A STUDY OF THE EFFECT OF INTERACTIVE LANGUAGE IN THE STIMULATION OF COGNITIVE FUNCTIONING FOR STUDENTS WITH LEARNING DISABILITIES

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Introduction

Historically, researchers have attempted to identify a unified condition and a single, encompassing definition of learning disabilities (LD). Each has been elusive due to the dynamic complexity of both the problems and the applied solutions. Thus, critics have challenged both the conceptualizations and operational definitions that have guided research and practice in the field of learning disabilities over the past 20 years (Adelman, 1994; Lyon & Moats, 1993).

The diversity of perspectives and range of indicators presented by individuals with learning disabilities both plague and enhance the field of learning disabilities. Controversy surrounding the appropriate treatment for these students continues to abound.

In recent years, a prevailing philosophy has encouraged the position that much of the difficulty of individuals with learning disabilities lies within the educational environment (e.g., inappropriate instruction or materials), rather than within the student (Adelman, 1994). This perspective brings into question the need to be concerned about an inherent physiological basis for LD. Emerging evidence seems to indicate a distinct anatomy of learning disabilities related to brain structure and functioning. Semrud-Clikeman and Hynd (1994) cited recent research on the beginning efforts to relate brain structure to neurolinguistic functioning. Their data suggest a relationship between anomalies in brain structure and deficits in reading skills. These findings point to the interactive effect of systems within the brain needed to perform highly complex functions such as reading and writing.

Educational, psychological, and biomedical approaches to LD have often been parallel rather than integrated (Swanson & Keogh, 1990). Because the field of LD has lacked clear definition, specific disciplines have grappled with various aspects of the condition. For example, research funded by the Department of Education has been directed primarily at organizational and policy concerns. Psychological research has focused mainly upon identification and

classification issues (Swanson & Keogh, 1990), whereas biomedical research has investigated the physiology of LD (Duane & Gray, 1991).

In the past 10 years, considerable advances in research have produced technologies that allow educators a glimpse into the inner workings of the human brain. Rapidly growing knowledge of brain anatomy confirms that the brain is an organized structure containing consistent, discrete areas interconnected by fiber pathways (Galaburda, 1991). A clearer understanding of the dynamic complexity of the human brain appears to be a key factor in both the diagnosis and treatment of learning disabilities (Restak, 1994; Semrud-Clikeman & Hynd, 1994).

Further, current theory in the field of neurology suggests that complex behaviors such as reading and writing arise from the interaction of functional systems with the brain (Golden, 1991; Restak, 1994). For example, recent research utilizing neuroimaging techniques such as positron emission tomography (PET), magnetic resonance imaging (MRI), and computerized axial tomography (CAT) scans indicates that connections between systems in individuals with learning disabilities may be inefficient (Semrud-Clikeman & Hynd, 1994). Further, studies of post-mortem brains are beginning to yield distinct characteristics in those diagnosed LD (Duane & Gray, 1991).

Educators are beginning to take note of the developing science of neuropsychology, that is, the assigning of functions to specific areas of the brain. As a result, articles on brain functioning are appearing in educational journals. In the case of special education, the field is beginning to link this research with early findings relative to the physiology of learning (Branch, Cohen, & Hynd, 1995; Caine & Caine, 1991; Das, Mishra, & Pool, 1995).

To date, research in the LD field has consisted primarily of "single-shot" investigations (Lyon & Moats, 1993), comparing students achieving normally with students with learning

disabilities on one or more dependent variables at one point in time. It appears that educators have attempted to oversimplify the difficulties encountered by students with learning disabilities. Thus, research focused upon only one aspect of learning such as attention, perception or memory does not seem to take into account the dynamic functioning of inter-dependent neurological systems (Luria, 1981).

Perhaps the time has come for LD to be viewed as a set of related but partially independent conditions with a number of possible causes (Keogh, 1990). Such a perspective would allow the educator to deal with a diversity of symptoms and confirm the legitimacy of variation within and between students. To that end, educators must complete two critical tasks. First, we must impose a certain order on the variation of student learning needs. Second, we must develop and test effective interventions. It is time to expand and enlarge upon the understandings in the field of learning disabilities reached to date. Potentially, increased collaboration between education and neuropsychology will yield new insights and effective treatment programs for learning disabilities.

