existed, the latter testing should have picked it up. This raises questions about many areas. Do the constructs within various typologies differ to the extent that they become meaningless in describing individuals? Were all the children misdiagnosed to begin with? Are the subtypes of dyslexia as they are used within these two institutions describing a different syndrome from the Boder typology? Or, as was found in the study of Subject F and the Rankin (1984) study, are there more combinations of strengths and deficits within individuals than are covered by all typologies? Are these combinations so variable as to confound any typology construct?

The Rankin (1984) study contained a similar limitation to the study of Question 2. In both studies numbers of subjects were too small to make generalizations to the dyslexic population. A strength of the Rankin study was its use of specific neuropsychological tests compared to Boder test results under controlled conditions. The constructs underlying the Boder typologies failed to receive support when compared to the constructs underlying the other tests. When these results are examined with the Rankin results, the results in the study of Questions 1 and 2 suggest that the typology constructs may be too general to account for an individual's reading and spelling difficulties.

Boder and Jarrico's (1982) claim that they are identifying cognitive deficits through reading and spelling patterns deserves attention at this time. The basis for this claim resides in the assumption that a student may favor one style over another and that

that style will reflect an orientation to one hemisphere over another. The results of this study suggest that simply an orientation to one hemisphere over another will not necessarily be reflected in an individual's reading and spelling behavior. This subject appeared to rely on one hemisphere yet exhibit processing weaknesses in that same hemisphere. The subject's reading and spelling behavior on the Boder test suggested a deficit in left hemisphere processing, yet ignored deficits in what is generally considered right hemisphere governed behaviors. In the case of this subject, reliance on one cognitive style does not preclude deficits in the same area. In addition, treatment prescribed on the basis of the Boder diagnosis would not have addressed deficits in the visual gestalt processing of this individual.

Conclusions

The usefulness of the Boder test to clinicians who diagnose dyslexics is limited. Some individuals may not fit the subtypes outlined by the Boder typology theory. The test may fail to target deficits which exist within the more general categories of cognitive components of auditory analytic and visual gestalt functions. Reading and spelling patterns may not accurately reflect underlying neurological deficits. The Boder typology constructs measured by the test may not correspond to other typology constructs, such as auditory dyslexia. The causes of an individual's performance on the Boder test may not be deficits in cognitive processing in a general area but may be caused by various combinations of strengths and weaknesses. The possibility exists that an individual may be diagnosed in an inconsistent manner from other means of diagnosis. The possibility exists that an individual may be diagnosed as having an opposite pattern to one found with other measures.

The results of this study suggest that comprehensive evaluations of individuals are still needed by clinicians for accuracy of diagnosis. Although the subtype constructs may contribute to the study of reading and spelling behaviors, the study does not support inferences of neurological correlates to these behaviors. Questions remain as to neuropsychological correlates and the study of cognition as measured by neuropsychology. More research is needed before this or any one instrument may stand alone in the area of diagnosis.

Critique of the Study

The investigation of Question 1 is subject to some practical and theoretical limitations. Strengths may be seen in correlating EEG data with the subject's performances on the WISC-R, the Woodcock, and the WRAT. Consistencies between these measures of behavior allowed inferences to be made about that individual's functioning. These consistencies also allow questions to be raised about the accuracy of the Boder diagnosis. A diagnostic picture was formed which was at odds with the picture predicted by the Boder test. On the other hand, conclusions must be limited to conclusions about this subject only: the Boder test did not diagnose this subject accurately.

Conclusions about intercortical connections with this subject cannot be reached due to the procedure for gathering EEG data.

Measures of electrical activity were taken from two electrode sites on each hemisphere over the occipital and parietal lobes. The equipment and computer did not have the capacity to compare separate readings from each electrode; thus, electrical activity was obtained from each hemisphere but not differentiated as to which lobe. Whether this subject demonstrated more coherence within hemispheres than across hemispheres is unknown. The presence of theta wave activity, as measured by the center frequency readings, was consistent with other research which differentiated dyslexics from normals. Results are limited to which hemisphere demonstrated greater arousal and to the presence or absence of slow wave activity in the hemispheres.

A weakness in the investigation of Question 1 occurred with the small number of subjects studied. If more subjects had been available, a group design comparing diagnoses between the Boder and a specific test battery would have yielded conclusions with generalizability. The results of the study are thus limited to questioning the construct validity of the Boder rather than disputing it.

