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The Classification of Reading Disability Subtypes and the Efficacy of Hemisphere Specific Stimulation

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THE CLASSIFICATION OF READING DISABILITY SUBTYPES AND THE EFFICACY OF HEMISPHERE SPECIFIC STIMULATION

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This study examined the utility of categorizing students with reading difficulties by fluency and error rates and the efficacy of interventions proposed to remediate each type. Forty-eight students with low reading fluency in grades three through six were categorized into three dyslexic subtypes based on Bakker's (1992, 1994) Balance Model of Reading. Thirty-five participants were identified as M-type dyslexics, who display slow reading with many errors. Thirteen participants were identified as P-type dyslexics, slow reading with few errors. No L-type dyslexics (fast reading with many errors) were identified. Each grade-level group received one of two treatments (Hemisphere Specific Stimulation and repeated partner reading) counterbalanced for six weeks. Hemisphere Specific Stimulation (HSS) used a tactile training box to stimulate the targeted hemisphere as indicated in Bakker's Balance Model of Reading. The students worked in pairs, each participating as a student-examiner (placing letters in the training box) and a student-examinee (manipulating letters with a specified hand to stimulate the opposite hemisphere). The second treatment group received repeated partner reading. Each participant was assessed with AIMSWeb reading fluency (words read correct per minute), reading accuracy (percentage of words read correctly), and reading comprehension probes.

The results of this study suggest that both repeated partner reading and HSS produced significant ($p < .001$) gains in reading fluency and reading comprehension. The HSS procedure produced significant ($p < .008$) gains in reading accuracy but repeated partner reading did not significantly ($p < .092$) change a participant's reading accuracy. No significant differences were observed between the two treatments in reading fluency and reading comprehension. Slow, accurate readers (P-type dyslexics) demonstrated higher gains in reading fluency and reading comprehension than slow, inaccurate readers (M-type dyslexics). M-type dyslexics', however, displayed significant improvement in their reading accuracy. The results from this study validated Baker's model and the developmental nature of reading. The results suggest that reading accuracy should be the initial focus of reading intervention. Also, increases in reading fluency as well

as increases in reading accuracy produced similar increases in reading comprehension.

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INTRODUCTION

Students with reading difficulties are receiving more attention (Lyon and Moats, 1997) and comprise one of the greatest needs our schools presently face (National Center for Education Statistics, 2004). Schools today are using a variety of empirically-valid treatments (Allington and Baker, 2007; Joseph, 2006) with increasing frequency and duration (Reeves, 2003). Reeves (2003) reported that some students may require up to one hundred-eighty (180) minutes of reading instruction/intervention a day. Schools must find new ways to sustain a student’s interest and motivation while improving their reading skills. Bakker’s Balance Model of Reading (1992, 1994) and hemisphere stimulation (Bakker, 1990) attempt to link reading difficulties to interventions and may provide a variation from frequently used treatments to keep students actively involved.

The Problem

Educators face many problems inherent to the current practices of improving a child’s reading. Previously, there was little to no coordination between the assessment of reading difficulties and the interventions to remediate those problems (Gresham, 2001). This is exemplified in an Executive Summary presented at the Learning Disabilities Summit in August 2001 which stated, “The most serious flaw in the current process (discrepancy-based model for identification of learning disabilities) is the absence of a direct link between assessment procedures used for identification and subsequent interventions that might be prescribed on the basis of these assessment procedures” (Gresham, 2001). In addition, most children are ‘lumped’ together in one general group of reading disabled students. The lack of specific, individualized interventions may be the result of two fundamental problems: the number of students experiencing reading problems (National Center for Education Statistics, 2004) and the teachers’ lack of knowledge of empirically-valid interventions (Lyon and Moats, 1997).

Lyon and Moats (1997) have reported that at least 20% of the population in the United States has reading difficulties. As of the 2003-2004 school year, 5.8% of students were identified with specific learning disabilities (National Center for Education Statistics, 2004). Furthermore, current practices do not appear to be correcting the problem. Students' reading skills have worsened rather than improved since 1992, according to data gathered by the National Center for Education Statistics (2004).

The increase in students with reading problems has not occurred because educators have ignored the problem. Over 100,000 research studies on reading have been conducted since 1966 (National Reading Panel, 2000). The challenge is to produce research that is readily translated into practice. Lyon and Moats (1997) identified several hurdles that educational researchers face:

- Complex studies have difficulty replicating classroom conditions;
- Varying student characteristics make a study's population difficult to understand;
- Vague descriptions of interventions make identifying productive components challenging;
- Lack of interest due to weak generalization of treatment effects.

Teachers face many of the same obstacles when attempting to understand and implement empirically-validated practices in their classrooms. The complex methodological structures limit how well studies can represent/replicate classroom conditions. Studies that are conducted in laboratory conditions or with low participant to researcher ratios are difficult to conduct in a school setting. The heterogeneous samples make it difficult to provide a precise definition of student characteristics in these studies thus produce unaccounted-for variance between variables. Student characteristics such as gender, age, ethnicity, socio-economic status, location, size of school, and others are varied between subjects and it is difficult to determine how each characteristic will affect the results of the study. In addition, each student who we are attempting to apply these results to possess diverse characteristics themselves and finding study participants with common traits is not easily accomplished (Lyon and Moats, 1997).

Poorly defined or vague interventions make it difficult to know which intervention components are responsible for change. This is also a problem when implementing an intervention because many treatments may be present at the same time. Also, weak generalization of treatment effects fails to arouse interest in the interventions. Studies that use different statistics are difficult to compare and make conclusions unclear about which treatment is most effective. Schools that do not set standards of acceptability face inconsistent decisions pertaining to their usefulness (Lyon and Moats, 1997).

Although the Response to Intervention (RtI) model attempts to link the intervention's effectiveness to assessment, few curriculum-based assessments provide insight to the causal factors impacting the academic skill (National Association of State Directors of Special Education, 2005). RtI is the practice of providing high-quality instruction and interventions matched to student needs using learning rate over time and level of performance to make important education decisions (National Association of State Directors of Special Education, 2005).

RtI matches intervention to need and decisions are made based upon improvement rate. This problem-solving model is appropriate with students who demonstrate gains in rate of learning. Those students who do not show improvements in their rate of learning may require a different approach to investigate the possible causal factors that are impacting the specific academic skill. One way to begin to investigate why students are not responding to intervention is to find commonalities within their reading profiles and identify reading disability subtypes.

Reading Disability Subtypes

Since all students are different, all students' reading difficulties are different. However, common themes and difficulty with similar skills do emerge (Bakker, 1990). These skill deficits are evident during assessment and could be communicated with the team to expedite the evaluation process. Most school personnel do not want to further label children, even though a majority of these labels provide valuable information about a child and give a starting point to the person working with the child. Classifying subtypes of reading difficulties would allow teachers and support personnel to start closer to the actual problem.

Using reading disability subtypes would allow for the investigation of the causal factors of reading difficulty. Currently, the focus is on symptoms, broadly reading and more narrowly, reading decoding and/or reading comprehension (IDEIA, 2004). By investigating causes, remediation of the problem is more likely and is not complicated by how single causes may manifest in different children.

Reading disability subtypes also allow for the further identification of areas of need and provide a structure to base subsequent interventions. The identification of subtypes would provide teachers and support staff with the opportunities to use assessment data to 1) formulate goals/objectives, 2) individualize interventions, 3) target specific difficulties, and 4) evaluate progress. Therefore, linking assessment to intervention would require collaboration on empirically-based interventions and additional information on the specific reading disability subtypes.

Finally, the use of reading disability subtypes would expand the role of the school psychologist in a number of ways. First, the use of subtypes would require increased collaboration with teachers and support staff to share information on the expanding research on brain function and reading. This includes data on effective interventions and strategies to remediate specific subtype difficulties. The psychologist would have a role in intervention selection based on subtype. This role would increase their personal investment in the intervention, increasing the possibility of taking on an expanded role when implementing the intervention. All of these roles decrease the role of only the ‘gatekeeper’ of special education.

Linking assessment to intervention, identifying commonalities among reading difficulties, and finding new and different ways to increase a student's reading may be accomplished using Bakker's Balance Model of Reading (1992 and 1994).

Bakker's Balance Model of Reading

Bakker (1992, 1994) studied ear-advantage and brain imaging of readers at different levels of proficiency. He theorized that reading begins as a perceptual task in the right hemisphere and shifts to the left hemisphere when language becomes involved. Bakker's Balance Model of Reading (1992) categorizes students with reading difficulty into three dyslexic subtypes based on students failing to make the shift to the left hemisphere or shifting to the left hemisphere too early.

The three dyslexic types are P-type dyslexics, L-type dyslexics, and M-type dyslexics. P-type dyslexics display slow reading with few substantive errors. L-type dyslexics display fast reading with many substantive errors. M-type dyslexics display slow reading with many substantive errors.

One of the treatments that Bakker proposed to remediate those reading difficulties is Hemisphere Specific Stimulation (HSS). Hemisphere Specific Stimulation uses a tactile training box to stimulate the targeted/deficit hemisphere. Implementing hemisphere stimulation as a treatment has several positive aspects.

First, hemisphere stimulation is relatively easy to administer and does not require much equipment. Teachers or other school personnel can be trained in using this intervention in a few days and the only equipment required is a tactile box and some computer software. Although the complete model and treatment needs further investigation, aspects of this model could be implemented immediately through consultation with teachers. When suggesting a multi-modal approach, hemisphere specialization should be taken into mind and suggest using both hands for tactile tasks. Teachers currently have children tracing letters with a finger and manipulating shapes although they do not specify what hand to use. Children will probably use their dominant (right in a majority of students) hand. Bakker’s model suggests that input from the right hand to stimulate the left/linguistic hemisphere thus not having the same amount of impact that stimulating the perceptual hemisphere would have, theoretically speaking.

An advantage of this intervention is how vastly different it is from traditional interventions. After hundreds of worksheets, canned instruction, and hours of choral reading, hemisphere stimulation will be a welcomed change and may increase motivation and attention to task. The novelty of the task may account for increases in interest; however, it is difficult to separate novelty from reaction to the treatment. In addition, Goldberg and Costa’s (1981) Novelty Theory proposes that the right cerebral hemisphere is used in processing novel information.

The most encouraging aspect of hemisphere stimulation is the ages of the participants who displayed reading improvement. Most studies looked at children past the third grade, which is where reading instruction is deemphasized and reading improvements are believed to plateau (Ogle and Lang, 2007). Improvements by older students suggests that the leveling off may be due to ineffective treatments and lack of instruction, not to the stability of the reading process in the brain. If a child has been treated with the same strategies since displaying reading problems in first or second grade, it is not surprising that they lose their effectiveness by the end of third grade.

This study will identify the problems in current practice and discuss the advantages of reading disability subtypes to link assessment with intervention. The context of reading disability subtypes is based on Bakker’s Balance

Model of Reading (Bakker, 1992, 1994). In particular, the following aspects of Bakker's theory will be examined:

a) neuropsychological research pertaining to the possibility of 'fine-tuning' the processes of the brain and whether those changes will stabilize,

b) hemisphere specialization in relation to the reading process, and

c) the validity and utility of Bakker's classifications of dyslexia (L-type, P-type, and M-type dyslexics).

This study will classify third through sixth grade students with reading difficulties into Bakker's subgroups and investigate the efficacy of interventions based on hemisphere-specific stimulation within each group. This study will examine the efficacy of HSS by analyzing each participant's reading fluency, reading accuracy, and reading comprehension rates compared to participants who received a traditional reading intervention (repeated partner reading).

Research Questions

The purpose of this study is to investigate Bakker's Balance Model of Reading (1992) and link reading interventions to reading difficulties. This will be accomplished by categorizing students with reading difficulties by fluency and error rates and examining the efficacy of interventions proposed to remediate those different reading difficulties.

Previous research (Dryer, Beale, and Lambert, 1999; Kappers, 1997; Robertson, 2000; Lorusso, Facoetti, Paganoni, P., Pezzani, Molteni, 2006) investigated Bakker’s model (1992) by providing appropriate and inappropriate treatment. Appropriate treatment is defined as stimulation to the hemisphere believed to be underdeveloped. Inappropriate treatment is defined as stimulation to the hemisphere that is opposite the underdeveloped hemisphere. This study does not attempt to valid Bakker’s model, but rather investigate Hemisphere Specific Stimulation’s (HSS) efficacy in a public school setting as compared to a currently used empirically-valid reading intervention (repeated partner reading).

This study will attempt to answer several research questions. First, what impact will HSS have on a participant’s reading fluency (words read correctly per minute) as compared to a participant who received repeated partner reading? In addition, what impact will HSS have on the reading fluency of slow, accurate readers (P-type dyslexic), fast, inaccurate readers (L-type dyslexics), and slow, inaccurate readers (M-type dyslexics) as compared to each of those types of readers who receive repeated partner reading?

Second, what impact will HSS have on a participant's reading accuracy (the percentage of words read correctly per minute) as compared to a participant who received repeated partner reading? Also, what impact will HSS have on the reading accuracy of slow, accurate readers (P-type dyslexic), fast, inaccurate readers (L-type dyslexics), and slow, inaccurate readers (M-type dyslexics) as compared to each of those types of readers who receive repeated partner reading?

Third, what impact will HSS have on a participant's reading comprehension as compared to a participant who received repeated partner reading? What impact will HSS have on the reading comprehension of slow, accurate readers (P-type dyslexic), fast, inaccurate readers (L-type dyslexics), and slow, inaccurate readers (M-type dyslexics) as compared to each of those types of readers who receive repeated partner reading?

Finally, what impact will HSS and repeated partner reading have on participants of varying grade level, income level, and sex.

Hypotheses

This study will examine three hypotheses within the context of the research questions. First, students who receive HSS intervention that targets their reading disability subtype will

- significantly increase their reading fluency (words read correct per minute on the AIMSWeb Reading CBM) as compared to students who received traditional interventions (repeated partner reading),
- significantly increase their reading accuracy (percentage of words read correct per minute on the AIMSWeb Reading CBM) as compared to students who received traditional interventions (repeated partner reading), and
- significantly increase their reading comprehension (number of correct responses on the AIMSWeb Reading Maze) as compared to students who received traditional interventions (repeated partner reading).

Second, students who receive repeated partner reading will

- display no change in their reading fluency (words read correct per minute on the AIMSWeb Reading CBM) as compared to students who received HSS

- display no change in their reading accuracy (percentage of words read correct per minute on the AIMSWeb Reading CBM) as compared to students who received HSS, and
- display no change in their reading comprehension (number of correct responses on the AIMSWeb Reading Maze) as compared to students who received HSS

Third, there will be no significant difference in scores on the reading fluency (F-CBM), reading accuracy, and reading comprehension (Maze) measures between males and females, students who receive free or reduced lunch and students who do not receive free or reduced lunch, and grades levels after each treatment (HSS and repeated partner reading). Figure One identifies the latent variables that will be investigated in this study.

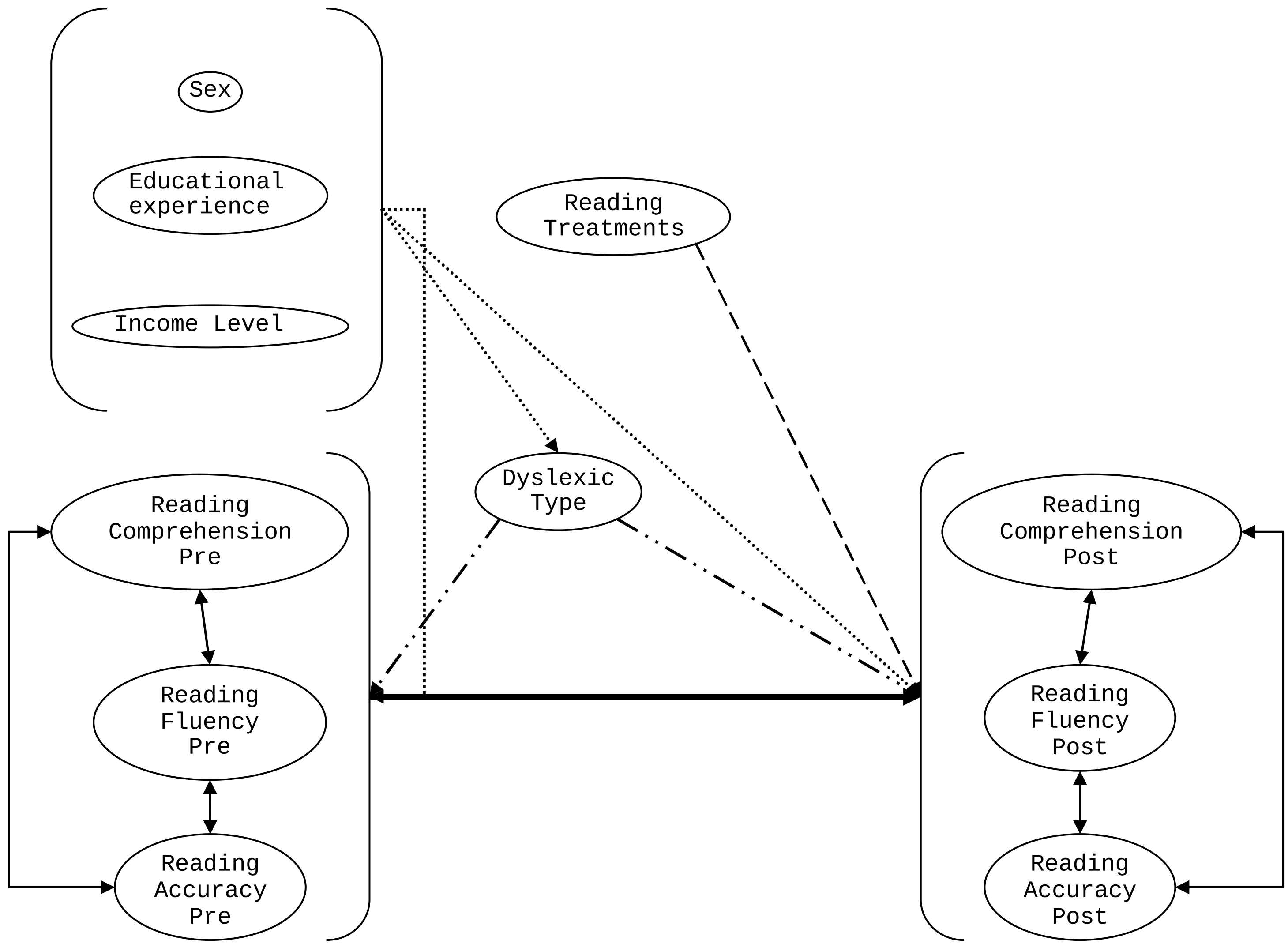

Figure 1. Research path diagram of the latent variables.

Problem Significance

The current practice of identifying students with learning disabilities is somewhat inconsistent. Practitioners 'sit the fence' between the stringent limitations and impractical means of the discrepancy model and the lack of understanding of the underlying causal factors of the Response to Intervention (RtI) model (National Association of State Directors of Special Education, 2005). By characterizing readers by common error patterns, educators may begin to understand why some problems are occurring and use similar practices to remediate those concerns. The use of reading disability subtypes will not identify the presence of a learning disability, by using these classifications; practitioners will attempt to rectify concerns of the current practice.

Many of the current achievement batteries lack 'true' reading assessments. A 'true' reading assessment requires a student to read connected text to acquire information. Due to the need for a standard score to determine if a discrepancy exists, batteries such of the Woodcock-Johnson Tests of Achievement – Third Edition (WJ-III ACH) (Woodcock, McGrew, and Mather, 2001) are used. The WJ-III ACH measures reading by requiring the student to identify letters and words in isolation, completing sentences with words omitted (CLOZE technique), decoding nonsense words, and determining if simple sentences are true or false in an efficient manner. None of these techniques involve reading connected text in a manner to acquire information. Furthermore, few standardized assessments provide teachers with the information necessary to formulate effective interventions.

Another problem with the current practice of assessing learning disabilities is the lack of a clear identification of the problem. Practitioners must state that a student qualifies for special education as a student with a Specific Learning Disability (IDEIA, 2004). The type of learning disability, such as reading decoding and reading comprehension, are not required to be identified on the conclusion page. Although a thorough explanation may exist in the body of the report, too many times this information goes unnoticed by those who implement the intervention. Even if reading is listed as the disability type, the scope and nature of the problem is not highlighted, which may lead to uniformed remediation strategies which decrease the intervention's likelihood of success.

Current practice does not link assessment to intervention (Gresham, 2001). After a student is identified, the special education teacher usually conducts informal assessments to gauge the student’s current level of functioning and designs an intervention. The desire to move away from the gatekeeper role is prevalent among many school psychologists (Merrell, Ervin, and Gimpel, 2006), but until assessment and identification is provided that is practical and can be used by the people responsible for the implementation of the intervention, school psychologist are destined to continue to fill the role of gatekeeper for special education.

Time is another factor that prevents many school psychologists from conducting the types of assessments that can be used to develop an intervention plan. However, with the implementation of the response to intervention model (RtI), the need for cognitive ability assessments with learning disabled students will diminish (Gresham, 2001). This problem-solving approach will free up a substantial amount of time to conduct assessments to investigate the nature of the learning problem. In addition, most authentic reading assessments take very little time. Curriculum-based measures (CBM) of reading skills, such as AIMSWeb (Shinn and Shinn, 2002) and Dynamic Indicators of Basic Early Literacy Skills (DIBELS) (Good and Kaminski, 2002) can be given in just a few minutes. Even standardized measures, such as the Gray Oral Reading Test (GORT-4), can be administered in 15 to 45 minutes.

In addition to problems with the current nature of reading assessment, resistance to reading difficulty subtypes exists (Gladdes and Edgell, 1994). This resistance may exist due to the neuropsychological affiliation of many of the models of classifying reading difficulty and the use of the term dyslexia. Many in field equate dyslexia with neurological damage. Without the means of assessing the existence of neurological damage, practitioners are uncomfortable with its use and subsequent applications. However, Gladdes and Edgell (1994) define Specific Developmental Dyslexia and Dyslexia, respectively as:

‘A disorder manifested by difficulty in learning to read despite conventional instruction, adequate intelligence, and socio-cultural opportunity.’

and

‘A disorder in children who, despite conventional classroom experience, fail to attain the language skill or reading, writing, and spelling commensurate with their intellectual abilities.’ (pp.336)

These definitions are consistent with how most school psychologist would define a specific learning disability in reading and do not indicate a brain lesions or specific area of dysfunction. Chapter 14 Pennsylvania Regulations 300.7 (10) uses the term dyslexia in defining a Specific Learning Disability. This suggests that neuropsychologists and school psychologists are investigating the same things and would benefit from sharing ideas such as reading disability subtypes.

Definitions

Three Subtypes of Dyslexia

Bakker’s Balance Model (1992, 1994) suggests reading difficulties can occur in three ways. First, if a reader shifts from the right hemisphere to the left hemisphere too soon, reading difficulty could occur. Second, a student will have difficulties reading if they fail to shift from the right to the left hemisphere. Finally, if a student starts with the left hemisphere, problems with reading could occur. These dysfunctions in the shift of reading can result in three types of dyslexia (P-type, L-type, and M-type).

The P-type (perceptual) dyslexic will display slow, labored reading and will make few substantive errors although many fragmentation errors. Substantive errors are classified as errors that may change the meaning of the text, such as omissions, substitutions, and additions. Fragmentation errors have less affect on the meaning of the text and include fragmented word reading and hesitations. The P-type dyslexic may still be processing the text in a perceptual manner (shape by shape) and Bakker (1992, 1994) believed these children fail to make the shift to the left hemisphere. P-type dyslexic dyslexics are also called "spellers" (Van der School, Licht, Horsley, and Sergeant, 2000).

The L-type (linguistic) dyslexic will read hastily and inaccurately with many substantive errors. These children made the switch to the left hemisphere too soon or started the reading process on the left. Bakker (1992, 1994) indicated L-type dyslexics make substantive errors because they disregard the perceptual text features and are likely to omit or add to the text. These readers were denoted L-type dyslexic children or "guessers" (Van der School et al, 2000).

The M-type (mixed) dyslexic displays characteristics of both P-type and L-type dyslexics. The M-type dyslexic will read slowly and make many substantive errors. Bakker

(1994) reported that M-type dyslexics make up approximately 35% of all dyslexics.