Justification for the Study

Although the number of students with LD who receive diplomas has increased (Seventeenth Annual Report to Congress, 1995), most interventions for students with learning disabilities have yielded disappointing results (Adelman, 1994). For example, in a review of both recent and earlier studies of interventions for LD, Spreen (1988) found only one study that showed positive results. Some evidence suggests that most interventions have lacked intensity, have adapted a one-dimensional or watered-down educational approach, or have attempted to "fix" specific modalities of inefficient functioning (Keogh, 1990; Kronick, 1988; Martin, 1993). Brain-behavior studies seem to support the position that cognitive functioning can be enhanced through effective instruction (Bakker, Licht, & Kappers, 1995; Caine & Caine, 1991; Feuerstein,

Hoffman, Egozi, & Shachar-Segev, 1994). For example, it appears that structured verbal interchanges between teachers and students can effectively direct and enhance cognitive development (Das et al., 1995; Luria, 1973; Vygotsky, 1962/1975).

The current study will approach the field of learning disabilities from the standpoint that learning disabilities are a result of physiological or neurological dysfunction. This position is based upon the following assumptions:

1. Learning is an intrinsic, active process influenced by both interactive and inner (unspoken) language (Das et al., 1995; Luria, 1966, 1973; Vygotsky, 1962/1975).
2. Students with LD need intensive stimulation of interactive cognitive systems in order to improve mental processing (Bakker et al., 1995; Feuerstein, 1994; Kronick, 1988; Luria, 1966, 1973; Presseisen & Kozulin, 1994; Vygotsky, 1962/1975).
3. Both distal (hereditary) and proximal (environmental) etiological factors in LD can be negated through dynamic mediation, the verbal interaction between teacher and student (Feuerstein et al., 1994; Presseisen & Kozulin, 1994).
4. Interhemispheric collaboration, or the effective communication across the brain's hemispheres, is essential for efficient cognitive processing (Bakker et al., 1995; Levy, 1985; Semrud-Clikeman & Hynd, 1994).

Statement of the Problem

This study will investigate the effects of five core instructional techniques that require the use of precise and accurate verbalization by students with learning disabilities as a means of improving cognitive functioning. Specifically, it is hypothesized that a direct and focused intervention incorporating interactive dialogue between educational therapists and students working in individualized settings will stimulate improvements in reading, spelling and arithmetic skills. Additionally, it is hypothesized that intensive intervention will lead to

improvements in verbal, nonverbal, and general cognitive functioning.

Research Questions

This study will investigate and test the validity of an intervention program for students with LD. Specifically, the interactive effects of five core instructional techniques that incorporate precise and accurate oral language production will be examined. The proposed integrative model will be measured through test score differences on pre- and posttest measures.

Students with LD in an experimental group completed a three-year program of intensive stimulation of cognitive functioning through the interactive effect of five core techniques designed and developed by the National Institute for Learning Disabilities (NILD). Control group students with LD did not participate in the intervention.

The following general hypotheses are offered. It is hypothesized that the experimental group of students will demonstrate significant improvement in: (a) reading words in isolation as measured by a standardized reading test; (b) spelling as measured by a standardized spelling test; (c) arithmetic as measured by a standardized arithmetic test; (d) general cognitive functioning as measured by a standardized test of general intelligence; (e) verbal cognitive functioning as measured by a standardized test of verbal intelligence; and (f) nonverbal cognitive functioning as measured by a standardized test of nonverbal intelligence.

The specific assessment measures used in the study include the Wide Range Achievement Test - Revised (WRAT-R) (1984) and the Detroit Tests of Learning Aptitude - Second Edition (DTLA-2) (1985).

General Design

This three-year longitudinal study will utilize a quasi-experimental, nonequivalent control-group design. Students were not assigned randomly to the experimental or control groups based upon a prior diagnosis of a learning disability. All students in the study (N=72) had learning disabilities identified through a battery of psychological and educational tests. All students were recommended to receive educational therapy intervention through NILD. The control group (n=25) consisted of those students whose parents declined the intervention program. Students who received the intervention comprised the experimental group (n=47).

Summary of Review of Literature

Theoretical foundations. It is important to examine the building blocks of cognition and neurological functioning in the light of theories posited by Piaget (1959), Luria (1961, 1966, 1973, 1976, 1980), and Vygotsky (1962/1975, 1978). Their combined contributions to the field of cognitive developmental psychology provided the essential framework for the present study. Specifically, the interrelatedness of thought and language and the contributions of these concepts to cognitive development will be explored.

Piaget, considered by many to be the father of cognitive developmental psychology, laid the foundation for the egocentrism of children's thinking in his seminal work, The Language and Thought of the Child (1959). In describing the differences between egocentric and socialized thought, Piaget stated, "It is non-discursive, and goes straight from premises to conclusion in a single intuitive act, without any of the intervening steps of deduction" (p. 127).