Implications for Future Research

Gaps appear in the literature on dyslexia between the disciplines of neurology, neuropsychology, psychology, and education. A theory of dyslexia is being developed at the present time which may begin to close some of these gaps. The tradition of employing group experimental designs may hinder rather than expedite this development. Within a single subject, exemplified by this study, there existed a degree of variability and potential interactions between variables which are complex and subtle. Instrumentation for measuring these variables was capable of obtaining some gross measures of these variables. In the field of learning disabilities a need exists for some measurable characteristics of individuals which can be used to prescribe effective educational and eventually psychological treatments.

The need appears to be for an extensive investigation of single subjects to search for neurological, psychological, neuropsychological, and behavioral correlates of the disorder(s) involved. Patterns of correlations could be elicited from single case research which could be tested with group designs.

The relationship between hemisphere arousal and cognitive style needs to be researched more fully. At the present, writers are dealing with assumptions of cognitive style related to hemisphere dominance. Group correlation studies which investigate WISC-R scores (verbal greater or less than performance) compared to hemisphere arousal may or may not yield some consistent patterns. If patterns are elicited by this line of research, application of these patterns to individual cases should be undertaken. Neuropsychological tests could be administered as well in individual case studies and compared with EEG functioning to search for specific correlations.

Data on intercortical connections, reading and spelling behavior, and cognitive correlates would be useful to determine the relationships between these factors. Hemisphere arousal may not be the definitive factor in determining cognitive style; studies employing comparisons of how the two hemispheres interact/coordinate may yield some interesting patterns. Individual case studies would be most useful in examining the variables involved. The researchers would be searching for variables that remain constant. This could be done by comparing EEG wave levels within hemispheres and across as in the Sklar et al. (1972, 1973) and Hanley (cited in Boder & Jarrico, 1982) studies. Neuropsychological examination could be done with the same subjects and also the Boder test given as a sample of reading and spelling behaviors.

A typology theory is needed which demonstrates correspondence between these areas of study and which demonstrates stability in its differentiation between subtypes. This theory would need to be tested extensively through both single case and group research. Constructs which need to be isolated within this theory are varied. The reading and spelling strengths and weaknesses need to be addressed in terms of how subjects adapt to the learning process. Secondly, the issue of cognitive style needs to be dealt with in relation to learning style and neuropsychological functioning. Specific neurological impairment may exist independently of cognitive style, so ways of isolating these within the theory need attention.

APPENDIX

Determining Subjects' Specific Reading Disability

Subject A, 10 years old, tested by Specific Learning Disabilities Center

Tests administered and results:

Wide Range Achievement Test
- Reading grade level 2.8
- Spelling grade level 2.1
- Math grade level 2.7

Gray Oral Reading Test, Form C
- Total passage score 7
- Grade score 1.5

Peabody Picture Vocabulary Test (PPVT)-Revised, Form L
- Raw score 100
- Percentile 55

Jordan Written Word Screening Test

Jordan Auditory Screening Test (JAST)
- Age score 3.0 for auditory attention span for unrelated words
- Age score 7-9 for auditory attention span for related syllables

Bender Gestalt Visual Motor Test
- Poor in visual perception, included two reversals of designs

IOTA Word Test
- Grade score 1.4

Copy (copying physical movements in test room)
- Recall was poor
- Right handed, right eyed, and right footed
- Difficulty with left-right orientation
- Eyes tracked and converged well

Copying a passage from far point
- Mixed manuscript and cursive letters
- Spaced words poorly
- Incorrect letter conformation

Diagnosis: Visual and auditory dyslexia.

Subject B, a 10-year-old boy, tested at Specific Learning Disabilities Center

Tests administered and results:

Wide Range Achievement Test (WRAT)
Reading grade level 5.1
Spelling grade score 3.3
Math grade score 4.1

Gray Oral Reading Test
Total passage score 21
Grade score 2.0

Jordan Written Word Screening Test

Written Sample
Three sentences written about baseball
Capitalization and punctuation correct
Sentences incomplete
Substituted d for b

Bender Gestalt Visual Motor Test
Visual perception of form, pattern, and spatial relationships poor

Peabody Picture Vocabulary Test (PPVT)-Revised
Verbal IQ 114, high average learner

Diagnosis: Visual and auditory dyslexia.