Hemisphere Stimulation

Interventions based on the Balance Model of Reading include two types of hemisphere stimulation (hemisphere-specific stimulation and hemisphere-alluding stimulation). Hemisphere-specific stimulation (HSS) attempts to target only the specified hemisphere through visual, tactile, or auditory stimuli. Visual HSS flashes letters or words in the opposite visual field of the intended hemisphere using a computer program developed by Bakker and colleagues (Bakker, Licht, and Kappers, 1995). Tactile HSS uses a tactile box, which requires the participant to manipulate magnetic letters that are out of sight. Auditory HSS requires the participant to listen to words or sounds in the ear that is opposite the targeted hemisphere.

Hemisphere-alluding stimulation (HAS) stimulates a specific hemisphere based on the demands of the task. Language-based tasks will stimulate the left hemisphere more than the right hemisphere and perceptual tasks will stimulate the right hemisphere more than the left hemisphere. Language-based HAS use rhyming sentences that are missing a word thus allude the left hemisphere.

Perceptual HAS uses perceptually difficult text. The Scrambler (Bakker, Licht, and Kappers, 1995) is a computer program that will change the size and font of each letter in a text thus creating a task that allude to the right (perceptual) hemisphere.

Assumptions

Four major assumptions based on past research need to be understood to present a context in which Bakker’s model (1992, 1994) will exist. The first assumption is the cross lateral specialization of hemisphere function. In other words, each hemisphere has a majority of responsibility for certain functions (although never sole responsibility) and each hemisphere is responsible for the opposite body side. In addition to specific functions, the second assumption is one hemisphere is considered a dominant hemisphere. This dominant hemisphere is responsible for language and is usually found in the left hemisphere (Bryden, 1988), based on electro-activity and cerebral blood flow of readers (Bakker, 1994).

The final two assumptions pertain to the possibility of ‘fine-tuning’ the processes of the brain and whether those changes will stabilize. Bakker (1994) reported that neuropsychological stimulation cannot change the macro aspects of the brain but can change its ‘fine-tuning’ and its response to written text (reading).

Bakker explained this concept by describing the brain as a house. He describes the weekend handyman as a metaphor for stimulation. This handyman cannot change the placements of the walls or add a floor (macro aspects) but he/she can paint the walls or change a light bulb (micro aspects). Bakker concluded that no physical changes will occur but the brain may function differently. If the brain responds differently to enriched and impoverished learning and educational environments, then the brain can be considered a dependent variable and will react to stimulation. Bakker (1994) uses a cup and marble example to illustrate the stabilization of change. He posits the following: the marble in the cup. When the cup is moved (stimulated), the marble changes location within the cup but will retake its original position once stimulation is stopped thus no long-term changes. When the marble in on an overturned cup and is moved (stimulated), the marble will never exist in its original position and will be forever changed. Bakker equates brain stimulation to the second example. He indicated that once change occurs, the brain is never the same.

One way a dyslexic's brain could improve without a biological change would be a stronger or more accurate connection between a grapheme and a phoneme. No structural changes need to take place but if a better 'map' is processed between the two, reading will improve (Bakker, 1992, 1994).

Hemisphere specialization in relation to the reading process is the strongest aspect of The Balance Model of Reading. The asymmetrical nature and the specialized function of the hemispheres are widely accepted (Bakker, 1990). Further, few dispute that the dominant/left hemisphere is more responsible for language and the opposite/right hemisphere for visual-spatial tasks (Bryden, 1988).

When first learning to read, it would be expected to be a perceptual process with students trying to give these shapes some meaning. The right hemisphere is used during the initial stages of learning to read because perception of shapes (letters) and directional processing (object constancy) are needed. As individuals become more proficient, a shift to a language approach would be expected based upon the need for semantics and syntax. The syntactical analysis and verbal comprehension occurs in the left hemisphere. This shift is displayed in studies that measured electro-activity and cerebral blood flow of readers at different levels of proficiency. The results of these studies, listed in Bakker (1992, 1994) show that beginning readers are using more of their right hemisphere (perceptual side), while advanced readers displayed increased activity in their left hemisphere (linguistic side).

Limitations

The results of hemisphere-specific stimulation (HSS) and hemisphere-alluding stimulation (HAS) have been varied but positive (Dryer, Beale, and Lambert, 1999; Robertson, 2000; Patel and Licht, 2000; and Strien, Stolk, and Zuiker, 1995). Although approximately half of the studies showed expected performance increases and the others showed unexpected increases, all showed increases in different aspects of reading. Studies that support Bakker's theory showed expected increases relative to the type of intervention (Kappers, 1997). If a P-type dyslexic received stimulation to the left hemisphere, whether visual and/or tactilely, they showed increases in fluency and comprehension. L-type dyslexics displayed less substantive errors in reading. These studies also showed that errors equated with the opposite type of dyslexic increased after treatment. P-type dyslexics that improved fluency also increased the amount of substantive errors and P-type dyslexics that decreased errors also decreased fluency. This suggests that stimulation of a hemisphere adjusts the reading style to reflect the opposite dyslexic type, not a proficient reader.

The studies (Goldstein and Obrzut, 2001; Dryer, Beale, and Lambert, 1999) that do not support Bakker’s theory (1992, 1994) state that similar increases of appropriate and inappropriate treatment invalidate Bakker’s model. Dryer, Beale, and Lambert (1999) gave P-type dyslexics stimulation to the left hemisphere and L-type dyslexics stimulation to the right hemisphere, which is the intended (appropriate) treatment. To test Bakker’s model (1992, 1994), Dryer et al. (1999) also gave P-type dyslexics stimulation to the right hemisphere and L-type dyslexics stimulation to the left hemisphere (inappropriate treatment). The authors (Dryer, Beale, and Lambert, 1999) hypothesized that L-type dyslexics already had a strong right hemisphere thus stimulation to the right hemisphere should not generate a difference. The same argument pertains to the L-type dyslexic and left hemisphere stimulation. This assumes, however, that each skill is fully developed and the only way to make gains is improving the weakness. Stimulation to a strength could improve the skill even further. If a student has poor phonemic awareness, he/she may be recommended an increase in sight word vocabulary. This student currently has a strong sight word vocabulary so the instruction is tailored to his/her strength. This does not mean that since they already have a strong sight word vocabulary that it can not become stronger. This argument should also hold true for stimulating an already strong hemisphere. If stimulation to a weakness may produce a positive result, it can be expected that stimulation to a strength may also produce a similar result.

Another limitation of the current body of research is the inconsistent methods for determining subtype. Some studies (Kappers, 1997) used only error type while others use a combination of error type and speed. Until a standard for the determination of subtype is found, results of hemisphere stimulation can not be compared. In addition, the results were varied and differed between similar types of studies. Studies that used similar methods or replications of earlier studies showed differences and sometimes opposite results compared to the previous studies.

Most studies (Strien et al., 1995; Jonkman et al., 1992; Licht et al., 1990) used age equivalents as the sole measure of reading proficiency and does not specify amount of gains that are comparable to a norm group. Finally, the treatment sessions were usually on a one-to-one basis, which questions the utility of this treatment in a school environment.

This study will attempt to rectify some of the disadvantages and provide a clearer look at the possible advantages of this model to service children with reading difficulties. First, a clear and specific method is needed to determine subtypes. This study will use one-minute reading prompts to generate scores for the number of words read correctly per minute and the percentage of words read correctly per minute. The scores will be compared against local and group norms to determine if the reader is significantly slower or faster (one standard deviation above or below the mean) and if the reader committed more or less errors (one standard deviation above or below the mean) than the group.

Secondly, M-type dyslexics, those who are slow readers and display many substantive errors, are in the most need of intervention although few studies even mentioned them. If reading is a developmental process and progresses from the right to the left hemisphere, M-type do not have those basic skills associated with the right hemisphere and should receive stimulation to the right hemisphere to progress to a P-type dyslexic.

Next, HSS focuses on the isolation of a hemisphere during input but does not consider the effect of the output. Stimulating the right hemisphere with visual or tactile HSS while requiring a verbal response uses the left hemisphere. Future studies should examine what reaction would occur based on different types of response. A participant that is stimulated in the right hemisphere visual and required to respond tactilely, by drawing in sand what was seen in the left visual field with the left hand would isolate all stimulation to the right hemisphere. This would create receptive and expressive stimulation and may increase results.

And finally, previous research (Strien et al., 1995; Jonkman et al., 1992; Licht et al., 1990) measured improvement in reading in age or grade equivalents, but do not state where the participant started or ended. Years of progress in age equivalents depend on the size and relationship to same-age peers. Also, age equivalents do not detect minute changes over time. Standardized instruments that provide age equivalents can not be administered regularly to better understand the effectiveness of the interventions. This study suggests using a standardized words-per-minute fluency on leveled connected text to determine improvement. This would provide a realistic measure of how a child is progressing and make comparisons between methods possible.

Summary

Currently, students with reading difficulties can be identified as reading disabled without actually reading connected text and the assessment may only specify that a disability exists in reading decoding and/or comprehension. In addition, there is little coordination between the assessment of reading difficulties and the interventions used to remediate those problems. Also, reading interventions are usually administered group-wide thus fail to address individual differences in error patterns. Bakker’s Balance Model of Reading (1990, 1992, and 1994) identifies different types of reading difficulties and recommends interventions for each type to link assessment to intervention. Bakker theorizes that beginning reading occurs in the right hemisphere as students focus on the perceptual differences in text. A student’s reading then shifts to the left hemisphere when the language component is involved. Thus, reading difficulties occur if this shift occurs too soon, if the student starts on the left hemisphere, or if the student fails to make the shift at all. By stimulating the deficit hemisphere, a student will improve reading. This is accomplished by tactile hemisphere specific stimulation (HSS), where the student receives input from the opposite hand to stimulate the appropriate hemisphere. By identifying the types of errors students make and focusing the interventions on those areas, students will make significant gains in reading fluency, reading accuracy, and reading comprehension.

CHAPTER TWO

REVIEW OF LITERATURE

Introduction

At least 20% of the population in the United States has reading difficulties (Lyon and Moats, 1997). As of the 2003-2004 school year, 5.8% of students were identified with specific learning disabilities, with a majority of those learning disabilities occurring in reading (National Center for Education Statistics, 2004). In addition, current practices do not appear to be correcting the problem. Students' reading skills have worsened rather than improved since 1992, according to data gathered by the National Center for Education Statistics (2004).

The National Reading Panel (2000) outlined the five 'big ideas' in reading. Phonemic Awareness, Phonics, Fluency, Comprehension, and Vocabulary provide a framework to guide instruction and major skills to target intervention (National Reading Panel, 2000). The Direction Instruction Reading Mastery program (Englemann and Bruner, 1988), Orton-Gillingham (Gillingham and Stillman, 1997), and Success for All (Ross, Smith, Slavin, and Madden, 1997) are all examples of reading programs that emphasis various aspects of the big ideas in reading. In addition, several websites, such as Intervention Central (www.interventioncentral.org) and the Florida Center for Reading Research (www.fcrr.org), provide reading interventions that are utilized in many public schools today.

Allington and Baker (2007) outline several strategies to use with struggling readers. In addition to integrating reading and writing into other subject areas and extending the amount of time for reading instruction, Allington and Baker (2007) recommend extended independent reading with discussion, playing with word parts, and writing about most reading tasks. Joseph (2006) differentiates between word-level and comprehension interventions. The word level interventions were divided into phonemic awareness tasks (sound manipulation , sound boxes, and sound sort), phonics tasks (onsets/rimes, word boxes, word sorts, and sight word practice), and fluency tasks (repeated reading, phrase drills, listening while reading, paired reading, and readers' theater). Increasing understanding while reading is divided into interventions for vocabulary (word webs, process and product-oriented semantic maps, and meaning sorts) and comprehension (question generation, summarizing text, story maps, retell, and response cards) (Joseph, 2006).

Most schools use a combination of the above stated empirically-validated interventions to achieve limited results. To have a profound impact on the reading ability of a student who struggles, the amount of intervention needs to be increased. Dr. George Batsche from the University of Southern Florida, while speaking at the annual conference for the Association of School Psychologists of Pennsylvania (2004), stated, that the lowest achieving readers may need up to 180 minutes of reading instruction/intervention a day. Reeves (2003), while describing 90/90/90 schools (90% eligible for free and reduced lunch, 90% ethnic minorities, and 90% achieved high academic standards) reported, “Some students spent as many as three hours per day in literacy interventions designed to get students to desired achievement levels.” Bakker’s Balance Model of Reading (1990, 1992, and 1994) asserts to link the assessment of reading difficulty to the intervention. Bakker’s (1990, 1992, and 1994) proposed interventions provide a significantly different approach to reading intervention than students are traditionally accustomed to and appear to generate increased interest.

Bakker’s Balance Model of Reading originated from research that examined auditory ear advantage and brain imaging studies of readers at varying levels (Satz and Sparrow, 1970). Bakker found that beginning readers use their right hemisphere to identify perceptual differences in the text and moved to the left hemisphere once proficiency in reading is achieved. Bakker (1992 and 1994) theorized that students who experience difficulties with reading are either making the switch from the right hemisphere to the left hemisphere too soon, fail to shift to the left hemisphere, or start on the left hemisphere. These difficulties materialize in three types of dyslexia: P-type dyslexic, L-type dyslexic, and M-type dyslexic. P-type dyslexics display slow, labored reading with few substantive errors because they fail to make the shift to the left hemisphere. L-type dyslexics read fast and display many substantive errors. These readers are thought to make the shift to the left hemisphere too soon. M-type dyslexics display slow reading with many substantive errors. It is unclear if M-type dyslexics start in the left hemisphere with underdeveloped reading speed or start in the right hemisphere without developing perceptual skills.

Bakker (1992 and 1994) proposed the stimulation of the deficit hemisphere to remediate these reading errors. A hemisphere can be stimulated in two ways: First, a hemisphere can be stimulated by providing sensory input to the opposite side of the body, through visual, auditory, or tactile means (hemisphere specific stimulation); Second, a hemisphere can be stimulated by providing a task that alludes to the function of the hemisphere (hemisphere alluding stimulation). Researchers (Baker, 1990, 1992, and 1994; Kappers, 1997; Robertson, 2000; Robertson and Bakker, 2002) have shown that hemisphere specific stimulation and hemisphere alluding stimulation have produced significant gains in reading achievement in students with reading difficulties. These interventions have been effective with students past third grade when reading gains are believed to stabilize (Ogle and Lang, 2007). Dryer, Beale, and Lambert (1999) suggested, however, that interventions targeting the hemisphere opposite the side of concern also showed improvement. Strien, Stolk, and Zuiker (1995) found that students reading ability did not improve overall but reflected the opposite error pattern. These finding suggest that hemisphere stimulation can be effective in changing reading performance. More research is needed to investigate ways to accentuate the positive gains while limiting negative consequences.

Origins of Bakker's Balance Model

Bakker's Balance Model can be traced to Satz and Sparrow's (1970) work with ear advantage and auditorally presented linguistic inputs. Three concepts in force at the time were: 1) written language is primarily controlled by the left cerebral hemisphere in most people, 2) the left hemisphere gradually specializes for the control of language, and 3) the stage of left-hemisphere control is reflected by the degree of right-ear advantage (REA) in the process of auditorally presented linguistic inputs. Satz and Sparrow presented at a conference hosted by Bakker in 1968, then published two articles (Satz and Sparrow, 1970; Sparrow and Satz, 1970), theorized that because left-hemisphere specialization for language was considered to be a deficiency for dyslexics, people who had difficulty reading would have a different ear advantage than those proficient readers. The authors (Satz and Sparrow, 1970; Sparrow and Satz, 1970) predicted no ear advantage (NEA) or left ear advantage (LEA) in dyslexics. They found good readers to have a REA and poor readers to have a NEA or LEA.

Baker and colleagues (Bakker, 1979; Bakker, Smink, and Reitsma, 1973), however, found proficient reading to be associated initially with LEA or NEA, not REA. They found proficient reading to be associated with REA only after the age of eight. These findings were also found by Kappers (1986) and Sadick and Ginsburg (1978).

Ear advantage indicates which ear would better process which type of input. Most people are more accurate in reporting verbal items arriving at the right ear than verbal items arriving at the left ear (Bryden, 1988). This tendency is commonly referred to as the right-ear advantage (REA) for verbal stimulus. Bryden (1988) suggest that people with left-hemispheric language lateralization constitute more than 95 percent of the population. Conversely, the majority of people have a left-ear advantage (LEA) for tasks involving the recognition of music or environmental sounds (Bryden, 1988; Rattan and Dean, 1987a).

According to Bakker and associates (Bakker, 1979, 1990, 2002, 2006; Licht, Bakker, Kok, and Bouma, 1988; Robertson, 2000), the initial and advanced phases in the learning to read process are different in nature. In addition to differences in ear advantage, beginning readers are also faced with a large amount of letter shapes that do not obey the law of shape constancy (Bakker, 1992). Shape/object constancy refers to the principle that shapes/objects retain their meaning, independent of their positions in space. For example, a chair is a chair no matter if you turn is upside down or on its side. Letters do not follow the same rules. A ‘d’ is a d unless you turn it upside-down and it becomes a ‘p’. However, a ‘d’ is the same as a ‘D’. These shape inconstancies present additional difficulties for the beginning reader, who is analyzing the perceptual features of the text. Thus, the analysis of these perceptual and directional text features should primarily occur in the right hemisphere.

To test this theory, Bakker and colleagues (Licht, 1988; Licht, Bakker, Kok, and Bouma, 1988; Licht, Kok, Bakker, and Bouma, 1986) designed a 4-year longitudinal study that started with kindergarten students. The students were taught words until mastery, and then these words were flashed in their central visual field. Brain responses were recorded in the temporal and parietal locations in the left and right hemisphere. Bakker found larger amplitudes in the right hemisphere than the left hemisphere during Years 1 and 2 but larger amplitudes in the left hemisphere than right in Years 3 and 4. This shift was not found in the control group who were shown matching figures. Thus, the shift appears to be word related. This shift was found in studies with reading and spelling tasks (Carmon, Nachshon, and Starinsky, 1976) and also with lateral visual fields (Bakker, Licht, and Kappers, 1994; Jonkman, Licht, Bakker, and Van den Broek-Sandmann, 1992; Licht, Jonkman, Bakker, and Woestenburg, 1990). All of this research suggests the hemispheric shift of reading subservience occurs at the end of Grade 1/beginning of Grade 2. Therefore, reading would be a developmental process that proceeds from the right hemisphere with the recognition of perceptual stimuli to the left hemisphere with the analysis of verbal information.

Determining Subtypes

Bakker (1990) proposes three types of dyslexia. The P-type dyslexic will display slow, labored reading and will make few substantive errors. This is because the child is still processing the text in a perceptual manner, shape by shape. Bakker (1992, 1994) believed these children fail to make the shift to the left hemisphere. The opposite error pattern is classified as L-type dyslexia. These readers will read hastily and inaccurately with many substantive errors. These children made the switch to the left too early or started the reading process on the left. They make substantive errors because they disregard the perceptual text features and are likely to omit or add to the text. M-type dyslexics demonstrate characteristics of both P-type dyslexics (slow, labored reading) and L-type dyslexics (many substantive errors).

The actual procedure in determining subtypes is not expanded on by Bakker; however, many researchers (Dryer, Beale, and Lambert, 1999; Robertson, 2000; Patel and Licht, 2000; and Strien, Stolk, and Zuiker, 1995) have used varying techniques to determine reading disability subtype. Determining subtypes involve the investigation of two components: speed (fast or slow) and type of errors (substantive and fragmentation). P-type dyslexics are classified as displaying slow reading with many fragmentation errors and few substantive errors. L-type dyslexics are classified as fast readers with many substantive errors and few fragmentation errors. M-type dyslexics are classified as slow readers and many substantive and fragmentation errors. However, the procedure to classify students varies between researchers.

Dryer, Beale, and Lambert (1999) used the GORT-R to classify students based only on the frequency of a specific type of errors. The authors (Dryer, Beale, and Lambert,

1999) identified a P-type dyslexic by dividing the number of time-consuming (fragmentation) errors by the total number of errors times 100. A fragmentation error is time-consuming because the reader pronounces individual phonemes of a word. Reading the word ‘apple’ as ‘a’ ‘p’ ‘l’ is an example of a fragmentation error. If that number is greater than or equal to 60, the student was classified as P-type dyslexics. If the number of substantive errors divided by the total number of errors times 100 was equal to or greater than 60, the L-type dyslexia classification was used. A substantive error changes the meaning of the text. Reading the word ‘man’ as ‘mean’ is an example of a substantive error. Basically, the authors (Dryer, et al., 1999) found the percentage of each type of error and used 60% as a benchmark. Of the 75 students assessed, 35 of the students could not be classified as either P-type dyslexics or L-type dyslexics because they committed a similar number of each type of error. Using only error types appear to have limited utility because half the sample could not be categorized. In addition, students who are accurate yet display slow reading rate are in as much need of intervention as those students who are inaccurate readers. This study (Dryer, Beale, and Lambert, 1999) and Robertson

(2000) did not factor speed into the determination of subtype.

Robertson (2000) used the Neale Analysis of Reading Ability and classified students only by the frequency of error type. The author (Robertson, 2000) classified L-type dyslexics as committing more than the average of substantive errors and less than the average number of fragmentation errors. P-type dyslexics committed more than the average number of fragmentation errors and less than the average number of substantive errors. This method yielded one P-type dyslexic, 20 L-type dyslexics, and 13 M-type dyslexics. Robertson provides another example of how using only error frequency may not produce accurate classification. With only one P-type dyslexic identified, it is likely that those students who are accurate yet slow readers and are still processing the text in a perceptual manner are misidentified.

Patel and Licht (2000) used both error type and speed in their determination. The authors (Patel and Licht, 2000) divided the student’s reading time by the mean time for the standardization sample for the instrument and calculated the percentage of each type of error. P-type dyslexics were found to display reading times that were 25% slower than the standardization sample and 55% or more reading errors were time-consuming (fragmentation). Students were classified L-type dyslexics if their reading time divided by the standard time was less than 25% greater than the standardization sample and 55% or more of their errors were substantive. The authors were able to classify 33 out of 40 students (19 L-type dyslexics and 14 P-type dyslexic dyslexics). This study (Patel and Licht, 2000) found a similar number of each subtype and was not able to classify only seven participants. However, not all studies used only error rates or speed and error rates.

Strien, Stolk, and Zuiker (1995) used the number of substantive, or meaning changing, errors with speed or fragmentation errors in their analysis. P-type dyslexics scored below the median on substantive errors and either scored above the median on fragmentation errors or scored above the median on time. L-type dyslexics scored above the median on substantive errors and either below the median on fragmentation errors or time. Out of 98 students who were screened, 34 were classified as P-type dyslexics and 28 were classified as L-type dyslexics. While subtypes were similar, Strien et al. (1995) were unable to classify approximately a third of the subjects. Although the percentage of each subtype varies between studies, none generate the 60% M-type dyslexics that Bakker (1990) predicted. The questions now becomes how valid are these classifications.

Validity of Subtypes

The validity of the subtypes was investigated in two ways. One, researchers classified subjects as either P-type dyslexics or L-type dyslexics then examined how the subject's brain reacted to visual stimuli that were directed at each hemisphere. Second, studies investigated how P-type dyslexics and L-type dyslexics performed on tasks that were directed at one hemisphere (i.e. perceptual or verbal).

Research on flashing words in the central and lateral visual fields (Bakker and Licht, 1986; Jonkman et. al., 1992; Licht et. al., 1990) resulted in larger brain amplitudes in suggested hemisphere depending on type. When the researchers flashed words in the central and lateral visual fields of P-type dyslexics, increased activity was found in the right hemisphere. L-type dyslexics were found to display increased activity in the left hemisphere. The authors (Bakker and Licht, 1986; Jonkman et. al., 1992; Licht et. al., 1990) also found significant differences between types.

Van Strien, Bakker, Bouma, and Koops (1988 and 1990) administered verbal and perceptual cognitive tasks to boys with P-type dyslexia and L-type dyslexia, nondisabled boys, and their biological parents and found L-type dyslexics performed better than P-type dyslexics on two verbal tasks and P-type dyslexics performed better than L-type dyslexics on two perceptual tasks. In addition, mothers of P-type dyslexics performed better on block design than mothers of L-type dyslexics and fathers of L-type dyslexics performed better than the fathers of P-type dyslexics on a verbal memory task. Van Strien and others (1988 and 1990) believe these findings support the validity of the subtypes because the subjects' performance reflects a strength in the hemisphere opposite the perceived reading deficit.