From this theory of egocentrism, Piaget developed the important concept of verbal syncretism. Stated simply, children often think they understand and jump quickly to conclusions without any request for assistance. For example, children hear the remarks of adults and instead of asking for clarification, they instantly imagine that they understand. Thus, they develop their

own schemas based upon faulty perceptions and are resistant to explore other possibilities.

Piaget contended that childish egocentrism predominates up to the age of seven or eight when social thought begins to be formed. After this age, the egocentrism does not disappear, but "remained crystallized in the most abstract and inaccessible part of the mind... the realm of purely verbal thought" (p. 128). To Piaget, a child's thinking could be directed and structured through verbal interchange. As the adult requested clarification of a concept, the child's mental processes could be taken through specific steps of deduction.

Vygotsky reaffirmed the notion that human learning presupposed a specific social nature. He contended that egocentric speech played an important role, in fact, that the development of thought was determined by language. As a result, Vygotsky viewed verbal interaction with adults as prerequisite for the development of conceptual thinking within the child (Vygotsky, 1962/1975).

In his classic work, Thought and Language, Vygotsky (1962/1975) traced the child's development of speech and thought. He maintained that these skills did not stem from one root, rather, initially thought was nonverbal, speech was nonintellectual. Eventually, the lines met and became essentially linked. Both Piaget (1959) and Vygotsky (1962/1975) noted the importance of inner speech. Vygotsky stated, "Inner speech develops through a slow accumulation of functional and structural changes... and finally the speech structures mastered by the child become the basic structures of his thinking" (pp. 50-51). Vygotsky (1978) refuted Binet's (1909) assumption that development was always a prerequisite for learning. He believed that the developmental process lagged behind the learning process, and that social development gave rise to new functional systems within the mind.

Vygotsky (1962/1975) is perhaps best known for his theoretical position regarding the "zone of proximal development." In essence, this is the distance between a child's actual

developmental level and the level of potential development (that which a child can attain with assistance). The role of interactive speech was viewed as crucial in the creation of this zone of proximal development. To Vygotsky (1978), learning was more than the acquisition of the ability to think. It was the acquisition of many specialized abilities for thinking about a variety of things. In other words, he conceived of learning as a dynamic process involving social contact, verbal interchange, and active learner involvement.

Building upon the philosophies of both Piaget and Vygotsky, Luria (1973) affirmed that mental activities were conditioned by social relations. Concurring that new functional systems were developed in the child as a result of adult interaction, Luria confirmed that egocentric language did not disappear, but became abbreviated internal language, an essential component of thought processing.

Influence of language on learning. In investigating the influence of language upon learning, Luria (1961) conducted an experiment in which he gave young children (aged 12-30 months) two boxes, an empty green one and a red one filled with sweets. It proved difficult for the children to remember which box contained the sweets. When language was introduced to the experiment, however, (i.e., when the colors of the boxes were named), the children were able to identify correct choices more quickly. Luria concluded that language substantially modified the children's perception and permitted them to work out a system of stable associations.

Mounting evidence suggests some students with learning disabilities have significant problems using language functionally (Bryan, Donahue, & Pearl, 1981). Further, in ambiguous or socially complex situations, students with LD have great difficulty asking questions, disagreeing or supporting an argument (Vellutino, 1987). Language development appears to alter the relative strength of stimuli acting upon a child. Thus, Luria discovered that speaking to a child could reshape perception of a compound stimulus and enable weaker perceptual

components to predominate. For example, when the backgrounds were verbally described in a visual stimulus, children attended to them in preference to the stronger foreground stimulus. To Luria, this cognitive restructuring signaled the rise of new functional systems.

These important discoveries paved the way for Feuerstein's theory of cognitive modifiability (1980). Feuerstein studied under Piaget and built upon the theories of Vygotsky and Luria. Although Piaget, Vygotsky and Luria all recognized the importance of social interaction in the development of cognition, in particular, interactive speech, it was left to Feuerstein to define the role of the mediator, the facilitator of learning, in the learning process.

From the theoretical foundations of Piaget, Vygotsky, Luria and Feuerstein, to the emerging understanding of the neuropsychology of learning, educators can begin to design effective interventions for students with learning disabilities. A collaborative spirit of interactive inquiry between educators and neuropsychologists is beginning to direct the return of the LD field to its scientific roots.