<u>Subject C</u>, age 9, tested by the Specific Learning Disabilities Center

Tests administered and results:

Wide Range Achievement Test
- Reading grade level 3.2
- Spelling grade level 2.8
- Math grade level 2.5

Gray Oral Reading Test, Form D
- Total passage score 4
- Grade score 1.3

Peabody Picture Vocabulary Test (PPVT)-Revised, Form M
- Raw score 107
- Percentile 91

Jordan Written Word Screening Test

Jordan Auditory Screening Test (JAST)

Bender Gestalt Visual Motor Test
- Performance satisfactory for age

IOTA Word Test
- Grade score 1.5

Written Sample

<u>Diagnosis</u>: Visual dyslexia.

Subject D, 9-year-old boy tested by WMU Reading Clinic

Tests administered and results:

San Diego Quick Assessment List

Independent	Grade 1.0
Instructional	Grade 1.0-2.0
Frustration	Grade 2.0

Burns and Roe Informal Reading Assessment

Level	Grade
Independent	Preprimer
Instructional	1st
Frustration	2nd

Gates Association Test (measures word and symbol association)

	1st Trial	2nd Trial	3rd Trial
Visual-visual	60%	70%	100%
Visual-auditory	60%	100%	

Peabody Individual Achievement Test (PIAT)

Math	mid 2nd grade
Reading recognition and spelling	mid 3rd grade
Reading comprehension	late 2nd grade
Overall	early 3rd grade

Jordan Written Screening Test
Indicates auditory processing problems

Diagnosis: Mild auditory deficiency and attention deficit disorder.

Subject E, 11-year-old boy, tested by WMU Reading Clinic

Tests administered and results:

San Diego Quick Assessment List--Sight Words

Level	Grade
Independent	3.0
Instructional	4.0
Frustration	5.0

Difficulty noted in sounding out words

Burns and Roe Informal Reading Assessment

Level	Oral	Silent
Independent	3.0	2.0
Instructional	4.0	3.0
Frustration	5.0	4.0

Listening capacity 5.0

Woodcock-Johnson Psychoeducational Battery

	Aptitude	Achievement
Broad cognitive ability 4.7		
Reading	3.9	2.8
Math	4.2	4.6
Written language	4.2	3.2
Knowledge	2.8	5.4

Jordan Written Screening Test
Indicates minimal auditory deficiency

Personality Inventory (IPAT)

Diagnosis: Mild auditory processing dysfunction.

BIBLIOGRAPHY

Ayers, F. W., & Torres, F. (1967). The incidence of EEG abnormalities in a dyslexic and control group. Journal of Clinical Psychology, 23, 334-336.

Bakker, D. J. (1972). Temporal order in disturbed reading: Developmental and neuropsychological aspects in normal and reading-retarded children. Rotterdam: Rotterdam University Press.

Birch, H., & Belmont, L. (1964). Auditory visual integration in normal and retarded readers. American Journal of Orthopsychiatry, 34, 852-861.

Boder, E. (1973). Developmental dyslexia: A diagnostic approach based on three atypical reading-spelling patterns. Developmental Medicine and Child Neurology, 15, 663-687.

Boder, E., & Jarrico, S. (1982). The Boder test of reading-spelling patterns: Manual. New York: Guine & Stratton.

Critchley, M. (1970). The dyslexic child (2nd ed. of Developmental dyslexia). London: The Whitefriars Press.

Crasilneck, H. B., & Hall, M. D. (1975). Clinical hypnosis: Principles and applications. New York: Guine & Stratton.

Duane, D. (1979). Toward a definition of dyslexia: A summary of views. Bulletin of the Orton Society, 24, 40-56.

Ezzo, M. (1984) The chart recorder. Copyrighted software program.

Fehmi, L. G. (1978). EEG multisynchrony training and attention. In A. A. Superman & R. E. Tarter (Eds.), Expanding dimensions of consciousness (pp. 155-182). New York: Springer.

Felton, R. H. (1983). Dysnomia and its relationship to subtypes of reading disabilities (Doctoral dissertation, University of South Carolina at Greensboro, 1983). Dissertation Abstracts International, 45, 138A.

Geschwind, N. (1972). Language and the brain. Scientific American, 226, 76-83.