Robertson (2000) also found the classifications to be valid based on reaction to specific stimulation, although the author had a very small sample size (N=2). Robertson gave Goldberg and Costa's (1981) novelty theory as an alternative explanation. This theory proposes that the right cerebral hemisphere is effective in processing novel information.

Types of Hemisphere Stimulation

Bakker (1992) proposes that the treatment of dyslexia should focus on the hemisphere where the problems occurred and stimulate the deficit hemisphere. This is accomplished by either hemisphere-specific stimulation (HSS) or hemisphere-alluding stimulation (HAS). HSS involves the presentation of letters and words in the opposite visual fields or with the hand opposite the deficient hemisphere. In a L-type dyslexic, this would mean in the presentation of stimuli in the left visual field or the left hand. The opposite would be true for a P-type dyslexic. HAS is accomplished through the presentation of transformed passages of text taken from normal reading text. L-type dyslexics would be exposes to different typefaces within each word. P-type dyslexics would eliminate words with the text that have to be guessed by the reader on the basis of the context.

Bakker (1992) identifies classifications of P-type dyslexics and L-type dyslexics and states that approximately 35% of dyslexic children cannot be classified as either. This contradicts Bakker's (1990) earlier claim that 60% of participants may present as M-type dyslexics. Bakker also expanded on how to implement HSS and HAS.

Hemisphere-Specific Stimulation (HSS)

One way to implement HSS is through a computer program developed by Bakker and colleagues (Bakker, Licht, and Kappers, 1995) called HEMSTIM. HEMISTIM is a computer program that requires the participant to focus in the middle of the screen by moving the cursor to a dot in the center of the screen (Bakker, Licht, and Kappers, 1995). The program then flashes the input in the visual field opposite the targeted hemisphere for a fraction of a second (actual time predetermined by the researcher).

HSS can also be achieved tactilely. Letter or words are presented in a tactile training box out of sight of the participant. The participant uses the hand that is opposite the targeted hemisphere. The right hand is used for P-type dyslexic dyslexics and the left hand is used for L-type dyslexics. This allows manipulation of letters or words without visual input through the tactile receptors of the fingers (Bakker, 1992 and 1994).

Hemisphere-Alluding Stimulation (HAS)

Hemisphere-alluding stimulation (HAS) targets the specific hemisphere based on the type of stimulation that is given. Language-based stimulation would allude to the left hemisphere. Perceptually-based stimulation would allude to the right hemisphere. HAS for L-type dyslexics would allude to the right hemisphere because this is where the deficit is perceived. Conversely, HAS for P-type dyslexic dyslexics would allude to the left hemisphere (Bakker, 1992 and 1994).

HAS that alludes to the right hemisphere is achieved with texts that are perceptually demanding by printing letters within the words in different typefaces. Although information is processed by both hemispheres while reading these texts, it is presumed to allude more to the right hemisphere then do conventional text. The Scrambler (Bakker, Licht, and Kappers, 1995) is a computer program that can print out words in a number of different typefaces and font sizes. HAS using the Scrambler would be most beneficial for L-type dyslexics.

HAS that alludes to the left hemisphere involves sentences that are made phonetically and semantically demanding by the deletion of words that the reader has to find by rhyming or by using the context. An example of a HAS sentence would be ‘When walking down the street, I have to use my ________ (feet)’. These texts allude more to the left than traditional text and would be used for treatment of P-type dyslexic children. Several researchers have investigated the effectiveness of both HSS and HAS.

Investigation of Hemisphere Stimulation

Dryer, Beale, and Lambert (1999) tested Bakker's Balance Model of Reading and treatment of L- and P-type dyslexic dyslexia through HSS and HAS. Participants were either given a treatment that was consistent with their type of dyslexia (i.e. appropriate treatment) or a treatment that was inconsistent to the subjects determined subtype (i.e. inappropriate treatment). The authors (Dryer et al., 1999) attempted to determine the treatment effects of each type with different types of dyslexics and if a difference existed between participant and treatment interaction. The authors identified 21 children who were categorized as P-type dyslexic dyslexics. The students were categorized as displaying accurate but slow and fragmented readers. Also, the authors include 19 students classified as L-type dyslexics, who are fast but inaccurate readers.

Dryer, Beale, and Lambert (1999) included a pretest, 24 training session (4 per week), and a posttest. The training lasted approximately 40 minutes and consisted of three types of hemisphere stimulation. The visual HSS lasted 15 minutes and used the HEMSTIM program by flashing words of ranging typeface into the left visual field for a L-type dyslexic (appropriate treatment) and a P-type dyslexic (inappropriate treatment) group. The same was done to the right visual field of another L-type dyslexic (inappropriate treatment) and P-type dyslexic (appropriate treatment) group. The tactile HSS lasted about 15 minutes and used a tactile training box, planning board, and plastic magnetic lowercase letters. The session began with the presentation of individual letters and moved to the same words used in the visual HSS. Tactile HSS was used with the left hand of a L-type dyslexic and P-type dyslexic group and the right hand with the different L-type dyslexic and P-type dyslexic groups, thus providing an appropriate and inappropriate treatment for each subtype. The participants were asked to use the index and middle fingers of each hand. HAS used varying levels of text with corresponding font size and type depending on the proficiency of the reader. The participants had to find missing words by either using the context of the text or by rhyming.

Goldstein and Obrzut (2001) attempted to validate Bakker’s model in a classroom setting. Along with the classification of L-type dyslexics and P-type dyslexics, the authors included M-type dyslexics, which is a classification that includes characteristics of both previously mention types. The above authors also included handedness as a primary characteristic for selection into the sample. The total sample size was 45 middle school students whom are all right handed. The mean age of the sample is 12.76, which is interesting due to the prevailing research on the stability of reading performance after the third grade (Ogle and Lang, 2007). Goldstein and Obrzut (2001) used Bakker's classification of L-type dyslexics (excessively fast reader who make substantive reading errors) and P-type dyslexics (accurate but slow and laborious readers) and included the M-type dyslexics (readers who commit a combination of L-type dyslexia and P-type dyslexia errors). Goldstein and Obrzut (2001) identified 15 participants who exhibited L-type dyslexics and 15 participants who exhibited P-type dyslexia and randomly selected 15 participants out of 31 possible in the M-type dyslexic group (Goldstein and Obrzut, 2001).

Each participant was pretested, received 16 weekly training sessions, and was post tested. Each session lasted approximately 40 minutes. Participants received five minutes of visual HSS using a computer program called Hemi-Flash, which is an adaptation of Bakker's (1992) HEMSTIM. The program flashed 28 words to the right visual field of P-type dyslexics and to the left visual field of L-type dyslexics. Participants then received 20 minutes of tactile HSS using a tactile training box. Tactile HSS required participants to identify words and sentences using the hand that corresponds with the deficit hemisphere (i.e. right hand with children with P-type dyslexia and the left with L-type dyslexics). HAS training was 15 minutes of each session and used words of different font sizes and styles to create perceptually demanding text (Goldstein and Obrzut, 2001).

Kappers (1997) investigated the effects of hemisphere stimulation of the reading performance of students with dyslexia in an outpatient setting. The author also investigated the long-term effects of the interventions and the stability of the results after termination of the treatment. Kappers used Bakker's Balance Model of Reading (1990) and hemisphere stimulation as the treatment. The author (Kappers, 1997) focused of whether treatment initiates a significant improvement in single word reading and if the effects of the intervention are maintained after the termination of the intervention.

The sample in Kappers (1997) study consisted of 80 children between the ages of 6 and 15 with a Full Scale IQ score greater than 90 on the WISC-R. These children had varying reading skills (14 participants were described as severe) and were receiving services at a center for dyslexia. The treatment consisted of Hemisphere Specific Stimulation (HSS) that was presented visually (HSS-vis) and/or tactile (HSS-tac) in combination with hemisphere-specific auditory stimulation (HSS-aud). The HSS was used with HAS with modifications and supplements based on the information processing theory. HSS-vis used the HEMSTIM program that was previously explained and HSS-tac uses a tactile training box, also previously explained. A new component was the HSS-aud, which was used to supplement HSS-vis and HSS-tac. Since the ear contralaterally projects to the opposite ear, stimulation of one hemisphere will produce stimulation to the opposite ear. To reduce the amount of ipsilateral information presented to the same hemisphere, instrumental music is presented to the other ear while words were presented to the target ear. HAS was conducted similarly to previously discussed studies by presenting phonetically and semantically complex text with the omission of a word that must be inserted for left-hemisphere stimulation. For right-hemisphere HAS, participants are presented with perceptually demanding text (Kappers, 1997).

Kappers (1997) examined improvements from preclinical and clinical treatment. The preclinical treatment consisted of word reading and text reading. The stimuli were presented on flash cards that the parents of the participants were trained to administer. The treatment consisted of HSS(vis, tac, and aud) and HAS (specific to the deficit hemisphere). The average number of treatment sessions was 14 among the 80 participants. The post treatment assessment occurred at six months, 1½ years, and 2½ years (Kappers, 1997).

Patel and Licht (2000) investigated the existence of hemispheric differences between P-type dyslexic and L-type dyslexic children in processing auditory verbal material. Also, the authors (Patel and Licht, 2000) investigated the lateralization of the processing of prosody on P-type dyslexic and L-type dyslexic children. The population consisted of 53 right-handed children who possessed average intelligence, opportunity, and freedom from gross sensory, emotional, and neurological disabilities but did not acquire normal reading proficiency. Each participant was assigned a reading level based on his or her performance on a one-minute reading task. Four different words were spoken in four different affective tones producing 16 different stimuli. Participants were divided into four groups with L-type dyslexics and P-type dyslexics in each group. Participants were asked to respond to the presence or lack of to stimulus presented through earphones (Patel and Licht, 2000).

Robertson (2000) examined the experimental and clinic aspect on 20 L-type dyslexics and one P-type dyslexic. Because only one P-type dyslexic was identified, all were considered L-type dyslexics and received treatment to stimulate both hemispheres to validate Bakker’s theory. The population was between the ages of 8 and 13 and was randomly separated into two groups. One group received treatment theoretically proposed for L-type dyslexics while the other received treatment proposed for P-type dyslexic. The author investigated to determine if stimulation to the deficit or productive hemisphere would produce the greatest amount of change. Sessions were 40 minutes long and took place once a week for 12 weeks (Robertson, 2000).

Strien (1995) investigated the use of anxiety-laden words in HSS-vis with P-type dyslexics and L-type dyslexics while using the HEMSTEM program. Twenty students (mean age=10.4) attending two schools for children with learning disabilities were selected to participate. The screening criteria were average or higher FSIQ on WISC-R and a reading level of at least 1.5 years below expected level. Ninety-nine anxiety-laden words were chosen for the treatment group and 99 neutral words were chosen for the control group. All words were three to five letters long and drawn from a list that were believe to be familiar to most 6-year-old children. All forty participants received HSS-vis for 12 individual HEMSTIM sessions, 3 sessions per week. The words were categorized into three levels of difficulty. The anxiety-laden and neutral words were then matched on difficulty level, length, and frequency. Children with L-type dyslexia were stimulated through the left visual field and P-type dyslexics through the right. The words were flashed for 240 msec to the appropriate visual field. The HEMSTEM program ensures the participant must visual fix to the middle of the screen by requiring a cursor be moved to a spot in the center of the screen (Strien, 1995).

Results of Hemisphere Stimulation

Bakker's (1994) results of HSS indicate that stimulation of the left hemisphere display increased levels of activity and larger left-sided brain amplitudes. Stimulation of the right hemisphere shows similar results to the right. Using HSS and HAS separately or in combination induced improvements in reading performance relative to control treatments; however, HSS in the right hemisphere induced improvements in reading accuracy while

HSS to the left induced improvements in reading fluency. Differences were found using visual or tactile HSS on single word and sentence reading. The group differences (L-type dyslexics or P-type dyslexics) were mixed between studies. Vast differences among participants were also found, some having no reaction while other displayed signs of total improvement (Bakker, 1994).

Dryer, Beale, and Lambert (1999) found the predicted interaction between the specific treatment and type of dyslexia as Bakker (1992 and 1994) proposed was not observed. The L-type dyslexic and P-type dyslexic groups that received the appropriated treatment did not show greater improvement than the L-type dyslexic and P-type dyslexic groups who received inappropriate treatment although all groups showed improvement in reading. Both P-type dyslexic groups decreased time-consuming errors and an increase in substantive errors while both P-type dyslexic groups decreased substantive errors and increase time-consuming errors.

Dryer, Beale, and Lambert (1999) concluded that gains made in reading are likely to be due to other training contingencies and not to the specific nature of the hemisphere stimulation. Also, overall improvement may be attributed to regression to the mean. Finally, while one strategy tried to remediate a weakness, the other in theory could be capitalizing on a strength thus both produced gain in overall reading (Dryer et al., 1999).

The results of Goldstein and Obrzut’s (2001) study indicate that although neither P-type dyslexics nor L-type dyslexics improved word recognition, both groups improved their reading accuracy. This contradicts Bakker’s (1990) results of improvement on word recognition. Reading accuracy is defined as the number of errors on a timed reading passage. Bakker (1990) found P-type dyslexics improved their single word reading and L-type dyslexics showed marginal improvement in text reading. L-type dyslexics showed the most improvements while P-type dyslexics showed intermediate improvements.   M-type dyslexics demonstrated the least amount of improvement, which is consistent with Bakker’s results. All groups displayed improvements in reading comprehension with the amount of improvement similar to previous results (Bakker, 1990). These results (Goldstein and Obrzut, 2001) suggest that hemisphere stimulation is an effective intervention with certain types of dyslexic readers and those interventions can be effective in the school environment. Similar results were also found in an outpatient setting.

Kappers (1997) results indicated the rate of progress during treatment was much greater than before treatment. After the termination of treatment, the rate of progress decreased, although the subjects' reading level continued to improve. The improvement rate was not at the rate during treatment. The group of participants who needed preclinical training in phoneme-grapheme conversion showed significant improvements. Thus practicing grapheme-phoneme conversions at home delivered remarkable and consistent results with word reading. Kappers (1997) suggests poor grapheme-phoneme conversion is the 'key' to poor readers. The author (Kappers, 1997) found no difference in the progress made between left hemisphere and right hemisphere stimulation. This may be indicative of the length of the study (63 weeks), the specialization of treatment, or the progression from right hemisphere to left hemisphere once a set criterion had been met. No gender differences were found but this may be a result of a relatively small female sample size (24 females, N=80). The reading level upon entrance to the study affected the degree of improvement with higher level readers showing higher levels of improvement (Kappers, 1997).

Patel and Licht (2000) found an overall right ear advantage was obtained. However, there was no significant right ear advantage for P-type dyslexics; however, a right ear advantage was obtained for L-type dyslexics and the control. With affective tones, a left ear advantage was discovered, though, the results were not as strong as the word-effect. The results of the word task support Bakker's Balance Model, although no difference were observed between both types and controls with emotional prosody and certain task variables may have affected this result (Patel and Licht, 2000).

Robertson's (2000) results indicate that the group who received the inappropriate treatment (L-type dyslexics who received treatment for P-type dyslexics) decreased in reading accuracy and the group who received appropriate treatment showed a nonsignificant increase. He suggested that the difference seen between treatment interactions validates Bakker's theory. Also surprising was that a difference was seen in such a short time (12 weeks), whereas all other studies were at least 16 weeks long (Robertson,2000).

Strien (1995) found the use of anxiety-laden words instead of neutral words in the HSS-vis (hemisphere-specific stimulation – visual)clearly impacted the treatment effects in children with L-type dyslexia. The control L-type dyslexic group received neutral words and the treatment L-type dyslexic group received stimulation with anxiety-laden words. Compared to the L-type dyslexic control group, the experimental group made fewer substantive errors and more fragmentation after treatment. This suggested that treatment resulted in a shift to more right hemisphere processes thus participants' reading style changed in the direction of the hemisphere stimulation strategy (Strien, 1995).

Robertson (2000) conducted clinical single-case study and found that a P-type dyslexic who received HSS-tac (hemisphere-specific stimulation – tactile) to the right hemisphere made gains in reading accuracy while a P-type dyslexic given HSS-tac directed at the left hemisphere made gains in fluency but little in reading accuracy.

Summary

Bakker's Balance Model of Reading originated from research that examined ear advantage and proceeded to investigate brain activity at varying levels of reading development. Bakker (1992 and 1994) found that beginning readers use their right hemisphere to identify perceptual differences in the text and moved to the left hemisphere once proficiency in reading is obtained. Students who experience difficulties with reading are theorized to either make the switch from the right to the left hemisphere too soon, fail to shift to the left hemisphere, or start on the left hemisphere.

Dysfunction in the typical process of learning to read produces three types of dyslexia: P-type dyslexics, L-type dyslexics, and M-type dyslexics. P-type dyslexics display slow, labored reading with few substantive errors. These students are thought to fail to make the shift to the left hemisphere. L-type dyslexics read fast and display many substantive errors. They are thought to make the shift to the left hemisphere too soon or started in the left hemisphere. M-type dyslexics display slow reading with many substantive errors.

To remediate these errors, Bakker (1992 and 1994) proposed the stimulation of the deficit hemisphere. This is accomplished through hemisphere stimulation. Based on the cross lateral specialization of hemisphere function, a hemisphere can be stimulated by providing sensory input to the opposite side of the body, through visual, auditory, or tactile means.

Research has shown that isolating stimulation to a specific hemisphere (hemisphere specific stimulation) through intervention such as HEMISTIM and Tactile Training Box has produced significant gains in reading achievement in students with reading difficulties. In addition, these interventions have been effective with older students when reading performance is believed to plateau. However, most studies suggested that students reading ability did not improve overall but reflected the opposite error pattern. For example, L-type dyslexics demonstrated less substantive errors but also displayed decreases in reading fluency. P-type dyslexics increased reading fluency while increasing the amount of substantive errors. These finding suggest that hemisphere stimulation is effective in changing reading performance; however, more research is needed to understand reading gains and consistent utilization of procedures.

CHAPTER THREE

METHOD

Introduction

In this study, hemisphere specific stimulation (HSS) using a Tactile Training Box will be administered as outlined in studies conducted by Bakker (1990, 1992) and others (Dryer, Beale, and Lambert, 1999; Kappers, 1997; Robertson, 2000; Lorusso, Facoetti, Paganoni, P., Pezzani, Molteni, 2006). This study will investigate the utility of classifying students based on their type of reading difficulty and linking the intervention to each type. Previous research that investigated HSS using a Tactile Training Box occurred in a clinical setting and the examiner was one-on-one with the examinee. This study will occur in a public elementary school and will have students fill both roles as student-examiner and student-examinee.

This study will include the twelve lowest readers at each grade level (3^{rd} through 6^{th}) who will be divided into two groups to receive HSS and a traditional reading intervention (partner repeated readings). Twelve students were selected to receive these supports and subsequently participate in this study to maintain at least a one to four adult to student ratio. Each teacher and two aides worked with twelve students. Both groups will receive each intervention in a counterbalanced order to provide a scale to determine the effectiveness of HSS. Also, the determination of reading disability subtypes will include both the reading rate (words correct per minute) and reading accuracy (percentage of words read correctly per minute). The current study examined reading fluency rates instead of grade equivalents, which will allow a direct comparison to other methods of reading intervention. In addition, accuracy rates will be investigated, as well as reading comprehension using a Cloze (Shinn, 2001) technique. The Cloze technique uses a reading passage with multiple words placed in brackets at every seventh word. A participant is asked to use context clues to determine what word fits the best, therefore assessing a participant's reading comprehension.

Design

The design of this quasi-experimental study involves:

1) classifying students with reading difficulties into reading disability subtypes;

2) dividing each grade-level group into two treatment groups (treatment group one and treatment group two);

3) providing reading fluency interventions (tactile Hemisphere Specific Stimulation and repeated partner reading using connected text) to each group for six weeks. The six week intervention schedule will allow each group to receive the intervention before the groups are rearranged due to new benchmark assessment scores. The school-wide benchmark reading assessment takes place approximately every twelve weeks;

4) providing the opposite intervention (tactile Hemisphere Specific Stimulation to the group that received repeated partner reading and repeated partner reading using connected text to the group who received HSS) to each treatment group for six weeks;

5) comparing the AIMSWeb R-CBM reading fluency rates (number of words read correctly per minute on grade-level material), reading accuracy rates (percentage of words read correctly on the AIMSWeb R-CBM probes), and reading comprehension rates (AIMSWeb Reading MAZE) for each student and by intervention to determine if differences exist between treatment groups.

This research is supported at the district level as evidenced in the letter from Assistant Superintendent Mr. Tom Bell (see attached letter). In addition, Dr. David Foley, Hillview Intermediate Center Principal, has given his permission to conduct this research at Hillview Intermediate Center and given support for the interventions proposed in this study (see attached letter).

Hemisphere Specific Stimulation and the use of the tactile training boxes were implemented in the district last year on a limited basis. The students responded very positively to the intervention and increased motivation among the students was observed by the teachers. In addition, tactile reading interventions such as drawing letters in sand/shaving crème, tracing letters cut out of sandpaper, and shaping letters with Wikki Stix/pasta shapes are commonly used throughout the district. The occupational therapist has provided staff training about ways to incorporate sensory techniques into their lessons. These techniques include gross motor movements to activate different parts of the brain and crossing midline movements to increase activity between the hemispheres.

Tactile and multi-sensory strategies are commonly used throughout the district and comparable in scope and impact to the proposed interventions. Brain research is increasingly used to guide instruction and learning and frequently incorporated into interventions with students who are learning at a different pace than their peers (Hale and Fiorello, 2004). The proposed interventions pose no threat to participants and may increase reading ability as part of an extensive reading intervention program. Figure 1 is a Research Path Diagram that illustrates the relationships between all dependent and independent variables.

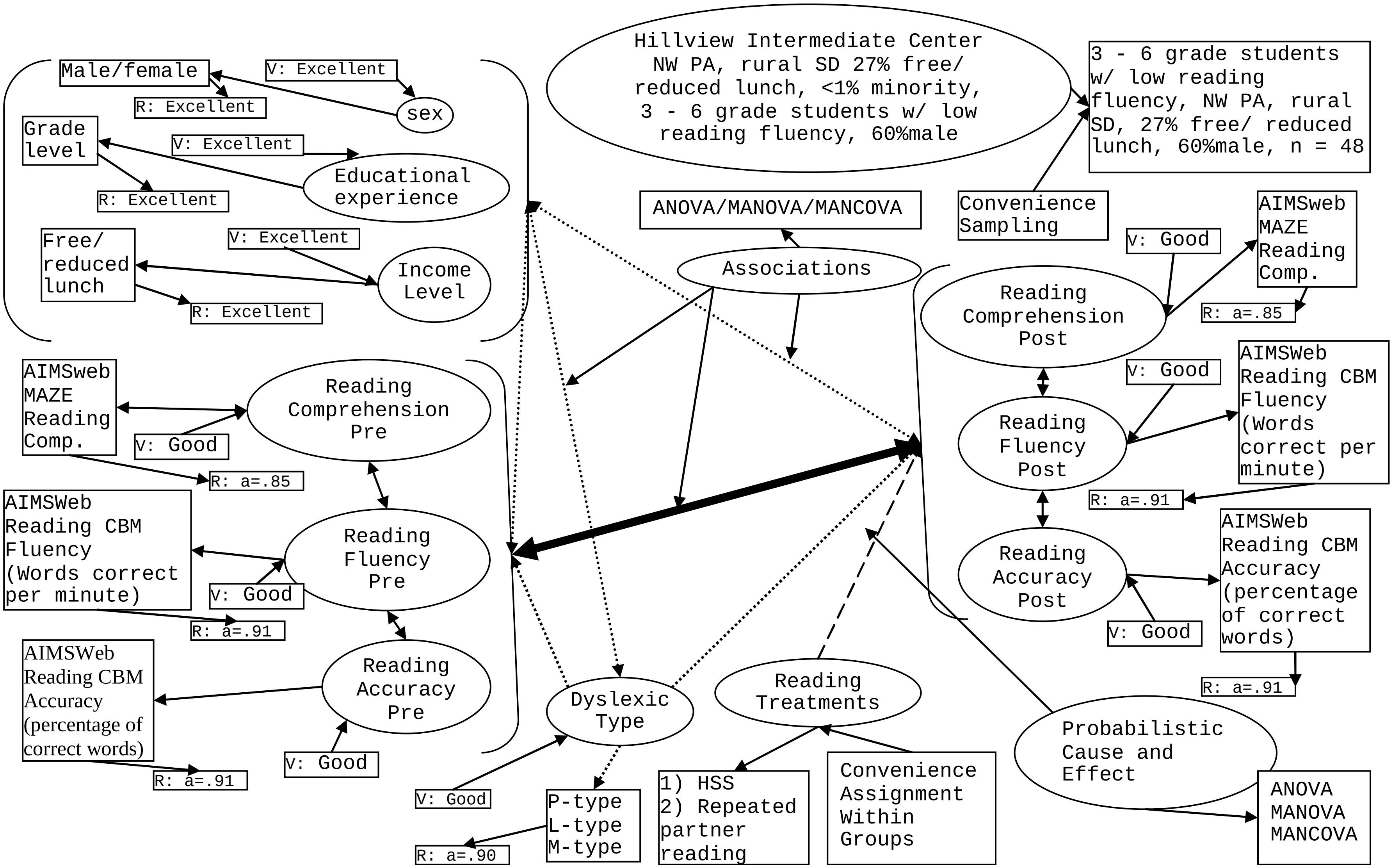

Figure 2. Research path diagram of the hemisphere stimulation project.