The importance of interactive language in the stimulation of cognitive functioning emerged from the literature review. The need for individualized, intensive mediation aimed at boosting weak cortical functioning was well documented. Further, the active involvement of the learner in verbal interchange appeared to be essential in the formulation of efficient thought processes. The concept of dynamic functioning gave credence to Luria's functional systems theory of brain organization. Deficient cognitive functions, viewed as weak or vulnerable, rather than nonexistent, provided rationale for the reversibility of these functions.

Summary, Conclusions, and Recommendations

Tracing the development of the field of learning disabilities over the past 20 years has revealed ambiguity and a loss of scientific rigor in research design and methodology. According to Martin (1993), two myths about learning disabilities persist. The first myth is that LD is

always a mild disorder. However, this myth is beginning to change in response to new evidence to the contrary (Seventeenth Annual Report to Congress, 1995).

Government statistics indicate that a considerable percentage of high school students identified with LD (26.7%) drop out of school prior to graduation (Martin, 1993). Another 16% diagnosed with LD exit school for "unknown" reasons. These percentages defy the myth of mildness and confirm significant needs that must be addressed in order for students to achieve in school and be well prepared for life. Outcome studies indicate that only 17.1% of students with learning disabilities pursue postsecondary education despite adequate intellectual abilities (Martin, 1993).

The second myth, according to Martin, is that supplemental education is sufficient to meet the needs of students with LD. Yet, research indicates that many students with learning disabilities do not succeed in traditional resource room settings (Martin, 1993; Spreen, 1988; Zigmond, 1990). With the move toward inclusion of many students with special learning needs in general education classrooms, we must continue to examine the appropriateness of full-time participation in general education for students with LD (Martin, 1993). Many classrooms use extensive whole group instruction that may not be appropriate for these students (Berk & Winsler, 1995). Students with learning disabilities appear to need personal, intensive assistance to address deficient cognitive processing (Bakker et al., 1995). For these reasons, educational policy should be driven by research knowledge concerning effectiveness rather than solely on trying to achieve philosophically desirable ends (Fuchs & Fuchs, 1994). No longer can science take a back seat to the social and political forces that have shaped the LD field to date.

The present study was concerned with building a theoretical foundation for the stimulation of cognitive functioning and applying knowledge and insight from the field of neuropsychology to the field of education. A number of studies have validated the premise that

cognitive functioning can be enhanced through effective instruction (Scruggs et al., 1994; Swanson, 1993). There is also evidence to support the necessity of interhemispheric collaboration for efficient cognitive processing (Bakker et al., 1995; Levy, 1985). Additionally, emerging research suggests that some deficient cognitive processes can be reversed under specific conditions of intervention (Feuerstein, 1994; Bakker et al., 1995). Neuropsychologists provide support for the premise that fiber pathways within the brain can be "fine-tuned" through intensive intervention (Bakker, 1994; Duane & Gray, 1991). By far, the most significant finding in this area suggests that effective verbal interchange between teacher and student can enhance interhemispheric collaboration and lead to more efficient cognitive processing (Bakker, 1994; Das et al., 1995; Presseisen & Kozulin, 1994).

This study investigated six hypotheses regarding effects of an intervention program aimed at stimulating the cognitive functioning of students with LD through interactive language. In order to test these hypotheses the following specific objectives were defined:

1. To determine if completion of an intensive, individualized program of educational therapy would differentially affect the achievement scores in reading, spelling, and arithmetic for students with learning disabilities.
2. To determine if completion of an intensive, individualized program of educational therapy would differentially affect the cognitive functioning measured by general IQ (GIQ), verbal IQ (VIQ), and nonverbal IQ (NVIQ) scores for students with learning disabilities.

Six hypotheses were formulated to examine these objectives. Each hypothesis will be discussed separately below in light of findings based upon the statistical measures, the analysis of covariance and post hoc, Tukey, tests.

Hypothesis 1. A significant difference at the .05 level was found in the measured

improvement of reading words in isolation on the WRAT-R reading test over time for the experimental group. The increase of more than 10 points denotes a significant treatment effect. The control group also made gains over time, although such gains were not statistically significant. Finally, there was an interaction effect, but no statistically significant difference between the experimental and control groups in the posttest means.

Hypothesis 2. A significant difference at the .05 level was found in the measured improvement of spelling scores for students in the experimental group. The increase of nearly 8 points denotes a significant treatment effect. The control group also improved over time, but not significantly. There was an interaction effect, but no significant difference in the posttest means between the experimental and control groups.

Hypothesis 3. A significant difference at the .05 level was found in the measured improvement of arithmetic scores over time for the experimental group. The control group also made statistically significant gains. There was no differential growth between the two groups, that is, no interaction effect.