Herson, M., & Barlow, D. H. (1977). Single case experimental designs: Strategies for studying behavior change. New York: Pergamon Press.

Mattis, S., French, J. H., & Rapin, T. (1975). Dyslexia in children and young adults: Three independent neurological syndromes. Developmental Medicine and Child Neurology, 17, 150-163.

McCready, E. G. (1909-10). Congenital word-blindness as a cause of backwardness in school children: Report of a case associated with stuttering. Pennsylvania Medical Journal, 13, 278-184.

Masland, R. L. (1978). Subgroups in dyslexia: Issues of definition. Bulletin of the Orton Society, 24, 23-30.

Metcalf, D. R. (1978). An investigation of cerebral lateral functioning and the EEG (Final report, National Institute of Child Health and Human Development (NIA), Bethesda, MD, No. BBB00456). Washington, DC: Office of Economic Opportunity.

Muehl, S., Knott, J. R., & Benton, A. L. (1965). EEG abnormality and psychological test performance in reading disability. Cortex, 1, 434-440.

Murphy, P. J., & Cunningham, M. (1981). The effects of bilateral EEG biofeedback on verbal, visual-spatial, and creative skills in learning disabled male adolescents. Journal of Learning Disabilities, 4, 204-208.

Murphy, P. J., Darwin, J., & Murphy, D. (1977). EEG feedback training for cerebral dysfunction: A research program with learning disabled adolescents. Biofeedback and Self-Regulation, 2, 288.

Newton, M. (1975, January, 3-7). A neuropsychological investigation into dyslexia. Paper presented at the International Federation of Learning Disabilities, Second International Scientific Conference, Brussels, Belgium. (ERIC Document Reproduction Service No. ED 113 866). (Originally published in A. W. Franklen & S. Naidoo (Eds.), Assessment and teaching of dyslexic children, pp. 14-21, London: Invalid Children's Aid Association, 1970.)

Nockleby, D. M. (1983). A study of dyslexia in children: The Boder Test of Reading and Spelling Patterns (Doctoral dissertation, Washington State University, 1983). Dissertation Abstracts International, 44, 3510B.

Oettinger, L., Jr., Nekonishi, H., & Gill, I. G. (1967). Cerebral dysrhythmia induced by reading (subclinical reading epilepsy). Developmental Medicine and Child Neurology, 9, 191-201.

Oliphant, G. (1978). Program planning for dyslexic children in general education. Paper presented at 29th annual conference of Orton Society, Minneapolis, MN.

Orton, S. T. (1925). Wordblindness in school children. Archives of Neurological Psychology, 14, 581-615.

Orton, S. T. (1931). Special disability in spelling. Bulletin of the Neurological Institute of New York, 1, 2.

Orton, S. T. (1937). Reading, writing and speech problems in children. London: Chapman & Hall.

Pirozzolo, F. J. (1979). The neuropsychology of developmental reading disorders. New York: Praeger, 1979.

Rankin, C. S. (1984). Neuropsychological deficits and reading performance in dyslexia: An exploratory study (Doctoral dissertation, Harvard University, 1984). Dissertation Abstracts International, 45, 1696A.

Rebert, C. S., Wexler, B. N., & Sproul, A. (1978). EEG assymmetry in educationally handicapped children. Electroencephalography and Clinical Neurophysiology, 45, 436-442.

Rosenthal, J. (1973). Recent advances in the neurophysiology of some specific cognitive functions. Academic Therapy, 8, 423-428.

Satz, P., Rardin,D., & Ross, J. (1971). An evaluation of a theory of specific development dyslexia. Child Development, 42, 2009-2021.

Sklar, B., Hanley, J., & Simmons, W. W. (1972). An EEG experiment aimed toward identifying dyslexic children. Nature, 240(5381), 414-416.

Sklar, B., Hanley, J., & Simmons, W. W. (1973). A computer analysis of EEG spectral signatures from normal and dyslexic children. Transactions on Biomedical Engineering, 20(1), 20-26.

Symmes, J. S., & Rappaport, J. I. (1972). Unexpected failure. American Journal of Orthopsychiatry, 42, 82-91.

Telzrow, C. F. (1983). The Boder test: Neuropsychological and demographic features of dyslexic subtypes. Psychology in the Schools, 20, 427-432.

Vellutino, F. R. (1979). Dyslexia: Theory and research. Cambridge, MA: The MIT Press.