Population

Participants attend a small western Pennsylvania public school district (2,800 total students), which is composed of a rural population that has a cross-section of children of varied socio-economic status; however, little cultural or racial diversity exists. This study was conducted in an intermediate center that houses approximately 700 students in grades 3 through 6.

District-wide student racial groups are as follows: White – 86%, Black – 11%, Hispanic – 2%, Asian/Pacific Islander – 1%, and American Indian/Alaskan Native - <1%. However, a residential treatment facility for adjudicated youth is a part of the district, thus these figures are not representative of the population at the school in which this study was conducted. Of the 700 students at the intermediate school where this study was conducted, less than 1% are considered a minority. Eighteen percent of students across the district are eligible for free or reduced lunch. But because fewer students use this program at the high school, the total district figures do not provide an accurate picture of the economic diversity of the school. At the intermediate center that houses grades three through six, 27% of the students are eligible for free or reduced lunches.

Sample

The sample consisted of approximately forty-eight low achieving readers recommended to receive reading fluency instruction in grades three through six. The twelve students in each grade with the lowest reading fluency scores on the AIMSWeb® R-CBM are placed in a reading fluency intervention group while all other students are placed in various reading skill groups. Twelve students were selected to participate to allow for three pairs of participants within each group and maintain a four to one student to teacher ratio. AIMSWeb® R-CBM is a one-minute reading fluency task that is administered to all students, three times per school year. These groups were formed as a result of the implementation of the Response to Intervention (RtI) model to provide remediation of early academic concerns. The students in the RtI reading fluency group were asked to participate in this study.

The age range of participants was between the ages of eight and thirteen. This age range is the typical age range of students in grades three through six in school districts in Pennsylvania and the age when improvements in reading appear to stabilize. There is no restriction to sex so both males and females will be included in this study. Currently, the number of males and females in academic remediation groups at Hillview Intermediate Center range from an even number of boys and girls at one grade level group to approximately two boys for every girl at another grade level group. The overall percentage is approximately 60% boys and 40% girls. Oswald, Best, Coutinho, and Nagle (2003) found the ratio of males to females identified for special education services was approximately three to one.

Assignment

The RtI groups are specialized reading fluency groups, which are part of the school-wide reading skill groups (PSSA groups). These groups meet five days a week for thirty minutes and all students participate. Based on AIMSWeb reading benchmark scores, all students are placed in reading ability-level skills groups for 30 minutes a day, five days a week. These groups are formed at the beginning of the school year and reorganized in the middle of the year. This study will be conducted with the lowest reading group who has received reading fluency interventions from the start of school and will continue to receive reading fluency intervention at the conclusion of the study. The proposed interventions will be conducted on two of the days for thirty minutes. The interventions will occur on Tuesdays and Thursdays (Table 1). These days were selected to allow the students to experience some variety with the interventions and those days allow for the most consecutive weeks without missing a day due to school closure.

Table 1

RtI Groups Intervention Schedule

Time/Day	Monday	Tuesday	Wednesday	Thursday	Friday
0 - 15 minutes		T1 – HHS tac T2 – Repeated Partner Reading		T1 – HHS tac T2 – Repeated Partner Reading	
		Switch roles		Switch roles	
15 - 30 minutes		T1 – HHS tac T2 – Repeated Partner Reading		T1 – HHS tac T2 – Repeated Partner Reading	

Note. T1 = Treatment group one; T2 = Treatment group two

Procedure

Informed consent was sought from the parents of the students, the students themselves, and the participating teachers. The rationale for using reading fluency as a dependent variable, the correlations between reading fluency and the state exam (PSSA), the correlations between reading fluency and reading comprehension, and the reliability and validity of the AIMSWeb measures will be discussed.

Informed Consent

The parent consent and student assent forms will be sent home through the mail with an addressed stamped envelope (See Appendixes A, B, and C). Parents and students will also have the option of dropping off the form at the school office. Consent will also be sought for all participating teachers (See Appendixes D and E). An administrative assistant will collect all consent forms and communicate which students are participating in the study to the teachers.

Teachers' Role

The teachers who supervise the fluency group were selected at the beginning of the school-year based on their qualifications and experience with low achieving readers. The teachers' role is to implement the interventions. The permission of each teacher and aide will be sought and a complete explanation of the interventions will be given.

The teacher's written consent form is attached. The teacher will be asked to demonstrate how the intervention works and the roles of each student-examiner and student-examinee. In addition, the teacher will be responsible to tell the students to switch roles, monitor the students for correct spelling and hand usage, and answer any questions. The teachers' aide will administer all reading probes and deliver the scores to the administrative assistant.

Rationale for Using Reading Fluency

The AIMSWeb training manual (Shinn and Shinn, 2002) indicates a strong correlation between reading fluency scores and a student's performance on state assessments. AIMSWeb trainers reported that if a student was at or above benchmark in reading fluency, there was a 98% chance they would be proficient or advance on the state test. Hillview Intermediate Center assessment scores demonstrate strong correlations between reading fluency and the reading scores of the Pennsylvania System of School Assessment (PSSA). The district in which the present study is being conducted found between 94.30% and 99.42% of students who were at or above the reading fluency benchmark in the spring of 2008 achieved proficient or advanced scores on the PSSA (Table 2).

Table 2

2007-2008 Students Who Were Both Above Reading Fluency Benchmarks and Proficient on the State Exam

Grade	Students	%Fluent and Proficient
3rd	151	98.68%
4th	171	99.42%
5th	174	97.70%
6th	158	94.30%

Table 3 contains the correlations between reading fluency and performance on the PSSA for third, fourth, fifth, and sixth grade students at the end of the 2007-2008 school year. The correlation coefficients ranged from .619 to .709. Sattler (2000) reported that correlations over .5 indicate a strong relationship.

Table 3

2007-2008 Correlations Between Reading Fluency and Reading Scores on the State Exam at Grove City Area School District

Grade	Students	Pearson Correlation
3rd	163	.709(**)
4th	158	.619(**)
5th	171	.676(**)
6th	169	.641(**)

Note. ** = Correlation is significant at the 0.01 level (2-tailed).

Figures 2 contains a scatterplot of the correlation between AIMSWeb Reading CBM (reading fluency) and reading Pennsylvania System of School Assessment (PSSA) scores for third grade for the 2007-2008 school year. Notice the bottom right quadrant. The lack of students who fell in the bottom, right quadrant is representative of the low percentage of students who are fluent readers but failed to achieve proficiency on the PSSA assessment.   This occurrence translates into our focus that if a student can reach benchmark in reading fluency, we are confident that the student will be proficient or advanced on the PSSA.

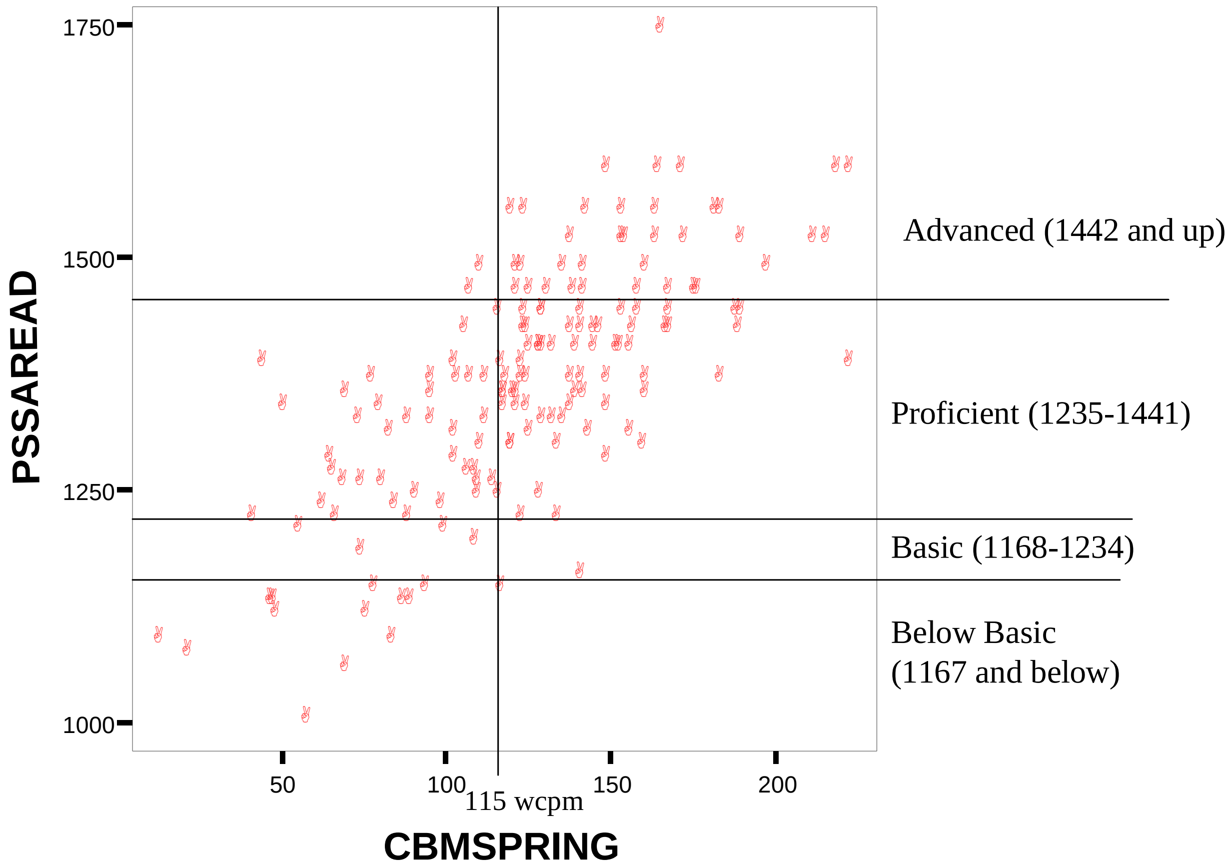

Figure 3. Third grade 2007-2008 Pennsylvania System of School Assessment (PSSA) reading scores and spring AIMSWeb reading fluency scatterplot.

The strong correlation between reading fluency and reading PSSA scores was also observed in grades fourth through sixth. Similar to third grade, few students were at benchmark in reading fluency and not proficient on the PSSA in fourth, fifth, and sixth grade. Appendixes F through H contain the scatterplots representing the correlations between reading fluency and reading PSSA scores for grades fourth through sixth.

Three studies (Allington and Baker, 2007; Joseph, 2006; and Shinn, 2001) have suggested the relationship between a student's ability to read fluently and their ability to comprehend what they read. Table 11 and Figure 3 represent the correlation between Hillview students' reading fluency and reading comprehension. Sattler (2000) reported that correlations over .5 indicate a strong relationship.

Table 4

Correlations Between Spring Reading Fluency (R-CBM) and Spring Reading Comprehension (MAZE) Scores for the 2007-2008 School Year

Grade	Students	Pearson Correlation
3rd	162	.802(**)
4th	158	.680(**)
5th	169	.700(**)
6th	169	.777(**)

Note. ** = Correlation is significant at the 0.01 level (2-tailed).

Figure 6 is a scatterplot of the correlations of AIMSWeb R-CBM reading fluency scores and AIMSWeb Maze comprehension scores for third grade students in the fall of 2007. The bottom, left quadrant represents students who are below the benchmark for both reading fluency (R-CBM) and reading comprehension (Maze). The top, right quadrant represents the students who are above the benchmark for both reading fluency (R-CBM) and reading comprehension (Maze).

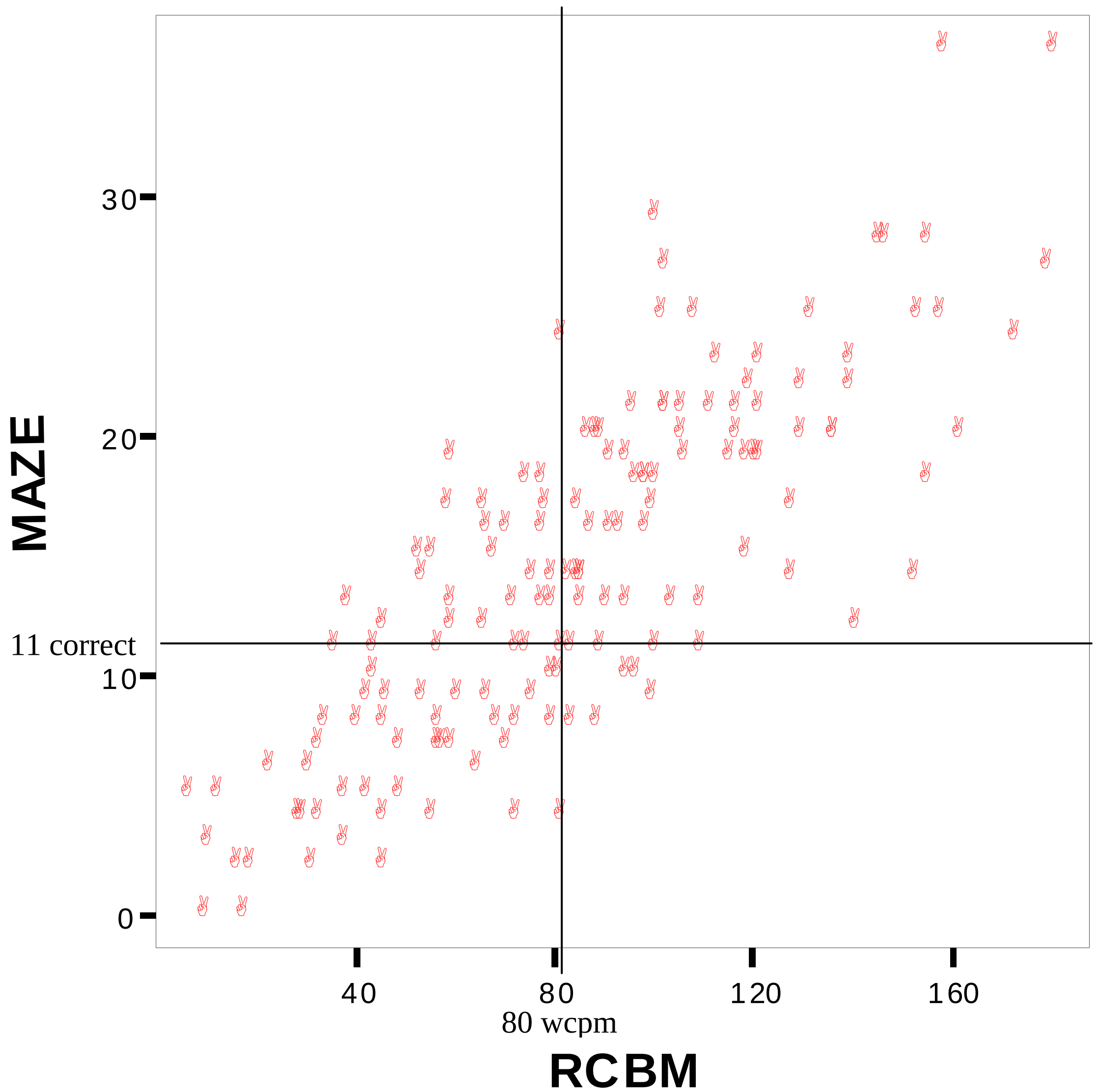

Figure 4. Third grade 2007-2008 fall AIMSWeb reading CBM and MAZE.

The above correlations and scatterplots demonstrate the positive relationship between reading fluency and PSSA scores and between reading fluency and reading comprehension. The strong relationship (correlation coefficients above 0.5, Sattler, 2000) justify the use of reading fluency as a dependant measure and the focus on reading fluency as a target for treatment.

Reading Assessments

All students are administered AIMSWeb R-CBM and Reading Maze (Shinn and Shinn, 2002) benchmark probes three times a school year (Fall, Winter, and Spring). The probes are administered by a reading assessment team of Title One Teachers, Special Education teachers, and teachers' aides.

The Reading CBM (Curriculum-based Measure) is an oral reading fluency assessment that assesses the student's reading by counting the number of words read correctly in one minute. The reading probes are on the grade-level of each student and at a similar readability level throughout the school year. The number of errors is also tallied and recorded. Reading accuracy, which is the percentage of words read correctly per minute, is also generated.

The Reading Maze is a multiple-choice cloze task that students complete while reading silently. The first sentence of a 150-400 word passage is left intact. Thereafter, every seventh word is replaced with three words inside parenthesis. Students are asked to read the text and circle the word that best completes the sentences. One of the words is the exact one from the original passage. Students have three minutes to complete as much of the passage as possible and correct responses and errors are recorded. The AIMSWeb assessments are part of the school-wide formative assessment that all student receive. This produces local norms to which each student is compared.

Using the local norms, a mean number of words read correctly per minute and mean number of errors per minute are produced. A student's performance on the AIMSWeb R-CBM reading fluency benchmark will determine placement in the specialized reading intervention. Each student who qualifies for the specialized reading intervention will be classified by a reading disability subtype using their scores from the fall 2008 AIMSWeb CBM benchmark.

Reliability and Validity of Curriculum-based Assessments

Empirical research (Shinn, 2001) has shown that reading fluency (words read correctly per minute) provides a reliable and valid measure of reading comprehension. Table 5 provides the test-retest and parallel forms reliability of reading fluency with students in grades one through six.

Table 5

AIMSWeb Standard Reading Assessment Passages

Grade	3	4	5	6
N	33	33	33	33
Mean Words Read Correct (WRC)	107.6	121.5	132.1	141.8
Standard Deviation	28.1	25.3	29.1	25.1
Standard Error of Measurement (SEM)	10.5	9.7	10.5	10.0
Reliability (alternate-form)	.86	.85	.88	.84

Note. From AIMSWeb Training Workbook by M.R. Shinn and M.M. Shinn, 2002, Edformation, Inc.

Table 6 indicates the reading probes are strongly correlated across numerous readability formulas. This strong relationship suggests that the assigned reading passage level by AIMSWeb is similar across many different formulas that generate a passage’s reading level. Also, different readability formulas produced similar reading level suggesting consistency within a passage’s reading level.

Table 6

Readability Correlations for AIMSWeb Reading Probes with Selected Readability Formulas

	Passage Level	Lexile	Fry	Flesch	Powers	Spache
Passage Level						
Lexile	0.97					
Fry	0.94	0.90				
Flesch	0.96	0.92	0.99			
Powers	0.92	0.88	0.98	0.98		
Spache	0.97	0.93	0.95	0.97	0.94	
SMOG	0.83	0.78	0.92	0.91	0.95	0.86
Median	0.95					

Note. From AIMSWeb Training Workbook by M.R. Shinn and M.M. Shinn, 2002, Edformation, Inc.

Table 7 describes the test-retest and parallel-form reliabilities of reading fluency measures. Test-retest reliabilities ranged from .84 to .94 across grade levels. Reliabilities for parallel-form reading fluency measures ranged from .85 to .96. Sattler (2000) suggested that reliabilities over .90 can be used for individual decisions and reliabilities over .80 can be used for group decisions. All reliabilities were over the .80 threshold therefore indicating that these coefficients meet psychometric standards (Sattler, 2000).

Table 7

Summary of Reliability Studies for Reading CBM

Study	Subjects	Type of Reliability	Results
Marston, 1982 (Grade 3 word list)	83 Students who scored below 15th %ile in written expression, grades 3 to 6	T10 parallel forms, 1 week test-retest (10 weeks) apart	.85-.96 (range) .90 (mean)
(Grade-level list		Test-retest (10 weeks) 10 parallel forms, 1 week apart	.84-.94 (range) .91 (mean)
Shinn, 1981	71 LD and low-achieving students, grade 5 (grade-level list	Test-retest (5 weeks) 4 parallel forms 1 week apart	.89-.94 (range) .91 (median)
Tindal, Germann, et al., 1983 (passages)	30 regular ed. students, grade 5	Test-retest (2 weeks)	.97
	110 regular ed. Students, grade 4	2 parallel forms at same time	.94
Tindal, Marston, et al., 1983	566 randomly selected students, grades 1 to 6	Test-retest (10 weeks)	.92
		Alternate form (1 week)	.89
		Inter-rater agreement	.99

Table 8 represents the validity of reading fluency measures compared to well-known reading assessments. Reading CBM and reading fluency measures displayed high correlation coefficients (greater than .5) when compared to other reading assessment (Sattler, 2000) Correlations ranged from .87 to .39 and all except DIBELS Retell (Good, 2000) indicate a strong relationship when using Sattler's (2000) standard (correlation coefficients greater than .5).

Table 8

Summary of Validity Studies for Reading CBM

Study	Subjects	Criterion Measure	Passages From	Correlations
Bain and Garlock, 1992	479	MacMillan Series	Comprehension Test of Basic Skills	.62 (1st) .79 (2nd) .72 (3rd)
Collins, 1989	58	Harcourt Basal Reader	California Achievement Test (CAT)	.75
Deno, Mirkin, and Chiang, 1982	45	Ally-bacon, Ginn, and Houghton-Miffling Basal Reader	Cloze Word Meaning	.86-.87 .56-.57
Fuchs and Deno, 1992	91	Ginn and Scott-Foresman	Woodcock Reading Mastery	.91 (Ginn) .91 (S-F)
Madelain and Wheldall, 1998	50	Wheldall Testing Of Reading Passages	Neale Analysis of Reading	.71
Shinn, Good, Knutson, Tilly, and Collings, 1992	238	Harcourt-Brace-Jovanovich Rasal Reader	Cloze SDRT Retell	.77 (3rd) .63 (5th) .59 (3rd) .58 (5th) .60 (3rd) .39 (5th)

Treatments

The Response to Intervention (RtI) groups will be formed as part of a school-wide component of the reading instruction that is in addition to the instruction that each student receives in the general education setting. Each student will be placed in skill-based reading groups. The groups are conducted for thirty minutes a day, five days a week. Each student is placed based on their scores on the AIMSWeb® reading fluency and comprehension scores that are conducted three times a year. This approach has been in place for the past four years. This study will be conducted in a group that has already been formed and is currently receiving reading fluency interventions.

Students whose oral reading fluency is a standard deviation below the local mean oral reading fluency and whose accuracy rate (percentage of words read correctly per minute) is at or above the local mean accuracy rate will be classified as a P-type dyslexic. One standard deviation was chosen as a cut score to yield a number of participants that are in need of support and can realistically be supported by the school’s current staff. Students whose oral reading fluency rates are within a standard deviation or above the local mean oral fluency rates and whose accuracy rate is a standard deviation below the local norm will be classified as L-type dyslexic. Students whose oral reading fluency rates are a standard deviation below the local mean and whose accuracy rate is a standard deviation below the local norm will be classified as M-type dyslexic. M-types dyslexics will also use their left hands to stimulate the right hemisphere because Bakker’s (1992, 1994) work suggests that this is where normal development starts. The handedness of the participant does not determine the dominant hemisphere that is responsible for language (Bryden, 1988; Bakker, 1994). The left hemisphere is responsible for language in the vast majority of participants (Bryden, 1988; Rattan and Dean, 1987b). Bakker (1994) also found the left hemisphere controlled language in readers based on brain electro-activity and cerebral blood flow.