Hypothesis 4. A significant difference at the .05 level was found in general cognitive functioning for students in the experimental group. The increase of nearly 10 points denotes a significant treatment effect. The control group also improved significantly over time. There was no significant difference between groups prior to the intervention, but a significant difference was found between groups following the treatment. Thus, we can conclude that there was a significant interaction effect leading to both group and time differences.

Hypothesis 5. A significant difference at the .05 level was found in verbal cognitive functioning for students in the experimental group. The increase of nearly 10 points denotes a significant treatment effect. The control group also improved significantly over time. No significant difference was found between groups prior to the intervention; however, a significant

difference between groups was found following the treatment. Thus, we can conclude that there was a significant interaction effect leading to both group and time differences.

Hypothesis 6. A significant difference at the .05 level was found in the measured improvement of nonverbal cognitive functioning over time for the experimental group The control group also improved over time, but not significantly. There was an interaction effect, but no significant difference in the posttest means between the experimental and control groups.

Summary of methodology. Using Cronbach's (1980) UTOS construct, defining parameters of a specific study can be designated utos. Each of these four components will be examined in detail. The population (u) for the study consisted of a sample of 72 students identified with learning disabilities through a battery of psychological and educational tests. Students were served in private, parochial schools in seven school systems throughout the United States and one English-speaking school in Venezuela. Students ranged in age from 6-18 years and were enrolled in grades 1 through 12 at the outset of the three-year longitudinal study.

Students in the experimental group (n=47) completed a program of individualized educational therapy intervention twice weekly for periods of 80 minutes or 160 minutes per week in addition to their general classroom instruction. Students in the control group (n=25) were diagnosed with LD, but received no specific intervention other than general classroom instruction.

The specific treatment (t) in the study was the intervention developed by the National Institute for Learning Disabilities (NILD), consisting of at least five core techniques administered by educational therapists trained in the NILD method. Specific technique implementation had been standardized and copyrighted in a training manual, Teaching Techniques for the Learning Disabled (NILD, 1993).

The instruments (o) used to measure the treatment effects and test the hypotheses were

the Wide Range Achievement Test - Revised (WRAT-R) and the Detroit Tests of Learning Aptitude - Second Edition (DTLA-2). Although the WRAT-R yields a limited sample of behavior, it does measure acquisition of basic school codes, which are prerequisites for literacy. The DTLA-2 (1985), in turn, measures cognitive behavior and correlates highly with the WISC-R.

The setting (s) of the study was combined with u, t and o (utos) to define the domain of investigation (Cronbach, 1982). Since all participants in the study shared a common private, parochial school culture, the underlying norms and values defined both parental and student involvement. Students were served in a one-to-one setting, but were mainstreamed in the general classroom for the majority of their school experience.

A quasi-experimental nonequivalent control-group design was used as it was not possible to randomly assign students to groups based upon a prior diagnosis of a learning disability. Initial group differences were determined by chi-square analysis and independent t-tests. An analysis of covariance was conducted for each of the six variables: WRAT-R reading, WRAT-R spelling, WRAT-R arithmetic, DTLA-2 GIQ, DTLA-2 VIQ, DTLA-2 NVIQ followed by a post-hoc, Tukey, test. Covariates in the study were parental income, WRAT-R reading and spelling.

Conclusions

Recent studies confirm that learning disabilities persist into adulthood and that interventions generally are not clearly related to outcomes. Spreen (1988) saw outcome as dependent upon the severity of the disability, parents' socioeconomic status, and the presence or absence of neurological impairment. Additionally, evidence suggests that a language deficit subtype may result in poorer outcomes than other subtypes, since students with LD often have difficulty learning rule-based linguistic systems (Carlisle, 1994). In the present study, it was hypothesized that intensive, individualized intervention would lead to improved academic and

cognitive outcomes in students with diagnosed learning disabilities in an experimental treatment group compared to a control group.

Three questions were asked prior to the statistical analyses:

1. Are the groups different? The results indicated a significant difference between groups on two of the six variables used to test the hypotheses. Specifically, students in the experimental group significantly outperformed students in the control group on general and verbal cognitive processing as measured by the DTLA-2. These intelligence measures correlate highly (from .90 to .95) with the full scale and verbal intelligence quotients of the WISC-R. Generally, students with learning disabilities tend to regress in language-related standardized assessments (Spreen, 1988), so an increase of approximately 10 points on each of these variables indicates a significant treatment effect.