These classifications will determine which hand they will use while receiving HSS using the tactile training box. Due to the fact that all students asked to participate in this study display slow reading, accuracy rate will ultimately decide dyslexic type. The majority of prior research did not investigate error rate and most did not have similar numbers among each type (Lorusso, Facoetti, Paganoni, Pezzani, and Molteni, 2006; Robertson, 2000; Goldstein and Obrzut, 2001). In addition, the differences between identifying criteria within past research make predicting the number of each reading disability subtype difficult.

Intervention #1–Hemisphere Specific Stimulation (HSS)

The first treatment group will receive hemisphere specific stimulation using the tactile training box two days a week for 30 minutes. Pairs of students will become student-examiner and student-examinee for the first 15 minutes. The student-examiner will place words from a list into the tactile training box and provide feedback. Dolch words (Buckingham and Dolch, 1937) from the preprimer level to level three will comprise the word list. An investigator-made picture word list will provide participants with the word to be placed in the tactile training box. The words were photographed as they should appear in the training box (upside down and backward). A sticker with each word presented correctly is in the bottom right corner of every picture. The word lists are separated into groups (preprimer, primer, one, two, and three) and bound into a booklet. Appendix J, K, and L provide examples of the picture word list.

The student-examinee will manipulate the letters with the predetermined hand and respond according to teacher instructions prior to each training session. The teacher and the aide will monitor each pair and be available for questions and to ensure proper implementation of the intervention. The teacher will indicate when the 15 minutes has expired and the students will switch roles. The HSS will consist of four phases:

1) identifying words
2) spelling forward
3) location of a letter
4) detect a letter.

Each phase will last for three sessions.

Phase one – Identifying words. When identifying words, the student-examiner will place words from a list in the tactile training box. The student-examinee will manipulate those words with the predetermined hand and form a mental picture of the word. The student-examinee will remove his/her hand from the box and identify the word. The student-examiner will report if the student- examinee is correct and allow the student-examinee to manipulate the letters again while silently repeating the correct word. While monitoring the intervention, the teacher or aide will verify the accuracy of the student-examiner’s feedback.

This will occur for 15 minutes then the students will switch roles.

Phase two – Spelling forward. The second phase will require the student-examinee to manipulate the letters placed by the student-examiner, remove his or her hand, spell the word out loud, and then say the word. The student-examiner will give feedback pertaining to the accuracy of the student-examinee's responses while the teacher or aide monitors the accuracy of the responses.

Phase three – Location of a letter. The third phase will require the student-examinee to manipulate the letters, remove his/her hand, and report the letter that occupies the position asked for by the student-examiner (What letter is in the third position?). The student-examiner will place the word 'cat' in the training box. The student-examinee will manipulate the letters with the predetermined hand, form a mental picture of the word, and remove his or her hand. The student-examiner will ask "what letter is in the third position?" The student-examinee will respond "t". The student-examiner will state "correct" and place the next word on the list. The student-examiner will give feedback pertaining to the accuracy of the response and allow the student-examinee to correct any mistakes.

Phase four – Detect a letter. The fourth phase will require the student-examinee to manipulate a word and determine whether or not the word contains a letter reported by the student-examiner (Is there an 'h' in this word?). The student-examinee will then read the word and the examiner will give feedback to both responses.

Intervention #2–Repeated Partner Reading

The second treatment group will receive repeated partner reading as described as "Reading Twosome" from The Florida Center for Reading Research. Students will be placed in pairs and each will be provided with a copy of the selected text. The teacher will model reading the passages as the students follow along during their first exposure to the text. Taking turns, students alternate reading sentences, paragraphs, and the entire text while providing assistance to each other. The students will reread the text multiple times and will work with the same text for the entire week. At the end of the six week period, this treatment group will receive HSS using the tactile training box and the other treatment group will receive the repeated partner reading.

Data Collection

The participants are in RtI groups based on their grade level. The students in each RtI group will be randomly assigned to one of two treatment groups. The first treatment group will receive hemisphere specific stimulation using the tactile training box. The second treatment group will receive repeated partner reading as described as “Reading Twosome” from The Florida Center for Reading Research (www.fcrr.org). The intervention will occur two days a week for 30 minutes and last for six weeks as part of a specialized reading intervention program.

At the conclusion of the treatment (six weeks), the teachers’ aides assess each student’s reading fluency and comprehension using the AIMSWeb R-CBM and MAZE probes. The aides will record the scores (number of words read correct per minute, percentage of words read correctly per minute, and number of correct responses on the Maze probe) on a paper and give the scores to the administrative assistant who enters the scores into the AIMSWeb data system. The teacher, administrative assistant, and principal will have access to the data, but only the teachers and the administrative assistant will know which students are participating in the study or which intervention each student has received. At the conclusion of the study, the administrative assistant will assign a number to each student. With the student number as the only identifying characteristic, the administrative assistant will report the order in which the student received the different treatments and the scores for each participant. This data will then be forwarded to the principal investigator.

The administrative assistant will complete all other tasks including:

1) entering all scores into the AIMSWeb data base,

2) collecting all consent forms,

3) informing the teachers which students will participate in the study,

4) randomly dividing each grade-level class into two groups,

5) assigning a number to each student, and

6) reporting all scores and their corresponding identification numbers to the principal investigator at the conclusion of the study.

In accordance with federal regulations, all data will be maintained for 3 years from the date of project completion.

Materials

1. Tactile Training Box (Figure 4) is a variation of Hemispheric Specific Stimulation (HSS) using the tactile mode. The box is wooden and has a removable metal tray. One side has a small opening (approximately three inches high) that the student-examinees place their hand to manipulate the letters. The other opening is large and allows the student-examiners to replace the letter tray and see the letters within the box. The boxes were constructed by district maintenance personnel to the specifications of Figure 4. P-type dyslexics stimulate the left hemisphere by tracing letters or words using the right hand and L-type dyslexics stimulate the right hemisphere by tracing letter or words by using the left hand.

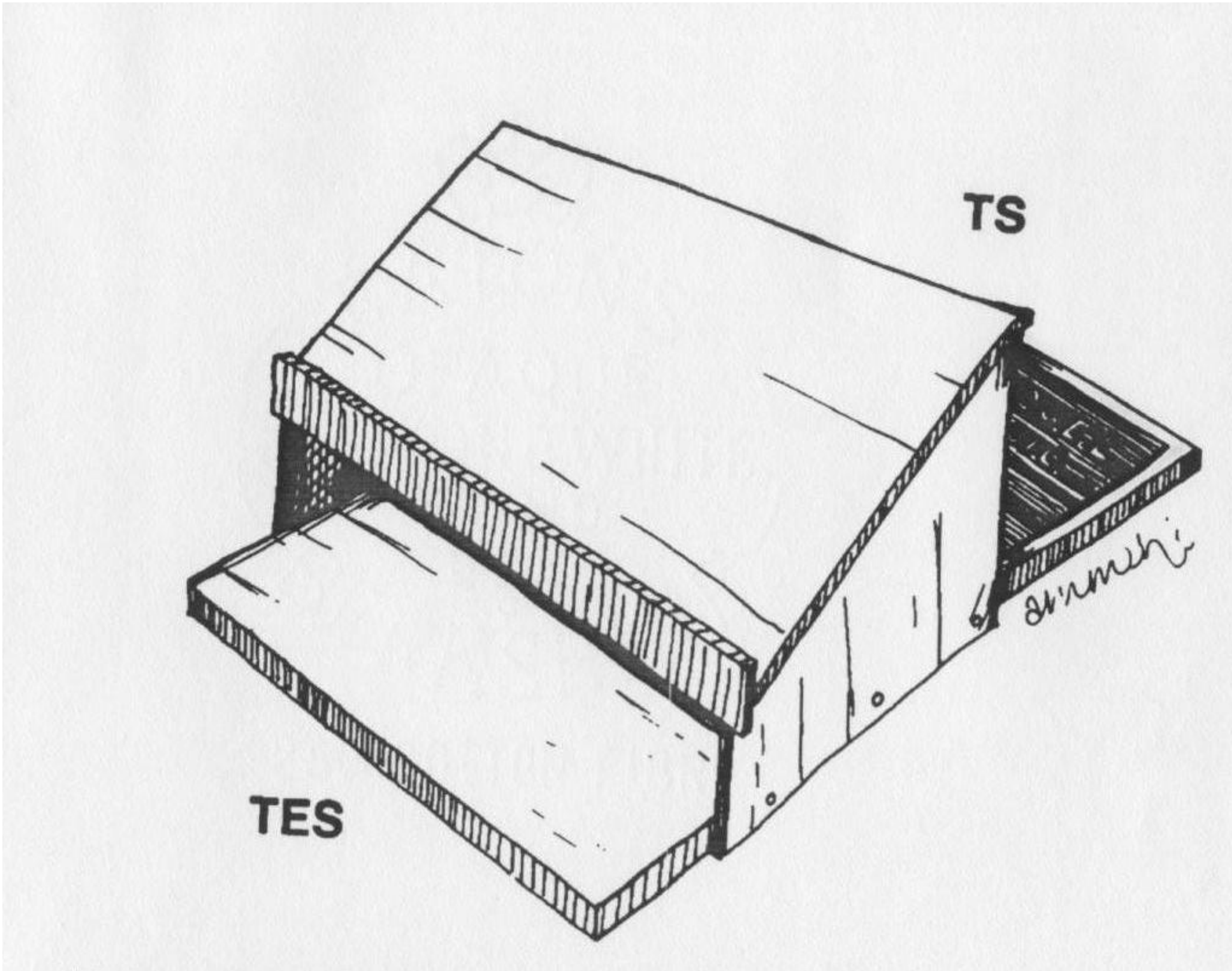

Figure 5. The tactile training box.

Note. TS – Trainer's or Examiner's side; TES – Trainee's or Examinee's side. From "*Neuropsychological treatment of Dyslexia*" by D.J. Bakker, 1990, p.71, Oxford University Press.

2. EZread Plastic Magnetic Letters – Uppercase. These letters were chosen based on their readability and being easily recognizable. The letters are approximately two inches high and all uppercase. Available online at www.reallygoodstuff.com.

3. AIMSWeb® Reading Curriculum-Based Measurement (R-CBM) Standard Oral Reading Fluency Assessment Passages AIMSWeb®. AIMSWeb® R-CBM probes are a set of standardized, individually administered measures of early literacy development. They are designed to be short (one minute) fluency measures used to regularly monitor the development of reading fluency skills. The measures were developed upon the essential early literacy domains discussed in both the National Reading Panel (2000) and National Research Council (1998) reports to assess student development of phonological awareness, alphabetic understanding, and automaticity and fluency with the code. Each measure has been thoroughly researched and demonstrated to be reliable and valid indicators of early literacy development and predictive of later reading proficiency to aid in the early identification of students who are not progressing as expected (Shinn and Shinn, 2002). When used as recommended, the results can be used to evaluate individual student

development, as well as provide grade-level feedback about validated instructional objectives. This testing practice, Reading Curriculum-Based Measurement (R-CBM) has met the standards for use in Reading First as determined by the Secretary of Education's Committee on Reading Assessment and the Office of Special Education Program's National Center for Student Progress Monitoring. The AIMSWeb® R-CBM probes are available for a fee on the Internet @ *www.AIMSWeb.com*.

4.   AIMSWeb® Maze Curriculum-Based Measurement Standard Reading Comprehension Assessment Passages. AIMSWeb® Maze is a multiple-choice cloze task that students complete while reading silently. The first sentence of a 150-400 word passage is left intact. Thereafter, every seventh word is replaced with three words inside parenthesis. One of the words is the exact one from the original passage. Each student is asked to read the text and circle the word that best completes the sentence. This is a group-administered task in which students have three minutes to complete as many as possible. Science-based research has shown that this provides a reliable and valid measure of reading comprehension as reported by the Office of Special Education Program's National Center for Student Progress

Monitoring and Fuchs, Fuchs, and Maxwell (1988). In addition to sound psychometric standards, the Maze probes were reported to:

- be sensitive to student's development of academic competence,
- be sensitive the effects of academic intervention,
- provide evidence to show improved teacher planning or student achievement,
- a basis to determine academic growth and/or the achievement of goals (Fuchs, Fuchs, and Maxwell, 1988).

The AIMSWeb® Maze reading probes are available for a fee on the Internet @ *www.AIMSWeb.com.*

5. SPSS v15 for Windows – SPSS is a computer program for statistical analysis within the social sciences.

6. Baking sheet – 12" X 18" used to organize the letters so that the student-examiners can find and place letters quickly.

7. Photo word list – This investigator-created word list provides pictures of the Dolch words (Buckingham and Dolch, 1937) as they should appear in the training box (up-side down and backwards) to increase the accuracy of the

placement of words by the student-examiners. The words are also printed in the lower right hand corner so the words can be easily identified. The word list is bound and randomly sorted. Examples of the photo list are available in Appendixes I, J, and K.

Statistical Analysis

This study will investigate three hypotheses within the context of seven research questions. Students who read slower and make more errors when reading have lower rates of comprehension, thus identifying students based on fluency and error patterns will focus the interventions to the areas of need. Hemisphere-specific stimulation (HSS) will be used to target the intervention to the reading disability type.

First, using HSS to link the intervention to the type of reading difficulty, students who read slowly but accurately (P-type dyslexics) who receive HSS intervention targeted at their reading disability subtype will significantly increase their reading fluency (words read correct per minute), reading accuracy (percentage of words read correct per minute), and reading comprehension (MAZE) on the AIMSWeb Reading CBM and MAZE (Shinn and Shinn, 2002) when compared to students who receive a traditional intervention (repeated partner reading) designed to increase their reading fluency and comprehension.

Second, students who read fast but commit numerous errors while reading (L-type dyslexic) and receive HSS intervention targeted at their reading disability subtype will significantly increase their reading fluency (words read correct per minute), reading accuracy (percentage of words read correct per minute), and reading comprehension (MAZE) on the AIMSWeb Reading CBM and MAZE (Shinn and Shinn, 2002) when compared to students who receive a traditional intervention (repeated partner reading) designed to increase their reading fluency and comprehension.

Third, students who read slowly and commit numerous errors (M-type dyslexics) and receive HSS intervention targeted at their reading disability subtype will significantly increase their reading fluency (words read correct per minute), reading accuracy (percentage of words read correct per minute), and reading comprehension (MAZE) on the AIMSWeb Reading CBM and MAZE (Shinn and Shinn, 2002) as compared to students who receive a traditional intervention (repeated partner reading) designed to increase their reading fluency and comprehension.

Each of these three hypotheses will be investigate within the context of seven research questions. Research question one (Table 9) will investigate HSS impact on reading fluency (R-CBM) while research question two (table 10) will investigate the impact of repeated partner reading on reading fluency (R-CBM). Research question three (Table 11) will investigate HSS impact on a participant's reading accuracy. Table 12 outlines research question four which is what impact will repeated partner reading have on a participant's reading accuracy. Research questions five (Table 13 - HSS) and six (Table 14 - repeated partner reading) will investigate each treatment's impact on reading comprehension (Maze). Research question seven (Table 15) will examine the relationship between the independent variables of sex, socio-economic status, and grade level.

To determine the effectiveness of hemisphere specific stimulation as compared to repeated partner reading, reading fluency rates, reading accuracy rates, and reading comprehension (Maze) scores were analyzed. Each participant was pretested using the AIMSWeb Reading CBM and MAZE. This will produce a reading fluency score (number of words read correct per minute on a student's grade level), reading accuracy score (percentage of words read correctly) on the one-minute AIMSWeb Reading CBM probe, and number of correct responses on the AIMSWeb Maze. A One-Way ANCOVA will be used to determine if there is any difference among the treatment groups before the intervention.

To determine if each treatment produced a difference among the three reading measures, the repeated measures factional Multivariate Analysis of Variance (MANOVA) was employed. The data analysis will examine mean differences in a student’s oral reading fluency, reading accuracy, and reading comprehension. To determine if a significant difference exists between the treatments, a paired samples T-test will be employed. In addition, group differences based on treatment group, dyslexic type, sex, socio-economic status, and grade level will be investigated using a repeated measures factional Multivariate Analysis of Covariance (MANCOVA).

Table 9

Research Question One – HSS and Reading Fluency (R-CBM), Hypotheses, Variables, Statistical Analyses, and Statistical Assumptions

Research Question	Hypotheses	Variables	Statistic	Assumptions	Assumptions Appropriateness
Question One- What impact will HSS have on a student's reading fluency?	P-type dyslexics will read significantly faster after HSS. L-type dyslexics will read significantly faster after HSS. M-type dyslexics will read significantly faster after HSS.	AIMSWeb Reading-CBM (words correct per minute) Dyslexic Type	ANOVA Repeated Measures Factorial MANOVA	1. Interval or Ratio data 2. Normal distribution of scores 3. Variances are equal, or fairly equal, across the groups. 4. Independent scores Must meet all assumptions of the ANOVA ***and*** 5. Inter-correlations (covariances) are equal.	1. Examine the instrument 2. Histogram with a normal curve 3. Descriptive Statistics

Table 10

Research Question Two – Repeated Partner Reading and Reading Fluency (R-CBM), Hypotheses, Variables, Statistical Analyses, and Statistical Assumptions

Research Question	Hypotheses	Variables	Statistic	Assumptions	Assumptions Appropriateness
Question Two- What impact will repeated partner reading have on a student's reading fluency?	P-type dyslexics will read at the same rate after partner reading. L-type dyslexics will read at the same rate after partner reading. M-type dyslexics will read at the same rate after partner reading.	AIMSWeb Reading-CBM (words correct per minute) Dyslexic Type	ANOVA Repeated Measures Factorial MANOVA	1. Interval or Ratio data 2. Normal distribution of scores 3. Variances are equal, or fairly equal, across the groups. 4. Independent scores Must meet all assumptions of the ANOVA ***and*** 5. Inter-correlations (covariances) are equal.	1. Examine the instrument 2. Histogram with a normal curve 3. Descriptive Statistics

Table 11

Research Question Three – HSS and Reading Accuracy, Hypotheses, Variables, Statistical Analyses, and Statistical Assumptions

Research Question	Hypotheses	Variables	Statistic	Assumptions	Assumptions Appropriateness
Question Three- What impact will HSS have on a student's reading accuracy?	P-type dyslexics will read at a higher accuracy rate after HSS L-type dyslexics will read at a higher accuracy rate after HSS. M-type dyslexics will read at a higher accuracy rate after HSS.	AIMSWeb Reading-CBM (percentage of words read correct) Dyslexic Type	ANOVA Repeated Measures Factorial MANOVA	1. Interval or Ratio data 2. Normal distribution of scores 3. Variances are equal, or fairly equal, across the groups. 4. Independent scores Must meet all assumptions of the ANOVA ***and*** 5. Inter-correlations (covariances) are equal.	1. Examine the instrument 2. Histogram with a normal curve 3. Descriptive Statistics

Table 12

Research Question Four – Repeated Partner Reading and Reading Accuracy, Hypotheses, Variables, Statistical Analyses, and Statistical Assumptions

Research Question	Hypotheses	Variables	Statistic	Assumptions	Assumptions Appropriateness
Question Four- What impact will repeated partner reading have on a student's reading accuracy?	P-type dyslexics will display no change in accuracy rate after partner reading. L-type dyslexics will display no change in accuracy rate after partner reading.	AIMSWeb Reading-CBM (percentage of words read correct) Dyslexic Type	ANOVA	1. Interval or Ratio data 2. Normal distribution of scores 3. Variances are equal, or fairly equal, across the groups. 4. Independent scores	1. Examine the instrument 2. Histogram with a normal curve 3. Descriptive Statistics
	M-type dyslexics will display no change in accuracy rate after partner reading.		Repeated Measures Factorial MANOVA	Must meet all assumptions of the ANOVA ***and*** 5. Inter-correlations (covariances) are equal.	

Table 13

Research Question Five – HSS and Reading Comprehension, Hypotheses, Variables, Statistical Analyses, and Statistical Assumptions

Research Question	Hypotheses	Variables	Statistic	Assumptions	Assumptions Appropriateness
Question Five- What impact will HSS have on a student's reading comprehension?	P-type dyslexics will display higher reading comprehension skills after HSS. L-type dyslexics will display higher reading comprehension skills after HSS.	AIMSWeb MAZE Dyslexic Type	ANOVA	1. Interval or Ratio data 2. Normal distribution of scores 3. Variances are equal, or fairly equal, across the groups. 4. Independent scores	1. Examine the instrument 2. Histogram with a normal curve 3. Descriptive Statistics
	M-type dyslexics will display higher reading comprehension skills after HSS.		Repeated Measures Factorial MANOVA	Must meet all assumptions of the ANOVA ***and*** 5. Inter-correlations (covariances) are equal.	

Table 14

Research Question Six – Repeated Partner Reading and Reading Comprehension, Hypotheses, Variables, Statistical Analyses, and Statistical Assumptions

Research Question	Hypotheses	Variables	Statistic	Assumptions	Assumptions Appropriateness
Question Six - What impact will repeated partner reading have on a student's reading comprehension?	P-type dyslexics will display no change in reading comprehension after partner reading. L-type dyslexics will display no change in reading comprehension after partner reading.	AIMSWeb MAZE Dyslexic Type	ANOVA	1. Interval or Ratio data 2. Normal distribution of scores 3. Variances are equal, or fairly equal, across the groups. 4. Independent scores	1. Examine the instrument 2. Histogram with a normal curve 3. Descriptive Statistics
	M-type dyslexics will display no change in reading comprehension after partner reading.		Repeated Measures Factorial MANOVA	Must meet all assumptions of the ANOVA ***and*** 5. Inter-correlations (covariances) are equal.	

Table 15

Research Question Seven – Relationship Between Sex, Socio-economic Status and Grade Level on Reading Fluency (R-CBM), Reading Accuracy, and Reading Comprehension (Maze), Hypotheses, Variables, Statistical Analyses, and Statistical Assumptions

Research Question	Hypotheses	Variables	Statistic	Assumptions
Question Seven - Were the demographic factors of sex, socio-economic status, or grade level predictors of a treatments likelihood of success?	No difference will be seen between males and females in reading fluency, reading accuracy, and reading comprehension after both treatments. No difference will be seen between students that receive a free/reduced lunch and those who do not in reading fluency, reading accuracy, and reading comprehension after both treatments. No difference will be seen between students at different grade levels in reading fluency, reading accuracy, and reading comprehension after both treatments.	Sex – Males and Females Socio-economic status – Free/reduced lunch and no free/reduced lunch Grade Level – grades three through six Dyslexic Type	Repeated Measures Factorial MANCOVA	Must meet all assumptions of the ANOVA and of the Repeated Measures MANOVA ***and*** The regression slopes (the slopes of the lines for each group when they are graphed) must be equal or close to equal.

Summary

This study will investigate the utility of reading disability subtypes and the effectiveness of Hemisphere Specific Stimulation (HSS) in the remediation of third through sixth grade students with reading difficulties. Students’ whose oral reading fluency is below that of same-age peers will receive tactile hemisphere specific stimulation (HSS) to investigate the effectiveness of this intervention in increases reading fluency, reading accuracy, and reading comprehension scores at a rate greater than partner repeated reading.

The current study differs from the previous research in a number of ways. First, the inclusion of tactile HSS to investigate alternative ways to deliver stimulation to the deficit hemisphere will be included. Second, this intervention will occur in public elementary classroom. The majority of previous research occurred in a laboratory setting with a small number of participants and individual administration of the intervention by an examiner (Kappers, 1997, Licht et. al., 1988). In addition, the current study will require each student to act as student-examiner and student-examinee. This will increase the utility of this intervention in a school setting and also investigate the effect administering the intervention may provide. This method of implementation will place greater emphasis on self-directed and peer-assisted implementation than previous research.

Statistical analysis will employ repeated measures Factional MANOVA to determine if a significant difference exists among the treatment groups after each treatment and a MANCOVA to investigate the interaction of sex, socio-economic status, and grade level.

CHAPTER FOUR

RESULTS

Introduction

This study investigated Bakker’s Balance Model of Reading (1992) and attempted to link reading interventions to reading difficulties. Forty-eight low achieving readers in grades three through six were categorized by reading fluency and reading accuracy and received two treatments in a counterbalanced order.   The treatments were Hemisphere Specific Stimulation (HSS), which used a tactile training box, and repeated partner reading. Each treatment was conducted twice a week for six weeks.

The data analysis and the results of this study are presented in this chapter. This chapter contains four parts and a summary. The first part details how the dyslexic subtype was determined for each participant. The second part outlines the descriptive statistics for each grade level. The third part provides the results of each of the seven research questions. The mean fluency, accuracy rates, and MAZE scores by treatment, as well as, by sex, socio-economic status, and grade level are discussed. The third part also contains a description of the ANOVA, MANOVA, and MANCOVA analyses utilized in this study. The fourth part outlines complications of this study. The chapter concludes with a summary of the four parts.

Computer Program

SPSS 15.0 for Windows was used for all analysis.

Complications

The random assignment of each grade level group into treatments was not conducted for several reasons. Repeated partner reading and other paired activities that are conducted in the RtI group require partners of similar reading ability. Student pairs with similar reading ability allow for materials to closely match the instructional level of the pair. Also, participants who must read with another participant with a higher or lower reading ability may lose interest or become apprehensive due to the difference in skill level.

In addition, participants work in pairs and small groups on other activities on days the treatments are not conducted. These pairs are based on reading ability and teacher recommendations for pairs to increase time-on-task and group cohesion. The teachers expressed concerns over the multiple pairing of participants and the decrease effectiveness of repeated partner reading due to partners with significantly different reading ability. Based on these concerns, the pairs were left intact and the random assignment to treatment groups was abandoned.

Analysis

The analysis begins with a detailed description of how dyslexic subtypes were determined. Mean fluency and accuracy rates that were obtained through local norms provided the guidelines for categorizing students into one of three dyslexic subtypes. Local norms were generated based on the performance of approximately 700 students who attended Hillview Intermediate Center in the Fall of 2008. Demographic results indicate the percentage of males to females, free/reduced lunch to no free/reduced lunch, and each dyslexic subtype. The seven research questions were identified and the results are provided for each. Due to identical dependant variables, research questions that utilized the same outcome measure were presented together. Research question one and two both investigate reading fluency (R-CBM), therefore questions were presented together. Research question three and four were presented together because both investigated reading accuracy. Reading comprehension (MAZE) was investigated in question five and six and will be presented together. Research question seven, which investigated the impact of sex, socio-economic status, and grade level on the effectiveness of each intervention, was presented in isolation.

Determining Subtypes

Students will be categorized as follows:

P-type dyslexic = oral reading fluency rate (R-CBM) is a standard deviation below the local mean oral reading fluency rate and accuracy rate is at or above the local mean accuracy rate.

L-type dyslexic = oral reading fluency rate (R-CBM) is within a standard deviation or above the local mean oral fluency rate and accuracy rate is a standard deviation below the local norm accuracy rate.

M-type dyslexic = oral reading fluency rate (R-CBM) is a standard deviation below the local mean fluency rate and accuracy rate is a standard deviation below the local norm accuracy rate.

A standard deviation was chosen as the cut score because it was used in previous research (Kappers, 1997) and to isolate differences in scores that fall outside what is considered average on a normal curve (<16%). Dryer, Beale, and Lambert (1999) used 60% as a benchmark and Strien, Stolk, and Zuiker (1995) used the mean scores as the cut scores. A standard deviation is a more stringent criterion and would provide greater differentiation between different types of readers.

Table 16 outlines the local norms of Hillview Intermediate center. The scores are based on the Fall 2008 AIMSWeb Reading CBM (R-CBM) scores for approximately 700 students attended Hillview Intermediate Center, grades three through six. Standard deviations are provided to give the ranges to make the dyslexic categorizations.

Table 16

Fall 2008-2009 Reading Fluency and Accuracy Rates for Third though Sixth Grade Students at Hillview Intermediate Center (local norms)

Gr	n	Mean R-CBM	R-CBM StDev	+/- 1 StDev	Mean Acc. (%)	Acc. StDev	Minus 1 StDev
3rd	162	91.7	44.4	47.4-136.1	94.3	6.80	87.5
4th	165	105.5	38.1	67.4-143.6	96.7	5.02	91.7
5th	161	121.2	38.1	83.0-159.3	97.1	4.55	92.6
6th	179	147.8	42.3	105.5-190.2	97.9	3.67	94.2

Note. StDev=Standard Deviation; Acc.=Accuracy; Gr=Grade

Appendixes L through O contain the reading fluency (R-CBM) and reading accuracy of each participant in the study.

In addition, each score is classified as to where it falls in relation to the above stated norms and subsequent standard deviations. Based on the classifications, each participant is identified with a dyslexic type.

Of the forty-eight students who were in the RtI groups and participated in this study, disability subtype classifications were as follows:

P-type = 13 students

L-type = 0 students

M-type = 35 students

Of the forty-eight students, thirteen were below the fluency rate but at the accuracy rate (slow, accurate readers) and were classified as P-type. The rest of the participants were below the fluency rate and below the accuracy rate thus were classified as M-type. No participants were at or above the fluency rate and below the accuracy rate so no participants were classified as L-type. The P-types, slow, accurate readers, were asked to use their right hand in order to stimulate the left hemisphere. The M-types, slow, inaccurate readers, were asked to use their left hand in order to stimulate the right hemisphere.

Demographic Results

The demographic results provide details of the sex, socio-economic status, and dyslexic types of the sample by grade level. Although historically males have a higher participation rate in programs to remediate reading difficulties and overall achievement in general (Oswald, Best, Continuo, and Nagle, 2003), the sample has only a slightly higher ratio of males (27) to females (21). This is similar to Hillview Intermediate Center's ratio of males (approximately 60%) to females (approximately 40%) currently receiving academic support. Socio-economic status, which was assigned based on participation in the free or reduced lunch program, was slightly higher (29%) as compared to the school's overall participation (18%). Students were placed in the RtI intervention group based on low reading fluency scores so it is not surprising that no students were categorized as L-type dyslexics (fast readers with many substantive errors). More students were found to display slow reading with many errors (M-type dyslexic) at the earlier grades (3^{rd} grade=12 and 4^{th} grade=10) than at the upper grades. The fifth and sixth grade groups were similarly represented by students who read slowly but accurately (P-type dyslexic 5^{th} grade=6 and 6^{th} grade=5) and students who read slowly with many errors (M-type 5^{th}

grade=6 and 6th grade=7). Table 17 outlines the results of sex, SES, and dyslexic type by grade level.

Table 17

Sex, Lunch Status, and Dyslexic Type by Grade Level of Study Participants

	3rd	4th	5th	6th	Total	%
Female	4	6	7	4	21	43.8
Male	8	6	5	8	27	56.3
Free/reduced lunch	3	5	4	2	14	29.2
No free/reduced lunch	9	7	8	10	34	70.8
P-type dyslexic	0	2	6	5	13	27.1
M-type dyslexic	12	10	6	7	35	72.9

Research Question One and Two

The first and second questions are “what impact will hemisphere specific stimulation (HSS) and repeated partner reading have on participants’ reading fluency as measured by AIMSWeb Reading CBM (R-CBM) in words read correct per minute”. It was hypothesized that because HSS targets the theorized deficit hemisphere, participants that receive HSS based on their dyslexic type would increase their reading fluency at a significantly higher rate than those who receive a traditional reading intervention (repeated partner reading). Table 18 reports the pre-test and post-test mean reading fluency scores for each treatment group by session. The difference in the scores is presented to indicate the impact of each treatment.

Table 18

Mean Fluency Scores by Intervention Type and Session

Session	Grade/Treatment	Fluency Pre	Fluency Post	Difference
1	3rd HSS	19.3	29.5	+10.2
1	3rd Repeated Reading	31.7	51.0	+19.3
2	3rd HSS	51.0	64.2	+13.2
2	3rd Repeated Reading	29.5	43.3	+13.8
1	4th HSS	28.3	32.7	+4.3
1	4th Repeated Reading	43.0	52.3	+9.3
2	4th HSS	52.3	66.7	+14.3
2	4th Repeated Reading	32.7	41.2	+8.5
1	5th HSS	40.2	42.3	+2.2
1	5th Repeated Reading	58.5	78.8	+20.3
2	5th HSS	78.8	83.7	+4.8
2	5th Repeated Reading	42.3	57.2	+14.8
1	6th HSS	36.7	41.8	+5.2
1	6th Repeated Reading	81.5	94.3	+12.8
2	6th HSS	94.3	97.8	+3.5
2	6th Repeated Reading	41.8	50.8	+9.0

The results of each treatment indicated that repeated partner reading produced higher reading fluency improvement in all but one (4th grade, 2nd session) of the treatment sessions. Overall fluency rate improvements by treatment, reported in Table 19, also were higher for repeated partner reading. The mean reading fluency improvement for HSS was 7.915 while the mean reading fluency improvement for repeated partner reading was 13.505.

Table 19

Overall Mean R-CBM Scores by Treatment

Treatment	Pre	Post	Difference
HSS	50.1	58.0	+7.9
Repeated Reading	45.1	58.6	+13.5

The data were analyzed using an Analysis of Variance (ANOVA) and a repeated measures Factorial Multivariate Analysis of Variance (MANOVA). The use of ANOVA requires interval or ratio data, the normal distribution of scores, equal or fairly equal variances across the groups, and independent scores. The use of MANOVA requires that all assumptions of the ANOVA are met and inter-correlations (covariances) are equal.

The ANOVA was used to determine if a difference exists in reading fluency (R-CBM) between the dyslexic types before the treatment. The MANOVA was used to determine if a difference exists between the pre-test and post-test reading fluency (R-CBM) scores and investigated the interaction of the treatment over time and by dyslexic type. Table 20 shows reading fluency (R-CBM) pre-test and post-test means for the two dyslexic types (P-type and L-type) used in the analyses.

Table 20

Mean Reading Fluency Scores (R-CBM) Before and After Each Treatment by Dyslexic Type

	Dyslexic Type	Mean	Std. Deviation	N
HSS Pre	P-type dyslexic	74.6	21.6	13
	M-type dyslexic	41.0	20.1	35
	Total	50.1	25.3	48
HSS Post	P-type dyslexic	81.5	22.9	13
	M-type dyslexic	49.3	23.7	35
	Total	58.0	27.4	48
Repeated Reading Pre	P-type dyslexic	62.6	15.6	13
	M-type dyslexic	38.6	15.6	35
	Total	45.1	18.8	48
Repeated Reading Post	P-type dyslexic	76.6	18.8	13
	M-type dyslexic	51.9	17.1	35
	Total	58.6	20.6	48

The ANOVA was used to determine whether there was a difference among the two dyslexic groups (P-type and L-type dyslexic) in reading fluency (R-CBM) before each treatment took place. The results of ANOVA using pre-test reading fluency (R-CBM) scores indicated that there was a significant difference among the dyslexic types before the treatments. The main effect for R-CBM was significant at $p < .001$ ($F = 22.796$; $df = 1$).

Two MANOVA procedures in which treatment (HSS and repeated partner reading) and dyslexic types (P-type and L-type) served as independent variables and the reading fluency (R-CBM) pre-test and post-test scores served as the dependent variables, were used to answer research questions one and two. The first MANOVA used pre-test and post-test data from the HSS treatment. The second MANOVA used pre-test and post-test from the repeated partner reading treatment.

The results of each MANOVA using mean gains in reading fluency (R-CBM) indicated that there was an overall significant difference among the two treatment groups after the treatment (time). Table 21 reports the main effect for HSS was significant at $p < .001$ ($F = 20.659$; $df = 1$) and repeated reading was significant at $p < .001$ ($F = 97.239$; $df = 1$). Thus, both treatments produced significant differences in reading fluency (R-CBM) after the intervention. There was no significant difference when investigating the interaction of the impact of treatment (time) and dyslexic type.

Table 21

Within Treatment Contrasts for Reading Fluency (R-CBM) Scores

Source	Treatment	Time	Type III Sum of Squares	df	Mean Square	F	Sig.
Time	HSS	Linear	1096.3	1	1096.3	20.659	<.001
Time* Dys-lexic	HSS	Linear	8.8	1	8.8	.166	.686
Time	RPR	Linear	3536.1	1	3536.1	97.239	<.001
Time* Dys-lexic	RPR	Linear	2.2	1	2.2	.061	.806

Note. RPT=Repeated Partner Reading

The results of each MANOVA indicated that there was a significant difference in reading fluency (R-CBM) gains within each dyslexic type. Table 22 indicates the dyslexic type effect for HSS was significant at p <.001 (F = 22.343; df = 1) and repeated reading was significant at p <.001 (F = 21.815; df = 1). Thus, both dyslexic types produced significant differences in reading fluency (R-CBM) after both treatments.

Table 22

Between Dyslexic Type Effects for Reading Fluency (R-CBM) Scores

Treatment	Type III Sum of Square	df	Mean Square	F	Sig.
HSS	20527.5	1	20527.5	22.3	<.001
Partner Reading	11222.1	1	11222.1	21.8	<.001

Although both dyslexic types displayed significant gains in reading fluency when comparing pre-test and post-test scores, partner reading produced greater gains within both dyslexic types. Table 23 contains the gains by dyslexic type and treatment. Total gains for each treatment were greater for partner reading. However, a paired samples t-test indicated that there is no significant difference between the gains after each treatment (*p* <.791).

Table 23

Pre-test and Post-test Mean Reading Fluency Scores (R-CBM) by Dyslexic Type

	Dyslexic Type	Pre	Post	Difference
HSS	P-type dyslexic	74.6	81.5	+6.9
	M-type dyslexic	41.0	49.3	+8.3
	Total	50.1	58.0	+7.9
Partner Reading	P-type dyslexic	62.6	76.6	+14.0
	M-type dyslexic	38.6	51.9	+13.3
	Total	45.1	58.6	+13.5

Table 24 contains mean reading fluency scores after each session. M-type dyslexics started significantly lower than P-type dyslexics but both groups displayed similar gains in reading fluency after both treatments.

Table 24

Overall Mean R-CBM Scores by Dyslexic Type

Dyslexic type	Measure	Pretest	Post 1	Post 2	Difference
P-type	R-CBM	62.0	75.2	82.9	+20.9
M-type	R-CBM	35.1	44.5	56.7	+21.6

Research Question Three and Four

The third and fourth questions are “what impact will hemisphere specific stimulation (HSS) and repeated partner reading have on a participants reading accuracy as measured by AIMSWeb Reading CBM (R-CBM) in the percentage of words read correct per minute”. It was hypothesized that because HSS targets the theorized deficit hemisphere, participants that receive HSS based on their dyslexic type would increase their reading accuracy at a significantly higher rate than those who received a traditional reading intervention (repeated partner reading). Table 25 contains the pre-test and post-test mean reading accuracy scores for each treatment group by session. The difference in the scores is presented to indicate the impact of each treatment.

Table 25

Mean AIMSWeb R-CBM Accuracy Scores by Intervention Type

Session	Grade/Treatment	Accuracy Pre	Accuracy Post	Difference
1	3rd HSS	72.4	86.1	+13.7
1	3rd Repeated Reading	82.6	90.2	+7.5
2	3rd HSS	90.2	92.3	+2.2
2	3rd Repeated Reading	86.1	86.9	+0.8
1	4th HSS	79.7	89.6	+9.9
1	4th Repeated Reading	90.0	95.0	+5.1
2	4th HSS	95.0	94.8	-0.3
2	4th Repeated Reading	89.6	86.0	-3.6
1	5th HSS	84.1	84.9	+0.9
1	5th Repeated Reading	95.1	91.9	-3.2
2	5th HSS	91.9	98.3	+6.4
2	5th Repeated Reading	84.9	89.8	+4.9
1	6th HSS	85.3	94.2	+9.0
1	6th Repeated Reading	95.8	97.9	+2.0
2	6th HSS	97.9	97.8	-0.1
2	6th Repeated Reading	94.2	90.3	-3.9

The results of each treatment indicate that HSS produced higher reading accuracy improvement in all the treatment sessions. A paired samples T-test indicate that was a significant difference in reading accuracy between treatments ($p <.032$). Overall accuracy rate improvements by treatment (Table 26) are higher for HSS. The mean reading accuracy improvement for HSS is 5.20% while the mean reading accuracy improvement for repeated partner reading is -0.44%.

Table 26

Overall Mean Accuracy Scores by Treatment

Treatment	Pre	Post	Difference
HSS	87.1	92.3	+5.2
Repeated Reading	89.8	89.4	-0.4

The data was analyzed using a Analysis of Variance (ANOVA) and a Multivariate Analysis of Variance (MANOVA). The use of ANOVA requires interval or ratio data, the normal distribution of scores, equal or fairly equal variances across the groups, and independent scores. The use of MANOVA requires that all assumptions of the ANOVA are met and inter-correlations (covariances) are equal.

The ANOVA was used to determine if a difference exists in reading accuracy between the dyslexic types before the treatment. The MANOVA was used to determine if a difference exists between the pre-test and post-test reading accuracy scores and investigated the interaction of the treatment over time and by dyslexic type. Table 27 shows reading accuracy pre-test and post-test means for the two dyslexic types (P-type and M-type) used in the analyses.

Table 27

Mean Reading Accuracy Scores (% of words read correctly) Before and After Each Treatment by Dyslexic Type

	Dyslexic Type	Mean	Std. Deviation	N
HSS Pre	P-type dyslexic	96.0	5.1	13
	M-type dyslexic	83.7	11.0	35
	Total	87.1	11.2	48
HSS Post	P-type dyslexic	96.8	4.6	13
	M-type dyslexic	90.6	6.8	35
	Total	92.3	6.8	48
Repeated Reading Pre	P-type dyslexic	95.6	3.9	13
	M-type dyslexic	87.7	6.6	35
	Total	89.8	6.9	48
Repeated Reading Post	P-type dyslexic	88.6	10.5	13
	M-type dyslexic	89.6	6.4	35
	Total	89.4	7.6	48

The ANOVA was used to determine whether there was a difference among the two dyslexic groups (P-type and M-type dyslexic) in reading accuracy (R-CBM) before each treatment took place. The results of ANOVA, using pre-test reading accuracy scores, indicate that there was an significant difference among the dyslexic types before the treatments.

The main effect for reading accuracy was significant at p <.001 (F = 17.605; df = 1).

Two MANOVA procedures in which treatment (HSS and repeated partner reading) and dyslexic types (P-type and M-type) served as independent variables and the reading accuracy pre-test and post-test scores served as the dependent variables, were used to answer research questions three and four. The first MANOVA used pre-test and post-test scores from the HSS treatment. The second MANOVA used pre-test and post-test scores from the repeated partner reading treatment.

The results of each MANOVA using mean gains in reading accuracy indicate that there was an overall significant difference after HSS in reading accuracy after the treatment (time); however, repeated reading did not produce a significant difference in reading accuracy after the treatment. The main effect for HSS (Table 28) was significant at *p* <.008 (F = 7.587; df = 1) while the significance for repeated reading was at *p* <.092 (F = 2.958; df = 1). Therefore, only HSS produced a significant difference in reading accuracy. There was a significant difference in reading accuracy when investigating the interaction of the impact of treatment (time) and dyslexic type in HSS (F = 4.832; df = 1) and partner reading (F = 9.566; df = 1).

Table 28

Factorial MANOVA Within Subject Contrasts for Reading Accuracy Scores

Source	Treatment	Time	Type III Sum of Squares	df	Mean Square	F	Sig.
Time	HSS	Linear	275.0	1	275.0	7.59	.008
Time* Dyslexic	HSS	Linear	175.2	1	175.2	4.83	.033
Time	RPR	Linear	116.3	1	116.3	2.96	.092
Time* Dyslexic	RPR	Linear	376.1	1	376.1	9.57	.003

The results of each MANOVA indicate that there was significant difference in reading accuracy within each dyslexic type only in the HSS treatment but not in the partner reading treatment. The dyslexic type effect, outlined in Table 29, for HSS was significant at p <.001 (F = 16.361; df = 1) and repeated reading was not significant at .052 (F = 3.976; df = 1).

Table 29

Between Dyslexic Types Effects for Reading Accuracy Scores

Treatment	Type III Sum of Squares	df	Mean Square	F	Sig.
HSS	1625.8	1	1625.8	16.36	<.001
Partner Reading	223.2	1	223.2	3.98	.052

Table 30 contains the gains in reading accuracy for both dyslexic types (P-type and M-type) during both treatments (HSS and repeated partner reading). Reading accuracy gains for M-type dyslexics were greater for both treatments, although both M-type dyslexic groups started lower. HSS produced significant changes in a participant's reading accuracy while participant's who received partner reading demonstrated no significant change in reading accuracy.

Table 30

Mean Reading Accuracy Scores (% of words read correctly) Before and After Each Treatment by Dyslexic Type

	Dyslexic Type	Pre	Post	Difference
HSS Pre	P-type dyslexic	96.0	96.8	+0.8
	M-type dyslexic	83.7	90.6	+6.8
	Total	87.1	92.3	+5.2
Repeated Reading Pre	P-type dyslexic	95.6	88.6	-6.9
	M-type dyslexic	87.7	89.6	-2.0
	Total	89.8	89.6	-0.2

Table 31 reports mean reading accuracy scores after each session. M-type dyslexics displayed significantly higher improvements in reading accuracy than the P-type dyslexics after both treatments; however, M-type dyslexics started significantly lower. P-type dyslexics' reading accuracy (97.41%) finished within expectations based on the local norms (94.30% - 97.89%).

Table 31

Mean Accuracy Scores by Dyslexic Type

Dyslexic type	Measure	Pretest	Post 1	Post 2	Difference
P-type	Accuracy	96.4	95.2	97.4	+1.0
M-type	Accuracy	81.6	89.8	90.0	+8.4

Research Question Five and Six

The fifth and sixth questions are "what impact will hemisphere specific stimulation (HSS) and repeated partner reading have on a participants' reading comprehension as measured by AIMSWeb Reading Maze". It is hypothesized that because HSS targets the theorized deficit hemisphere, participants that receive HSS based on their dyslexic type will increase their reading comprehension at a significantly higher rate than those who receive a traditional reading intervention (repeated partner reading). Table 32 contains the pre-test and post-test mean reading comprehension scores for each treatment group by session. The difference in the scores is presented to indicate the impact of each treatment.

Table 32

Mean MAZE Scores by Intervention Type

Session	Grade/Treatment	MAZE Pre	MAZE Post	Difference
1	3rd HSS	6.2	5.7	-0.5
1	3rd Repeated Reading	4.0	7.3	+3.3
2	3rd HSS	7.3	9.3	+2.0
2	3rd Repeated Reading	5.7	6.5	+0.8
1	4th HSS	2.8	3.0	+0.2
1	4th Repeated Reading	5.0	7.8	+2.8
2	4th HSS	7.8	12.7	+4.8
2	4th Repeated Reading	3.0	3.5	+0.5
1	5th HSS	5.5	7.5	+2.0
1	5th Repeated Reading	8.0	8.5	+0.5
2	5th HSS	8.5	12.7	+4.2
2	5th Repeated Reading	7.5	11.8	+4.3
1	6th HSS	8.3	8.7	+0.3
1	6th Repeated Reading	13.0	14.7	+1.7
2	6th HSS	14.7	19.0	+4.3
2	6th Repeated Reading	8.7	8.0	-0.7

The results of each treatment indicate that HSS and repeated partner reading produced higher reading comprehension improvement in an equal number of treatment sessions. Four sessions were higher for the HSS treatment group while four sessions were higher for the repeated partner reading treatment group. Interestingly, the group that scored higher during one treatment also scored higher in the subsequent treatment. Overall comprehension rate improvements by treatment (Table 33) were similar for both treatment groups. A paired samples T-test indicate that the difference between gains in reading comprehension was not significant ($p < .199$). The mean reading comprehension improvement for HSS is 2.16 correct responses in the three-minute Maze while the mean reading comprehension improvement for repeated partner reading is 2.18 correct responses in the three-minute Maze.

Table 33

Overall Mean Comprehension Scores by Treatment

Treatment	Pre	Post	Difference
HSS	7.6	9.8	+2.2
Repeated Reading	6.9	9.0	+2.2

The data was analyzed using a Analysis of Variance (ANOVA) and a Multivariate Analysis of Variance (MANOVA). The use of ANOVA requires interval or ratio data, the normal distribution of scores, equal or fairly equal variances across the groups, and independent scores. The use of MANOVA requires that all assumptions of the ANOVA are met and inter-correlations (covariances) are equal.

The ANOVA will be used to determine if a difference exists in reading comprehension (MAZE) between the dyslexic types before the treatments. The MANOVA was used to determine if a difference exists between the pre-test and post-test reading comprehension (MAZE) scores and will investigate the interaction of the treatment over time and by dyslexic type. Table 34 shows reading comprehension (MAZE) pre-test and post-test means for the two dyslexic types (P-type and L-type) used in the analyses.