2. Is performance different over time? For each of the six variables, performance increased significantly over time for the experimental group. Thus, increases were noted in reading, spelling, and arithmetic, and in general, verbal, and nonverbal IQ scores. Two of the variables, general intelligence quotient (GIQ) and verbal intelligence quotient (VIQ), also increased significantly over time for the control group. Evidence reflects that the experimental group's scores increased significantly over time. There was no apparent difference between groups at the pre- and posttest levels. The trend toward growth of the experimental group, coupled with nonsignificant differences between control and experimental groups, may reflect limited sample size.

3. Do the groups differ by time (is there interaction of group/time)? A significant interaction effect was noted for five of the six variables: reading, spelling, GIQ, VIQ, and NVIQ. In addition, GIQ and VIQ evidenced both group and time differences. Both groups evidenced significant growth; however, the experimental group demonstrated impressive gains

compared to the control group.

The treatment also seems to have resulted in successful language stimulation. On every measure, the experimental group made significant gains over time. The control group also progressed over time, although not significantly, in four of the six measures. This growth is possibly due to a smaller gap in this group between ability and achievement. That is, particular language deficits may have been less severe going into the experiment for controls.

Therefore, the conclusion can be drawn that intensive intervention using the NILD educational therapy model appeared to affect significant changes in academic achievement in reading, spelling, and arithmetic and in general, verbal and nonverbal cognitive functioning. Without the use of PET or MRI scans, it cannot be proven that neurological functioning has been enhanced. However, since increased performance on these outcome measures over time is atypical for students with learning disabilities, it may be assumed that greater neurological efficiency is a factor (Bakker, 1994). Follow-up studies on students with LD generally confirm a regression effect in the absence of specific intervention (Horn, O'Donnell, & Vitulano, 1983).

It is noteworthy that in cognitive processing the control group also made significant gains over time. This may reflect excellent classroom instruction and stimulating interactive dialogue within a group setting. However, the performance results of the experimental group were significantly different from those of the control group following intensive, individualized intervention.

Of the three variables measuring cognitive processing, the most significant gains for the experimental group were found to be in the areas of general and verbal intelligence. Thus, on these two measures (GIQ and VIQ), there was a significant group-by-time interaction in which both the experimental and control groups showed significant gains, although the experimental group's gain was significantly greater than that of the control group. Supporters of the NILD

model believe that the five core techniques may address these areas of higher cognitive functioning through the medium of interactive language. Further, it has been proposed that the intervention must be individualized and intensive.

Scruggs and Mastropieri (1994) suggested that effective interventions for students with LD should go beyond individualized tutoring. Generally, tutoring attempts to build upon student strengths and typically provides information for the student rather than specifically requiring a student response. Tutored students generally remain passive recipients of information rather than active participants in the learning process. The aim of tutoring generally is to teach content, rather than develop cognition (Kronick, 1988). Students with LD often reflect processing weaknesses manifested at the sensory level. These sensory-level weaknesses may prohibit the development of higher-level tertiary functioning. It is the process of interactive dialogue guided by a skilled mediator that appears to direct the integration of information impacting executive function. Access to basic school codes such as those measured by the WRAT-R (1984) primarily involves sensory-level processing. Whereas tasks such as those assessed by the DTLA-2 (1985) involve greater hemispheric differentiation. It is significant that in the current study the greatest interaction effects reflecting clear differences between experimental and control groups were seen in general and verbal cognitive processing.

Limitations. Continued controversy surrounding the definition of learning disabilities impacts the present study. Defining parameters of LD should include both ability and achievement. The mean IQ score for students in both the experimental and control groups was approximately 106, representing the upper end of the average band of 90-110. In terms of the LD ability-achievement discrepancy, described as one standard deviation below the mean, students within the experimental group fulfilled this criterion in the reading, spelling, and arithmetic pretests, but the control group did not. Generally, their achievement scores were less

than one standard deviation of their IQ scores, bringing into question whether they, in fact, had learning disabilities. This lack of significant discrepancy for the control group may actually serve to strengthen the study in light of impressive gains made by the experimental group.

Although all educational therapists in the present investigation were trained and certified in the NILD approach, it is not possible to account for individual differences in technique implementation and individual proficiency. Another limitation relates to the specific assessment tools used in the study. The WRAT-R measures basic school codes, decoding, encoding, and computation skills, which are basic to academic success in these areas; however, they are not indicative of higher level reasoning or language proficiency.