Table 34

Mean Reading Comprehension Scores (correct responses in the three-minute Maze) Before and After Each Treatment by Dyslexic Type

Treatment	Dyslexic Type	Mean	Std. Deviation	N
HSS Pre	P-type dyslexic	10.5	5.0	13
	M-type dyslexic	6.6	4.0	35
	Total	7.6	4.6	48
HSS Post	P-type dyslexic	15.2	6.6	13
	M-type dyslexic	7.8	4.5	35
	Total	9.8	6.1	48
Repeated Reading Pre	P-type dyslexic	9.5	4.8	13
	M-type dyslexic	5.9	3.1	35
	Total	6.9	3.9	48
Repeated Reading Post	P-type dyslexic	13.1	4.0	13
	M-type dyslexic	7.5	4.4	35
	Total	9.0	5.0	48

The ANOVA was used to determine whether there was a difference among the two dyslexic groups (P-type and L-type dyslexic) in reading comprehension (R-CBM) before each treatment took place. The results of ANOVA using pre-test reading comprehension (MAZE) scores indicated that there was not a significant difference among the dyslexic types before the treatments. The main effect for MAZE was not significant at p <.159 (F = 2.049; df = 1).

Two MANOVA procedures in which treatment (HSS and repeated partner reading) and dyslexic types (P-type and L-type) served as independent variables and the reading comprehension pre-test and post-test scores served as the dependent variables, were used to answer research questions five and six. The first MANOVA used pre-test and post-test data from the HSS treatment. The second MANOVA used pre-test and post-test from the repeated partner reading treatment.

Table 35 shows the results of each MANOVA using mean gains in reading comprehension (MAZE) and indicates that there was an overall significant difference after both treatments (time). The main effect for HSS was significant at $p < .001$ ($F = 33.887$; $df = 1$) and repeated reading was significant at $p < .001$ ($F = 31.987$; $df = 1$). Thus, both treatments produced a significant difference in reading comprehension (MAZE) after the interventions. There was a significant difference in reading comprehension when investigating the interaction of the impact of treatment (time) and dyslexic type in HSS ($F = 11.082$; $df = 1$) and partner reading ($F = 31.987$; $df = 1$).

Table 35

Within Dyslexic Types Contrasts for Reading MAZE Scores

Source	Treatment	Time	Type III Sum of Squares	df	Mean Square	F	Sig.
Time	HSS	Linear	163.5	1	163.5	33.89	<.001
Time* Dyslexic	HSS	Linear	53.5	1	53.5	11.08	.002
Time	RPR	Linear	131.8	1	131.8	31.99	<.001
Time* Dyslexic	RPR	Linear	131.8	1	131.8	31.99	<.001

The results of each MANOVA also indicated that there was significant difference in reading comprehension (MAZE) gains within each dyslexic type. The dyslexic type effect for HSS was significant at p <.001 (F = 15.187; df = 1) and repeated reading was significant at p <.001 (F = 14.148; df = 1). Thus, both dyslexic types produced significant differences in reading comprehension (MAZE) after both treatments (Table 36).

Table 36

Between Dyslexic Types Effects for Reading Comprehension Scores

Treatment	Type III Sum of Squares	df	Mean Square	F	Sig.
HSS	604.4	1	604.4	15.19	<.001
Partner Reading	393.3	1	393.3	14.1	<.001

Both treatments displayed similar total gains in reading comprehension when comparing pre-test and post-test scores, P-type dyslexics produced greater gains within dyslexic types. Table 37 contains the gains by dyslexic type and treatment.

Table 37

Mean Reading Comprehension Scores (MAZE) Before and After Each Treatment by Dyslexic Type

Treatment	Dyslexic Type	Pre	Post	Difference
HSS	P-type dyslexic	10.5	15.2	+4.6
	M-type dyslexic	6.6	7.8	+1.3
	Total	7.6	9.8	+2.2
Repeated Reading	P-type dyslexic	9.5	13.1	+3.6
	M-type dyslexic	5.9	7.5	+1.7
	Total	6.9	9.0	+2.2

Table 38 contains mean reading comprehension scores after each session. P-type dyslexics displayed higher improvements in reading comprehension than the M-type dyslexics after both treatments. P-type dyslexics also started with high reading comprehension scores.

Table 38

Mean MAZE Scores by Dyslexic Type

Dyslexic type	Measure	Pretest	Post 1	Post 2	Difference
P-type	MAZE	9.3	10.7	15.8	+6.5
M-type	MAZE	5.6	6.9	8.5	+2.9

Research Question Seven

The seventh question asked “were the demographic factors of sex, socio-economic status, or grade level predictors of a treatments’ likelihood of success?” It was hypothesized that sex, socio-economic status, or grade level would have no impact on a treatment’s outcome.

The data was analyzed using a Multivariate Analysis of Covariance (MANCOVA). The use of MANCOVA requires interval or ratio data, the normal distribution of scores, equal or fairly equal variances across the groups, independent scores, inter-correlations (covariances) are equal, and the regression slopes (the slopes of the lines for each group when they are graphed) are equal or close to equal.

The MANCOVA was used to determine if a difference existed in reading fluency (R-CBM), reading accuracy, or reading comprehension (MAZE) between the groups (sex, socio-economic status, and grade level) and whether there was an interaction of the grouping variables.

Results by Sex

Table 39 contains the pre-test and post-test mean reading fluency scores for each treatment group by session. The difference in the scores is presented to indicate the impact of each treatment. Males' gains were higher on all three measures than females; although, females' pretest scores were higher on all three measures.

Table 39

Mean R-CBM, Accuracy, and MAZE Scores by Sex

Sex	Measure	Pretest	Post 1	Post 2	Difference
Female	R-CBM	44.4	56.7	64.3	+19.9
Male	R-CBM	40.8	49.9	63.4	+22.6
Female	Accuracy	87.3	92.4	91.6	+4.2
Male	Accuracy	84.3	90.3	92.4	+8.1
Female	MAZE	6.8	7.7	10.4	+3.6
Male	MAZE	6.5	8.0	10.4	+4.0

A Factorial MANCOVA procedure in which sex (female and male) served as an independent variable and the reading fluency (R-CBM), reading accuracy, and reading comprehension (MAZE) pre-test and post-test scores served as the dependent variables, were used to answer research question seven. Specifically, “did either treatment have a significantly difference impact on females or males as measured by the three reading outcome measures?”

The results of the MANCOVA indicated that there was a significant difference between females and males on reading fluency (R-CBM) after HSS. Table 40 outlines that the effect was significant at p <.001 (F = 13.829; df = 1). The mean gain in reading fluency was 10.04 words correct per minute (wcpm) for males and 5.19 wcpm for females. Males displayed higher gains in reading fluency after HSS than females. There were no other significant differences between females and males on either treatment among all the outcome measures.

Table 40

Overall Mean Reading Fluency (R-CBM) Gains After HSS by Sex

Treatment	Sex	Measure	Mean	Std. Deviation	N
HSS	Female	R-CBM	5.2	8.2	21
	Male	R-CBM	10.0	11.2	27

Results by Socio-economic Status

Table 41 contains the pre-test and post-test mean reading scores for each socio-economic group by session. The difference in the scores is presented to indicate the impact of each treatment. Students that did not receive free or reduced lunches displayed higher gains on all three measures than students who receive free or reduced lunches when not differentiating between different treatments.

Table 41

Mean R-CBM, Accuracy, and MAZE Scores by Income Level

Free or reduced lunch	Measure	Pretest	Post 1	Post 2	Difference
Yes	R-CBM	38.2	45.8	57.1	+18.7
No	R-CBM	44.1	55.8	66.6	+22.5
Yes	Accuracy	85.2	91.8	90.9	+5.7
No	Accuracy	85.8	91.0	92.5	+6.7
Yes	MAZE	6.2	7.1	9.4	+3.2
No	MAZE	6.8	8.2	10.9	+4.1

The MANCOVA investigated differences in performances between participants of varying socio-economic status. Specifically, did either treatment have an significantly different impact on participants who receive free or reduced lunch and those who do not receive free or reduced lunch as measured by the three reading outcome measures?

The results of the MANCOVA indicate that there was a significant difference between participants who receive free or reduced lunch and those who do not receive free or reduced lunch on reading fluency (R-CBM) after HSS and in reading accuracy after partner reading. The effect was significant at *p* <.032 (F = 5.032; df = 1) for reading fluency (R-CBM) after HSS. The effect was significant at *p* <.045 (F = 4.333; df = 1) for reading accuracy after partner reading.

The mean gain in reading fluency (Table 42) was 8.5000 words correct per minute (wcpm) for participants who received free/reduced lunch and 7.6765 wcpm for participants who did not receive free/reduced lunch. Participants who received free reduced lunch displayed significantly higher gains in reading fluency after HSS than participants who did not receive free/reduced lunch.

The mean gain in reading accuracy (% of words read correctly per minute) was -4.39 for participants who received free/reduced lunch and 1.19 for participants who did not receive free/reduced lunch (Table 42). Participants who did not received free/reduced lunch displayed significantly higher gains in reading accuracy after partner reading than participants who received free/reduced lunch. Participants who received free/reduced lunch became less accurate in reading after the partner reading treatment. There were no other significant differences between participants that received or did not receive free/reduced lunch on either treatment among all the outcome measures.

Table 42

Overall Mean Reading Fluency (R-CBM) Gains After HSS and Reading Accuracy Gains After Partner Reading by Income Level

Treatment	SES	Measure	Mean	Std. Deviation	N
HSS	Free lunch	R-CBM	8.5	13.6	14
	No free lunch	R-CBM	7.7	8.7	34
RPR	Free lunch	Accuracy	-4.4	8.7	14
	No free lunch	Accuracy	1.2	9.6	34

Results by Grade Level

Table 43 contains the pre-test and post-test mean reading comprehension scores for each treatment group by session. The difference in the scores is presented to indicate the impact of each treatment. Third grade participants had the highest gains in reading fluency (R-CBM) and reading accuracy, while fifth grade participants had the highest gains in reading comprehension (MAZE).

Sixth grade participants had the lowest gains on all three measures.

Table 43

Mean R-CBM, Accuracy, and MAZE Scores by Grade

Grade	Measure	Pretest	Post 1	Post 2	Difference
3	R-CBM	25.5	40.3	53.8	+28.3
4	R-CBM	35.7	42.5	53.9	+18.3
5	R-CBM	49.3	60.6	70.4	+21.1
6	R-CBM	59.1	68.1	77.2	+18.1
3	Accuracy	77.6	88.2	89.7	+12.1
4	Accuracy	84.8	92.3	90.4	+5.6
5	Accuracy	89.6	88.4	94.0	+4.5
6	Accuracy	90.5	96.0	94.1	+3.5
3	MAZE	5.1	6.5	7.9	+2.8
4	MAZE	3.9	5.4	8.1	+4.1
5	MAZE	6.8	8.0	12.3	+5.5
6	MAZE	10.7	11.7	13.5	+2.8

The MANCOVA investigated differences in performances between participants at different grades levels. Specifically, “did either treatment have an significantly different impact on participants at one grade level compared to other grade levels as measured by the three reading outcome measures?”

The results of the MANCOVA indicate that there was a significant difference between participants at different grade levels on reading fluency (R-CBM) after HSS and on reading comprehension (MAZE) after partner reading (Table 44). The effect was significant at p <.002 (F = 5.990; df = 1) for reading fluency (R-CBM) after HSS. The effect was also significant at p <.002 (F = 6.442; df = 1) for reading comprehension (MAZE) after partner reading.

The highest mean gain in reading fluency was 11.67 words correct per minute (wcpm) for third graders and the lowest gain was 3.50 wcpm for fifth graders.

The highest mean gain in reading comprehension (MAZE) was 4.50 for fifth graders and the lowest gain was 1.67 for fourth graders. There were no other significant differences between grade levels on either treatment among all the outcome measures.

Fisher’s least significant difference test (LSD) post hoc analysis indicated that a significant difference of 8.1667 existed between third grade and fifth grade on R-CBM gains. Accounting to LSD, fifth grade was significantly different from all other grades with significance ranging from p <.001 to p <.039.

Table 44

Overall Mean Reading Fluency (R-CBM) Gains After HSS and Reading Comprehension Gains After Partner Reading by Grade Level

Treatment	Grade	Measure	Mean	Std. Deviation	N
HSS	3rd	R-CBM	11.7	14.2	12
	4th	R-CBM	9.3	10.5	12
	5th	R-CBM	3.5	5.4	12
	6th	R-CBM	7.2	8.0	12
Repeated Reading	3rd	MAZE	2.1	2.5	12
	4th	MAZE	1.7	2.1	12
	5th	MAZE	4.5	3.0	12
	6th	MAZE	0.5	3.0	12

Summary

The data analysis and the results of this study were presented in this chapter. This chapter contained an introduction and four parts. The first part described how the dyslexic subtypes were determined and the results for each participant. Local norms generated from the scores of the approximately 700 Hillview Intermediate Center students provided the cut-scores for each dyslexic subtype.

The second part outlined the demographic and dyslexic type for each grade level. P-types dyslexics, who display slow but accurate reading, comprised 13 participants. The rest of the sample (35 participants) was classified as M-type dyslexics, who display slow, inaccurate reading. No study participants were classified as L-type dyslexics, fast readers who commit many errors. The ratio of males to females (approximately 60% to 40%) that is seen with all students who were receiving support at Hillview Intermediate Center was also present within the study (27 males to 21 females). The percentage of study participants who receive free or reduced lunch (29%) was slightly higher than the percentage of students who receive free or reduced lunch school-wide at Hillview Intermediate Center (18%).

The results of each of the seven research questions were presented in the third part. The mean fluency, accuracy rates, and MAZE scores by interventions, sex, socio-economic status, and grade level were presented. The repeated partner reading treatment produced higher reading fluency while HSS produced higher reading accuracy. The gains in reading comprehension were similar for both treatments. The third part contained a description of the MANOVA and MANCOVA analyses procedures used in this study. When investigating the differences between dyslexic types, P-type dyslexics produced higher gains in reading fluency (R-CBM) and reading comprehension (MAZE) while M-types produced greater gains in reading accuracy. The fourth part outlined limitations of this study, which included a small sample size, differentiating the impact of other treatments, the lack of variability of demographic factors, and the lack of L-type dyslexics.

CHAPTER FIVE

DISCUSSION

Introduction

This chapter discusses the results of the study and implications for further investigations. The chapter begins with brief overview of the purpose of the study and the procedures employed. Next, a discussion of the results of each research questions is presented. Threats to internal and external validity are presented and implications for future research are suggested. The chapter ends with final conclusions and a summary of the chapter.

Purpose of the Study

The purpose of this study was to investigate Bakker's Balance Model of Reading (1992) and link reading interventions to reading difficulties. This was accomplished by categorizing students with reading difficulties by fluency and error rates and examining the efficacy of interventions proposed to remediate those different reading difficulties.

Bakker (1992, 1994) theorized that reading begins as a perceptual task in the right hemisphere and shifts to the left hemisphere when language becomes involved. Bakker's Balance Model of Reading (1992) categorizes students with reading difficulty into three dyslexic subtypes based on students failing to make the shift to the left hemisphere or shifting to the left hemisphere too early.

The three dyslexic types are P-type dyslexics, L-type dyslexics, and M-type dyslexics. P-type dyslexics display slow reading with few substantive errors. L-type dyslexics display fast reading with many substantive errors. M-type dyslexics display slow reading with many substantive errors.

One of the treatments that Bakker proposed to remediate those reading difficulties is Hemisphere Specific Stimulation (HSS). Hemisphere Specific Stimulation uses a tactile training box to stimulate the targeted/deficit hemisphere. This study examined the efficacy of this treatment by analyzing each participant's reading fluency, reading accuracy, and reading comprehension rates compared to participants who received a traditional reading intervention (repeated partner reading).

A Review of the Procedures and Analyses

Forty-eight students, 12 in each grade three through six, who were recommended to receive addition reading instruction, were included in this study. Each participant was categorized into three dyslexic subtypes (P-type dyslexic, L-type dyslexic, and M-type dyslexic). Each grade-level group was separated in two treatment groups. Each treatment group received one of the two treatments for six weeks then the opposite treatment for six weeks.

The treatments were Hemisphere Specific Stimulation (HSS) and repeated partner reading. Hemisphere Specific Stimulation utilized a tactile training box to stimulate the targeted hemisphere by having participants trace words out of sight with the hand opposite the targeted hemisphere. The students worked in pairs, each participating as a student-examiner (placing letters in the training box) and a student-examinee (manipulating letter with a specified hand to stimulate the opposite hemisphere). The second treatment group received repeated partner reading as described as "Reading Twosome" from The Florida Center for Reading Research (www.fcrr.org).

The student's reading was assessed using AIMSWeb reading R-CBM and MAZE probes to investigate reading fluency (words read correct per minute), accuracy rates (percentage of words read correctly), and reading comprehension. The intervention occurred two days a week for 30 minutes and lasted for twelve weeks (six for each treatment) as part of a specialized reading intervention program.

A Review of the Results

Seven research questions were proposed in this study, and the results will be summarized within that framework. The research questions that utilized the same outcome measure will be presented together. Research questions one and two both investigated reading fluency (R-CBM). Research questions three and four both investigated reading accuracy. Reading comprehension (MAZE) was investigated in questions five and six. Research question seven, which investigated the impact of sex, socio-economic status, and grade level on the effectiveness of each intervention, were presented in isolation. The results were analysis by treatment and by dyslexic types.

L-type dyslexics were not included in this study because no participants were identified as L-type dyslexic. The sample consisted of the slowest readers at each grade level so no participants were fast, inaccurate readers (L-type dyslexic).

The actual procedure to determine dyslexic subtypes is not expanded on by Bakker (1992, 1994); however, many researchers (Dryer, Beale, and Lambert, 1999; Robertson, 2000; Patel and Licht, 2000; and Strien, Stolk, and Zuiker, 1995) have used varying techniques to determine reading disability subtype. Dryer, Beale, and Lambert (1999) used only error type and were unable to categorize half their sample. Robertson (2000) used error type and found only one P-type dyslexic. Other researchers (Strien, Stolk, and Zuiker, 1995; Patel and Licht, 2000) used both error type and reading speed to generate similar numbers of P-type and L-type dyslexics. It appears to include participants of both dyslexic types requiring both reading speed and error type be investigated.

Research Questions One and Two

The first and second questions were “what impact will hemisphere specific stimulation (HSS) and repeated partner reading have on participants’ reading fluency as measured by AIMSWeb Reading CBM (R-CBM) in words read correct per minute”. It was hypothesized that because HSS targets the theorized deficit hemisphere, participants that receive HSS based on their dyslexic type would increase their reading fluency at a significantly higher rate than those who receive a traditional reading intervention (repeated partner reading).

Based on the results, both treatments produced significantly higher reading fluency (R-CBM) scores. However, repeated partner reading produced higher gains in reading fluency in all but one of the sixteen treatment sessions and by overall mean gains. Within each dyslexic type, P-type dyslexics outgained M-types within both treatments but P-types dyslexics who received repeated partner reading displayed higher gains in reading fluency (R-CBM) than P-types dyslexics who received HSS. Additional, M-types who received repeated partner reading displayed higher reading fluency (R-CBM) gains than M-types who received HSS.

The hypotheses that stated that P-type and M-type dyslexics who received HSS would display higher gains in reading fluency (R-CBM) than participants who received repeated partner reading is rejected. Likewise, the hypotheses that stated that P-type and M-type dyslexics who received repeated partner reading would display no significant change in reading fluency (R-CBM) when compared to P-type and M-type dyslexics was also rejected. The sample did not contain participants who displayed characteristics of a L-type dyslexics, therefore, the hypotheses that stated L-type dyslexics would display significantly higher reading fluency (R-CBM) after HSS and

L-type dyslexics who received repeated partner reading would display no change in reading fluency (R-CBM) were neither rejected or failed to be rejected.

Repeated partner reading was chosen as a comparison treatment to unequivocally validate the effectiveness of HSS. Repeated partner reading and other authentic connected text reading interventions are considered the gold standard in reading fluency interventions (Ogle and Lang, 2007). If HSS demonstrated similar gains as repeated partner reading, HSS would have to be considered a viable option in a school's reading intervention repertoire. HSS effectiveness as a reading fluency intervention was not realized and repeated partner reading continues to be a very good way to increase a student's reading fluency.

Similar to other studies (Bakker, 1994; Robinson, 2000), participants' gains were consistent to the hemisphere that was stimulated. Bakker (1994) found that participants who received stimulation to the right hemisphere improved reading accuracy while participants who received stimulation to the left hemisphere demonstrated improvement in reading fluency. However, a single case study, Robinson (2000) found the same outcome when stimulation of each hemisphere was provided to two P-type dyslexics.

The current study found the same interaction between the hemisphere stimulated and gains in reading fluency or reading accuracy. P-type dyslexics received stimulation to the left hemisphere by manipulated letters in the tactile training box with their right hand. M-type dyslexics received stimulation to their right hemisphere by using their left hand. Therefore, the same outcome of increase in reading fluency when stimulating the left hemisphere and increase in reading accuracy when stimulating the right hemisphere were found as in other studies (Bakker, 1994; Robinson, 2000).

The major difference between the current study and previous research (Kappers, 1997; Goldstein and Obrzut's, 2001, Dryer, et. al., 1999) was the use of a comparison treatment. The authors (Kappers, 1997; Goldstein and Obrzut's, 2001, Dryer, et. al., 1999) of previous studies attempted to validate Bakker Balance Model of Reading (1992, 1994) by providing appropriate (stimulation to the left hemisphere to P-type dyslexics and stimulation to the right hemisphere to L-type dyslexics) and inappropriate (stimulation to the right hemisphere to P-type dyslexics and stimulation to the left hemisphere to L-type dyslexics) treatment. These studies hypostasized that if the appropriate treatment was more effective than the inappropriate treatment, the theory was validated. Kappers (1997) and Robinson (2000) findings supported Bakker's model, while other studies (Goldstein and Obrzut, 2001; Dryer, Beale, and Lambert, 1999) did not support Bakker's findings; however, all previous studies showed increases in reading.

The current study found the same interaction between targeted hemisphere and type of reading improvement as Bakker (1992; 1994). The problem with the previously noted studies (Kappers, 1997; Robinson, 2000; Goldstein and Obrzut, 2001; Dryer, Beale, and Lambert, 1999) is without an empirically-validated comparison intervention, it is impossible to determine if the results of hemisphere stimulation are greater than other treatments. The overall goal of this study was not to validate Bakker's theory. The overall goal of this study was to determine the efficacy of HSS to improve reading skills within a public elementary school. The results suggests that repeated partner reading continues to be a better intervention to improve the reading fluency of low achieving reader in grades three through six.

Research Questions Three and Four

The third and fourth questions were “what impact will hemisphere specific stimulation (HSS) and repeated partner reading have on a participants’ reading accuracy as measured by AIMSWeb Reading CBM (R-CBM) in the percentage of words read correct per minute”. It was hypothesized that because HSS targets the theorized deficit hemisphere, participants that receive HSS based on their dyslexic type would increase their reading accuracy at a significantly higher rate than those who received a traditional reading intervention (repeated partner reading).

Based on the results, only HSS produced significantly higher reading accuracy scores. HSS produced higher gains in reading accuracy in all of the sixteen treatment sessions and by overall mean gains. Within each dyslexic type, M-type dyslexics outgained P-types within both treatments. P-types dyslexics who received HSS displayed higher gains in reading accuracy than P-types dyslexics who received repeated partner reading and M-types who received HSS displayed higher reading accuracy gains than M-types who received repeated partner reading.

The hypotheses that stated that P-type and M-type dyslexics who received HSS would display higher gains in reading accuracy than participants who received repeated partner reading was failed to be rejected. Similarly, the hypotheses that stated that P-type and M-type dyslexics who received repeated partner reading would display no significant change in reading accuracy was also failed to be rejected. The sample did not contain participants who displayed characteristics of a L-type dyslexics, therefore, the hypotheses that stated L-type dyslexics would display significantly higher reading fluency (R-CBM) after HSS and L-type dyslexics who received repeated partner reading would display no change in reading fluency (R-CBM) were neither rejected or failed to be rejected.