Since students in the study were drawn from private schools, the question of generalizability to the public sector becomes a possible limitation. To what extent did the setting contribute to the results? Students in the present study were predominately from two-parent families with a mean income of around $50,000. Parents were generally well-educated with a commitment to their children's education evidenced by a willingness to pay fees above private school tuition costs. Also, there was a time commitment evidenced through agreement to home practice and student support. Cronbach (1982) stated, "In the context of program evaluation, a conclusion about UTOS is a prediction" (p. 176). Judgment and formal reasoning must be combined in light of the evidence to reach a certain conclusion. The credibility of this conclusion depends upon the degree to which the working hypotheses are accepted by the relevant community. Conclusions drawn from the present study should be tested further to examine the findings thoroughly.

Using Cronbach's model, we may view the specific domains of the present study as utos and reflect upon the particular generalizability of the population (u) and the setting (s). Students designated with LD in private school settings are not necessarily comparable to students with LD

in public schools. First, the mean IQ scores of the private school group may be higher than in public settings. Students designated with LD in private settings are not strictly categorized according to standard IQ discrepancy formulas, nor must their achievement be two years below grade level to be determined eligible for services. Since evidence suggests (Spreen, 1988) that measured intelligence accounts for 49% of outcome variance, IQ seems to be by far the strongest of all predictors for success. It is students with the greatest intellectual potential who may benefit the most from this specific treatment intervention.

Further, the issue of parental commitment to education is important. Since the component of home practice defines the model under investigation, parental support (e.g., training in home supervision) and consistency (e.g., ongoing observations and time commitment) may be critical to the treatment's effectiveness. Therefore, the gains of the experimental group in the present study must be clearly defined in the context in which they were found. It is possible that the results evidenced in the present study may be context specific and not generalizable to public school settings. Further studies are needed to confirm effectiveness in other settings and with different populations.

A further limitation of the current study is the lack of data regarding specific classroom performance of the students under investigation. Although test results appear to support both aptitude and academic gains, it would be important to gather data, both statistical and anecdotal, from classroom teachers describing student progress in future studies. Examples of possible classroom measures include student attitudes to learning, motivation, consistency in homework and classwork, grades on tests, daily work, and report cards. Thus, the observing operations (o) need to be redefined in further studies.

Finally, it is not yet possible to measure neurological functioning of students during or following educational treatment interventions. Scientific evidence of increased interhemispheric

collaboration awaits more sophisticated technology.

Recommendations

Recommendations for future studies. The effects of a specific treatment program have been demonstrated in this investigation. The results raise a number of important questions for researchers to explore in future studies. A primary question involves the experimental group. Are these students getting better? That is, are they achieving academic results commensurate with their ability? It appears that the treatment may have widened the gap between ability and achievement. How does that impact classroom functioning? Are these students able to complete assignments independently? What are their grades and work habits following intensive intervention? Are further modifications needed in their instructional programs? A follow-up study on these 72 students is needed to assess outcome measures relative to performance in the classroom.

Additionally, students in the experimental group were given a treatment package. It is important to examine the elements (e.g., techniques, home practice, parental consistency) within that package individually. Was one of the techniques more powerful than the others, rendering one or more of the others unnecessary? Future studies could examine each of the five techniques in isolation over a period of time to assess its effectiveness.

Further, the elements of home practice, teacher training and effective questioning serve to define the model under investigation. Therefore, the relative importance of each of these elements should be studied individually. For example, would student progress be significant in the absence of consistent stimulation with the Rhythmic Writing technique? Further, how important is ongoing training in the effectiveness of educational therapists? It is assumed that therapists improve in questioning skill over time and with practice and that advanced training facilitates competency. These assumptions should be tested in future studies.

Future studies should employ assessment tools designed to measure reading comprehension, writing proficiency, grammar skills, and applied mathematics. For example, the Woodcock-Johnson Tests of Achievement would provide data relative to higher-level reasoning and language fluency. Further, other assessment tools designed to measure executive functioning could confirm the effectiveness of language stimulation for students with LD. Results of the present study seem to indicate that both intensity of service delivery and individualization are necessary to overcome the tenacious cognitive processing weaknesses within the LD population. In this regard, the guidance of a skilled adult mediator appears to be essential. Further studies designed to compare small-group and individual instruction are needed to test these hypotheses.

Administrative implications. Clearly, there are no simple answers to the complex disorder known as LD. Although knowledge of neurological functioning supplies needed insight for educators, such knowledge introduces questions in terms of appropriate solutions. The search for effective interventions must bridge the disciplines of education, neuropsychology, and biology. To date, research domains have been parallel rather than integrated. The field of biology has provided insight regarding brain mechanisms and biological markers relative to neurological functioning. The field of neuropsychology has begun to address and test theories of functional systems and their application to educational interventions. Educators may now draw upon research from other disciplines.

Given the prevalence of LD and the changing roles of administrators as instructional leaders, school administrators might benefit from training in the philosophy and biology of learning disabilities. Such training should be incorporated as part of preparation for leadership at a graduate level and should aim at integrating the academic disciplines of education, neuropsychology, and biology. Further ongoing coursework should be required for

administrators to stay current in advances in various fields and their application to learning disabilities.

In terms of staff development, all teachers might benefit from inservice opportunities designed to elaborate the physiology of learning and the importance of guided questioning and interactive dialogue. There is a need to study and research various aspects of interactive dialogue within classroom settings.

Theoretical foundations established by Piaget, Vygotsky, Luria, and Feuerstein should be examined and discussed during preservice and inservice learning. Books such as, The Language and Thought of the Child (Piaget, 1959), Thought and Language (Vygotsky, 1962/1975), Language and Cognition (Luria, 1981), and Instrumental Enrichment: An Intervention Program for Cognitive Modifiability (Feuerstein, 1980) provide rich sources for academic discourse and have significant implications for instruction. Finally, teachers need to be taught to use guided questioning to facilitate learning.

Certain elements of the techniques used in this study could be incorporated into classroom settings. In particular, dictation and mental math could be studied to determine if their integrative properties lead to simultaneous processing. This could be studied with students of different ability levels.

It has been recommended that students with LD need intensive, individualized intervention in order to improve their cognitive processing. Some suggest that these disabilities cannot be adequately addressed in a whole class or even a small-group setting. The costs of individual therapy are administratively daunting. It is clear, however, that something must be done to curb the numbers of students with LD who continue to drop out of school in record numbers. Further, the link between learning disabilities and juvenile delinquency has been well established (Brier, 1989). Already the cost to society is staggering. Certain treatment package

elements would need to be in place to test the efficacy of implementing the NILD model in public settings. First, school administrators would have to commit to the provision of one-to-one instruction for a three-year pilot study with a sample of students diagnosed with LD. Second, these students' parents would need to agree to the time commitment necessary to provide consistent support and home practice. Third, the students themselves, particularly at middle and high school levels, would need to be motivated and willing to become actively involved in the learning process. Finally, a system of professional collaboration would need to be instituted so that classroom teachers and trained educational therapists could work together to plan and design effective student programming. At this time, it has not been proven that the NILD intervention package would be effective in public school settings. It would be important to test the hypothesis that with administrative support and student motivation the individualized intervention would be both appropriate and effective within public schools.

In terms of staff development, building a successful intervention program for students with learning disabilities requires creative energy and the development of collaborative cultures within both schools and systems. Classroom teachers and educational therapists should be trained to work together in partnership dyads to share resources and mutually design appropriate accommodations for students with LD in the general classroom. Generalists and specialists would benefit from a structured problem-solving method that incorporates active listening and relationship-building components. In time, the dyads could form teams that may include families and even the students themselves.

Creative solutions for the growing numbers of students identified with LD must be explored through interagency collaboration. For example, teams composed of social workers, neuropsychologists, teachers, administrators, educational therapists, families, physicians, and other professionals could create a synergy released through the shared expertise of each. As the

medical and educational fields dialogue and explore new educational possibilities based upon rigorous scientific research across disciplines, all students with learning needs would benefit.

Traditional remediation programs for LD appear to have been minimally effective because they have addressed only the symptoms and not the underlying neurological problems of students with learning disabilities (Tallal, 1994). Collaboration of the medical and educational fields could well be a model of how scientific research in the field of LD should proceed in the future. By facilitating dialogue among researchers who bring a variety of perspectives to a given issue, scientific study can progress more rapidly. Such an approach makes wise and efficient use of both people and technology. More sophisticated technology continues to developed, bringing us closer to being able to identify specific neurological dysfunction and patterns of dysfunction within a given individual (Cruikshank, 1989).

Educators are faced with insurmountable tasks and unprecedented opportunities. They must unite with parallel disciplines to meet the needs of the burgeoning population of students with LD. Further, administrators must provide inservice opportunities for educators to learn more about the effects of interactive dialogue within classroom settings, as well as the neuropsychology of learning.

It has been suggested that current interventions are generally not powerful enough to make a difference in the LD population. Learning disabilities are not a mild disabling condition. The times demand solutions that are sound, effective, and based upon field-tested research. Studies investigating more neurologically based interventions are needed. It is hoped that the results of this study will prompt both replication of the study and further discourse among professionals.