The findings of improved reading accuracy after HSS are similar to other studies (Bakker, 1994; Robinson, 2000) when isolating the hemisphere that received the stimulation. Although M-type dyslexics and P-types dyslexics were not compared as in the current study, Bakker (1994) and Robinson (2000) found that participants that received stimulation in the right hemisphere demonstrated greater improvements in reading accuracy than participants that received stimulation to the left hemisphere. Strien (1995) found that after hemisphere stimulation, dyslexic types appeared to shift to characteristics of the opposite dyslexic type. L-type dyslexics would improve reading accuracy but decrease reading fluency and P-type dyslexics would improve reading fluency but decrease reading accuracy (Strien, 1995). This shift to the other dyslexic type was not observed. M-type dyslexics, who displayed higher increases in reading accuracy than P-type dyslexics, also displayed improvement in reading accuracy. Although M-type

HSS produced higher gains in reading accuracy. A student’s reading accuracy is often overlooked, which is evident in many popular formative assessments like DIBELS (Good, 2002). HSS impact on a student’s reading accuracy remains a good option for addressing these weaknesses, especially with M-type dyslexics, whose reading is both slow and inaccurate.

Research Questions Five and Six

The fifth and sixth questions were “what impact will hemisphere specific stimulation (HSS) and repeated partner reading have on a participants’ reading comprehension as measured by AIMSWeb Reading Maze”. It was hypothesized that, because HSS targets the theorized deficit hemisphere, participants that received HSS based on their dyslexic type would increase their reading comprehension at a significantly higher rate than those who received a traditional reading intervention (repeated partner reading).

The results suggested that both treatments produced significantly higher reading comprehension (MAZE) scores. HSS and repeated partner reading produced higher reading comprehension scores in an equal number of the sixteen treatment sessions (eight each). Overall mean gains in reading comprehension (Maze) were similar between HSS and repeated partner reading (2.16 and 2.18 correct responses gained in the three-minute Maze probe, respectively). Within each dyslexic type, P-type dyslexics outgained M-types within both treatments.

The hypotheses that stated that P-type and M-type dyslexics who received HSS would display higher gains in reading comprehension (MAZE) than participants who received repeated partner reading was rejected. Additionally, the hypotheses that stated that P-type and M-type dyslexics who received repeated partner reading would display no significant change in reading fluency (R-CBM) when compared to P-type and M-type dyslexics who received HSS was also rejected. The sample did not contain participants with a L-type dyslexic reading profile; therefore, the hypotheses that stated L-type dyslexics would display significantly higher reading comprehension (MAZE) scores after HSS and L-type dyslexics who received repeated partner reading would display no change in reading comprehension (MAZE) were neither rejected or failed to be rejected.

Bakker (1990) found that improvements in single-word reading and text reading after hemisphere stimulation translated into improvements in reading comprehension. Goldstein and Obrzut (2001) found improvements in word recognition and reading accuracy after hemisphere stimulation produced higher reading comprehension. Similar to the current study, these previous studies (Bakker, 1990; Goldstein and Obrzut, 2001) found varying levels of improvements between different dyslexic types and specific reading skills; however, all studies produced similar improvements in reading comprehension.

Both HSS and repeated partner reading produced similar overall reading comprehension (MAZE) gains. This was surprising due to the previously discussing strong correlation between reading fluency and reading comprehension. Repeated partner reading produced higher gains in reading fluency, but those gains did not translate into higher gains in reading comprehension. P-type dyslexics who started with higher reading comprehension scores showed greater gains in reading comprehension in both treatments. This suggests that reading fluency alone may not be sufficient to predict adequate reading comprehension. It, also, is reasonable that the more accurate a reader is, the more he or she will comprehend. With a focus to increase reading accuracy to improve reading comprehension, HSS should be considered based on the previously discussed improvements to reading accuracy.

Research Questions Seven

The seventh question investigated whether the demographic factors of sex, socio-economic status, or grade level impacted a treatments' likelihood of success? It was hypothesized that sex, socio-economic status, and grade level will have no impact on the treatment's outcome.

Based on the results, males produced significantly higher reading fluency (R-CBM) gains than females after HSS. Few previous studies examined differences between sex. One reason is the small number of females in previous studies. Kappers (1997) found no differences between males and females after hemisphere stimulation but this may be a result of a relatively small female sample size (24 females, N=80).

The mean gain by males was over 10 words correct per minute, while females gained only just over 5 words correct per minute. Although females' reading fluency was higher than males before the treatment, the difference (approximately 3.5) was not as large as the difference in reading fluency gains. Pre-test scores were higher for females on all three measures, while males displayed higher gains on all three measures. There was no significant difference between reading accuracy or reading comprehension scores between males and females after HSS. There was no significant difference between males and females on all three outcome measures after repeated partner reading. The hypotheses that stated that sex (female or male) would have no impact on reading fluency (R-CBM), reading accuracy, and reading comprehension after HSS was rejected. The hypotheses that stated that sex (female or male) would have no impact on reading fluency (R-CBM), reading accuracy, and reading comprehension after repeated partner reading was failed to be rejected.

The results indicated that there was a significant difference between participants who received free or reduced lunch and those who did not receive free or reduced lunch on reading fluency (R-CBM) after HSS and reading accuracy after repeated partner reading. Participants who received free or reduced lunch displayed significantly higher gains in reading fluency (R-CBM) than participants who did not receive free or reduced lunch after HSS. Participants who did not received free or reduced lunch displayed significantly higher gains in reading accuracy than participants who did receive free or reduced lunch after repeated partner reading.

There was no significant difference between participants who received free or reduced lunch and those who did not receive free or reduced lunch on reading accuracy and reading comprehension after HSS and on reading fluency and reading comprehension after repeated partner reading. The hypotheses that stated that socio-economic status (free/reduced lunch and no free/reduced lunch) would have no impact on reading fluency (R-CBM), reading accuracy, and reading comprehension after HSS was rejected. Likewise, hypotheses that stated that socio-economic status (free/reduced lunch and no free/reduced lunch) will have no impact on reading fluency (R-CBM), reading accuracy, and reading comprehension after repeated partner reading was, also, rejected.

According to the results, a significant difference existed on the reading fluency (R-CBM) gains between third grade and fifth grade after HSS. Third grade participants' reading fluency gain (11.67) was significantly higher than fifth grade's gain (3.50). Conversely, the fifth grade group was found to display a significantly higher gain in reading comprehension (MAZE) than all other grades after repeated partner reading. There was no significant difference between grade levels on reading accuracy and reading comprehension after HSS and on reading fluency and reading accuracy after repeated partner reading. The hypotheses that stated that grade level will have no impact on reading fluency (R-CBM), reading accuracy, and reading comprehension after HSS and repeated partner reading are rejected.

Implications of the Findings

Repeated partner reading remains a better option than HSS when attempting to increase a student's reading fluency; however, the overall implications of this study suggest that a student's reading accuracy also should be investigated during treatment selection. For slow but accurate readers (those whose reading accuracy is within a standard deviation of the population), repeated partner reading should continue to be used to increase a student's reading fluency and subsequently increase his or her reading comprehension. For slow and inaccurate readers (those whose reading accuracy is below a standard deviation of the population), a combination of HSS, to increase a student's reading accuracy, and repeated partner reading, to increase a student's reading fluency, should be utilized.

Frequent formative assessment measures need to be administered to determine the impact of each intervention. Weekly progress monitoring will validate the impact of the intervention on a student's reading fluency and reading accuracy. In addition, progress monitoring data will provide information on a student's gains in reading accuracy to give a determination of when it is appropriate to discontinue HSS. The HSS approach can be discontinued when a student's accuracy is within a standard deviation of the local norm.

Another implication of this study was that gains in reading comprehension were made when a student's reading fluency was increased and also when a student read more accurately. Examining only a student's reading fluency is not sufficient in making predictions about reading comprehension. Since gains in reading accuracy were found to produce similar gains in reading comprehension to gains in reading fluency, treatments that focus on reading accuracy, such as HSS, should be considered in reading remediation plans.

Internal Threats to Validity

There are several limitations that were present that threaten the internal validity of this study. The two limitations are the inability to randomly place students into treatment groups and the lack of participants who displayed L-type dyslexic qualities.

As previously discussed, repeated partner reading and other paired activities that are conducted in the RtI group necessitate partners of similar reading ability. Student pairs with similar reading ability allow for materials to closely match the instructional level of the pair and do not pose the threat to motivation that might occur with students of varying reading ability. In addition, participants work in pairs and small groups on other activities on days the treatments are not conducted. These pairs are based on reading ability and teacher recommendations for pairs to increase time-on-task and group cohesion. Concerns over multiple pairing of participants and the decreased effectiveness of repeated partner reading due to partners with significantly different reading ability were discussed with the teachers. Based on these concerns, the pairs were left intact and the random assignment to treatment groups was abandoned.

The other limitation was the lack of L-type dyslexics. Because the sample was based on participants with the lowest reading fluency, it was not surprising that no participant was categorized as a L-type dyslexics.

However, with no L-type dyslexics, it was impossible to investigate each treatments' impact on those types of readers. Furthermore, the utility of categorizing participants based on their reading dyslexic type cannot be considered without a sample of students at each type. The method that participants are categorized into dyslexic types will impact the number of participants within each type.

Other studies (Dryer, Beale, and Lambert, 1999; Robertson, 2000) did not find P-type dyslexics because only a participants' error type was investigated. Future studies should include both reading fluency and error type into the identifying process to attempt to find similar numbers of P-type and L-type dyslexics.

External Threats to Validity

There are several limitations that were present in this study that limit the generalizibility of the results to other populations. The sample size, impact of other treatments, and lack of variability of demographic factors pose problems in predicting the treatments' effectiveness in other environments.

The sample size of this study was small relative to other studies (Kappers, 1997) that looked at similar treatments. Although forty-eight participants participated in this study, due to the developmental nature of the reading process, each of the four grade levels were investigated individually reducing each treatment group to twelve. In addition, assigning participants into two treatment groups further reduced the cell size to six. There is a possibility that this may have reduced the statistical power to detect reliable interactions among reading performance, subtype, and treatment.

The participants in this study were the lowest readers at each grade level; therefore, each demonstrated the greatest need for additional reading interventions. Due to this great need, participants received extensive reading interventions provided in a variety of ways by numerous regular education and support personnel. Gains in reading fluency, accuracy, and comprehension that were attributed to a specific treatment may be due to other reading interventions and not specific to treatments that were provided within this study. A combination of support provided through the regular education curriculum, Learning Support, and Title I, in addition to fluency groups, nonfiction reading practice, group repeated reading (Crazy Poems), after-school tutoring, and strategies preformed at home by a students' parents are available to all participants in this study. Thus, it is difficult to isolate what method or combination of methods actually produced the results. However, it should be noted that all participants of this study received the same additional interventions, which strengthen the validity of these results.

Because the sample consisted of the lowest readers at each grade level, improvements in reading may have results from Regression to the Mean and/or the developmental nature of the reading process. Dryer, Beale, and Lambert (1999) found similar conclusions. They (Dryer, et. al., 1999) reported that gains made in reading were likely to be due to other training contingencies and not to the specific nature of the hemisphere stimulation. Also, overall improvement may be attributed to regression to the mean (Dryer et. al., 1999). The developmental nature of reading may have contributed to the identification of all third grade participants and ten of twelve fourth grade participants as M-type dyslexics. With only half of fifth and sixth grade participants identified as M-types, the decline in difficulty in reading accuracy without direct intervention suggests some of the improvements may be developmental in nature. Improvements in reading fluency during the treatment may also be developmental and not be a result of the intervention.

The demographic factors further diminish the predictive power of these treatments to other environments. No racial diversity existed within the sample. All participants were white, non-Hispanic students. All attend a rural school with an overall non-transit population. Socio-economic status was similar to the school and district (approximately 25%). Males only slightly outnumbered females (27 TO 21). Each of these demographic factors make the results of this study difficulty to generalize to urban/suburban schools, school with racial diversity, schools with a greater percentage of economically-disadvantaged students, and schools with a significantly higher percentage of male students in need of remedial support.

Direction for Future Research

The current research is promising when considering additional methods to increase a student’s reading ability. Future research should investigate the impact of HSS on L-type dyslexics, reading accuracy as a treatment’s focus, long-term stability of gains achieved through hemisphere stimulation, varying lengths of treatments, younger readers, and self-directed interventions.

As the sample did not contain participants who displayed L-type dyslexia, it was impossible to determine the impact of HSS with those types of readers. This was unfortunate, because HSS significantly increased a participant’s reading accuracy and L-type dyslexics are in most need of improvements in reading accuracy. Future studies should provide HSS to L-type dyslexics to determine if gains in reading accuracy are realized and how HSS impacts a L-type dyslexic’s reading comprehension. Including both reading fluency and reading error type during the dyslexic type identification may identify participants at both dyslexic types. Also, future studies may investigate the number of L-type and P-type dyslexics based on a reading comprehension measure that does not address either reading fluency or reading accuracy.

The results of this study suggest that improvements in reading accuracy translate into gains in reading comprehension. Future research should isolate reading accuracy as a viable reading measure and investigate various treatments to increase a participant’s reading accuracy. In addition, future research should examine if gains in reading accuracy produce similar gains in reading comprehension with different treatments for different populations.

This study was conducted over twelve weeks, with each treatment lasting six weeks. Future research should follow participants for an extended period after the conclusion of the study to determine if the gains made during the treatment are maintained. Follow-up assessments at monthly intervals and after a sustained absence (summer vacation) would provide information pertaining to the sustainability of gains and further document the usefulness of the treatment.

Although this study was conducted only twice a week for thirty minutes, future studies may want to look at varying lengths of treatment to determine a therapeutic range. HSS may become a more viable option if reading gains are produced with two, ten minute sessions as opposed to occupying large amounts of instructional time.

A main implication of this study was HSS impact on a student’s reading accuracy. Younger students are more likely to display low reading accuracy. Future studies should explore how HSS works with younger students to increase reading fluency and reading accuracy, as well as emergent literacy measures such as letter identification fluency, sound identification fluency, and nonsense word fluency (Good, 2002).

Finally, future studies should investigate the impact of self-directed or student-administered interventions. Student-administered interventions have a number of advantages. First, when students provide interventions to each other, school personnel are able to provide more one-on-one and small group instruction to the other students. Second, student motivation is high when they can “be the teacher”. Student motivation and excitement was high during the HSS treatment of this study based on student-reports and student comments to “do the boxes” on days which the treatment did not occur. Part of that excitement was the novelty of the treatment, but the opportunity to direct the instruction was equally motivating. Third, it is logical to believe that some of the gains in reading accuracy were an outcome of being the student-examiner.

Conclusions

Although the predicted outcome of greater gains in reading fluency and reading comprehension using HSS were not realized, students who received hemisphere specific stimulation demonstrated greater improvement in the accuracy of their reading. The final conclusions of this study suggest a specialized use of HSS for students with reading accuracy difficulties and the use of reading accuracy as an outcome measure.

M-type dyslexics, who read slowly and inaccurately may benefit from specific interventions that address their reading accuracy before attempting to increase their reading fluency. This study demonstrated that slow, accurate readers (P-type dyslexic) had higher reading comprehension scores and produced higher gains in reading comprehension scores than slow, inaccurate readers (M-type dyslexics). The overall goal of reading is comprehending what you read therefore skills that increase reading comprehension initially should be a primary focus of intervention. The progression of a student's reading should be to increase reading accuracy then increase reading fluency; this is essential to maintain some mastery of information read.

Improved accuracy should also be the main focus of L-type dyslexics and should be further investigated. Most L-type dyslexics make substantive errors which decrease overall reading comprehension. L-type dyslexics who improved the accuracy of their reading may also experience greater reading comprehension due to the decrease of substantive errors. Substantive errors are meaning changing errors and decrease overall reading comprehension.

Reading accuracy should receive more attention during data-based decision making regarding a student's response to intervention. Currently, popular curriculum-based reading assessments such as DIBELS (Good, 2002) and AIMSWeb (Shinn, 2002) do not offer benchmarks or aggregate norms in reading accuracy. Current progress monitoring only focuses on the total number of words read correctly (AIMSWeb R-CBM) or the total number of correct responses on the cloze passage (AIMSWeb MAZE). Without differentiating between the accurate and inaccurate readers, school personnel do not have a complete picture of the student's reading and therefore, can not make precise decisions regarding the need for support or provide the correct intervention. The results of this study suggest that a student's reading can not be accurately represented by a single fluency score. Predictions as to how well a student can comprehend are not accurately predicated on reading fluency. Reading fluency and reading accuracy both need to be investigated to better predict a student's reading comprehension.

Summary

This chapter discussed the utility of categorizing students based on their reading difficulty and the results of HSS and repeated partner reading. The chapter began with brief overview of the purpose of the study and the procedures employed. The results of each research questions were presented and the implications of those results were discussed. Threats to internal and external validity were investigated and suggestions for future research were given. The chapter ended with an overall conclusion of the study.

The results of this study suggest that repeated partner reading produced higher gains in reading fluency while HSS produced higher gains in reading accuracy. Interestingly, repeated partner reading and HSS produced similar gains in reading comprehension. This suggests that both increases in reading fluency, as well as, increases in reading accuracy will result in higher reading comprehension. Slow, accurate readers (P-type dyslexics) demonstrated higher gains in reading fluency and reading comprehension than slow, inaccurate readers (M-type dyslexics). M-type dyslexics displayed higher gains in reading accuracy. This validated the developmental nature of reading and indicates that reading accuracy should be the primary focus of reading intervention. The interaction of the independent variable such as sex, socio-economic status, and grade level were mixed and make predicting a treatment success based on those independent variables difficult.

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APPENDIXES

APPENDIX A INFORMED PARENT CONSENT LETTER

September 10, 2008

Dear Parent of a Hillview Student:

My name is Brian Buchan, and I am the school psychologist for the Grove City Area School District. I am also a doctoral candidate at Indiana University of Pennsylvania. As part of my training, I am studying ways to help students read better. You have received this letter because your child is already a part of our RtI (Response to Intervention) group. The purpose of this study is to learn ways to improve a student's reading ability. The study will take place for 30 minutes, two days each week during the RTI group time. The RTI group meets daily during school hours and is designed to improve a student's reading fluency. During this time, each student will try two reading interventions.

Your child will be asked to trace letters/words with their fingers. The letters will be placed in a box and your child will no be able to see the words. The class will be split into two groups. One group will use the boxes. The other group will partner read. After six weeks, everyone will switch. Your child will work in pairs with another student. Each student will take turns placing letters in the box and feeling the letters to picture the word in their mind. A teacher and an aide will be present to help each student. This intervention is similar to other strategies that have students trace letters/words.

Indiana University of Pennsylvania supports the practice of protection of human subjects participating in research. This project has been approved by the Indiana University of Pennsylvania Institutional Review Board for the Protection of Human Subjects (Phone: 724-357-7730). There are no known risks or discomforts associated with this research. Please be aware that even if you agree to participate in this study, you are free to withdraw your child at any time and you may do so without penalty by informing Judy Campbell, Hillview secretary. Although your participation is solicited, it is strictly voluntary. Families who choose not to participate will continue to be eligible for school psychological services. I will not know which students choose to participate. In addition, if you decide not to participate, your child will continue receiving instruction as a part of the RtI group. If you chose to participate, please indicate that on the following page and return in the enclosed envelope. If you do not want to participate, no further action is required. Your child’s consent will also be required for him/her to participate.

If you have any questions or concerns and would like additional information, please indicate that on the following page or feel free to contact either of us as listed below. We appreciate your time and cooperation and look forward to working with your child.

Sincerely,

Brian D. Buchan
School Psychologist/
Doctoral Candidate
Grove City School District
482 East Main Street
Grove City, PA 16127
(724) 458-7570
buchan@grovecity.k12.pa.us

Dr. Gurmal Rattan
Professor
Indiana University of Pennsylvania
Educational and School Psychology
251 Stouffer Hall
Indiana, PA 15705
(724) 357-3787
gurmalra@iup.edu

APPENDIX B INFORMED PARENT CONSENT FORM

Student name______________________________ Grade__________

Reading Intervention Study - Hemisphere Specific Stimulation

Please check all applicable spaces

__________ Yes, I give my child permission to participate in this study.

__________ I would like more information.

Phone number:______________________

Best time to call:______________________

___________________________ ___________ _______________

Parent Signature Date Phone number

Please return this to:
Reading Study
Hillview Intermediate
482 East Main Street
Grove City, PA 16127
724-458-7570

Or the Hillview Intermediate Office

APPENDIX C INFORMED STUDENT ASSENT LETTER

September 10, 2008

Dear Hillview Student:

My name is Mr. Buchan. I am the school psychologist for your school. Your teachers and I are testing new ways to help kids read better. We would like to try two different reading strategies. We want to see which one works better. We want to make sure you understand what is happening. We also want to know if you want to try this. If you don’t want to do this, you can do something else and that is OK.

We will be using the boxes in your rooms. The class will be split into two groups. One group will use the boxes. The other group will partner read. After six weeks, everyone will switch. You will do these activities two days a week during PSSA group. The boxes will help your brain see letters and words. You will work in pairs. You will put letters in the box for your partner to read. After 15 minutes, you will switch. Your partner will put letters in the box for you to read. When letters are in the box, you will not be able to see them. You will use the hand your teacher tells you to feel the letter. You will try to draw a picture of the word in your mind. Your partner will ask you to name the word.

If you want to try the boxes, check below and return to Mrs. Campbell in the Hillview Office. If you do not want to try this, you do not have to do anything.

____________ I want to try the boxes.

____________ I have some questions about the boxes.

_________________________________ _____________
Student Signature Date

Please return this to:
Reading Study
Hillview Intermediate
482 East Main Street
Grove City, PA 16127
724-458-7570

Or the Hillview Intermediate Office

APPENDIX D INFORMED TEACHER CONSENT LETTER

September 10, 2008

Dear Hillview Teacher:

As part of my doctoral training at Indiana University of Pennsylvania, I am conducting a research study to investigate the utility of categorizing students with reading difficulties by fluency and error rates, as well as examining the efficacy of interventions proposed to remediate each type. I am seeking your consent to participate in this study.

Students who are participating in our specialized reading program referred to as the RTI (Response to Intervention) group are being asked to participate in this study to investigate better ways to increase a student's reading ability. The interventions will occur for 30 minutes, two days a week during the RTI group time. The study will last for twelve weeks and each student will receive two different reading interventions (Hemisphere Specific Stimulation and repeated partner reading). Based on brain scans of readers at different levels, it is believed that beginning reading occurs on the right side of a students' brain as the child is figuring out all the different shapes of letters. After the shapes are understood, reading shifts to the left side of the brain and becomes a language task. So students that have difficulty reading may not have shifted to the left or shifted too soon. To help this, students trace letters without being able to see them. The students will use the hand opposite the side where the problem is occurring to figure out words in a box. The students will work in pairs. The teacher will have to demonstrate how the intervention works and the roles of each student-examiner and student-examinee. In addition, the teacher will be responsible to tell the students to switch roles, monitor the students for correct spelling and hand usage, and answer any questions.

Indiana University of Pennsylvania supports the practice of protection of human subjects participating in research. This project has been approved by the Indiana University of Pennsylvania Institutional Review Board for the Protection of Human Subjects (Phone: 724-357-7730). There are no known risks or discomforts associated with this research. Please be aware that even if you agree to participate in this study, you are free to withdraw at any time and you may do so without penalty by informing Judy, administrative assistant. Although your participation is solicited, it is strictly voluntary. Teachers who choose not to participate continue to be eligible for psychological consultations and all school psychological support services. If you choose to participate, please return to Judy Campbell in the Hillview Intermediate Office

If you have any questions or require additional information, please indicate that on the following page or feel free to contact either of us as listed below. We appreciate your time and cooperation and look forward to working with you.

Sincerely,

Brian D. Buchan
School Psychologist/
Doctoral Candidate
Grove City School District
482 East Main Street
Grove City, PA 16127
(724) 458-7570
buchan@grovecity.k12.pa.us

Dr. Gurmal Rattan
Professor
Indiana University of Pennsylvania
Educational and School Psychology
251 Stouffer Hall
Indiana, PA 15705
(724) 357-3787
gurmalra@iup.edu

APPENDIX E INFORMED TEACHER CONSENT FORM

Teacher name_______________________   Grade_______________

Reading Intervention Study - Hemisphere Specific Stimulation

Please check all applicable spaces

__________   Yes, I will participate in this study.

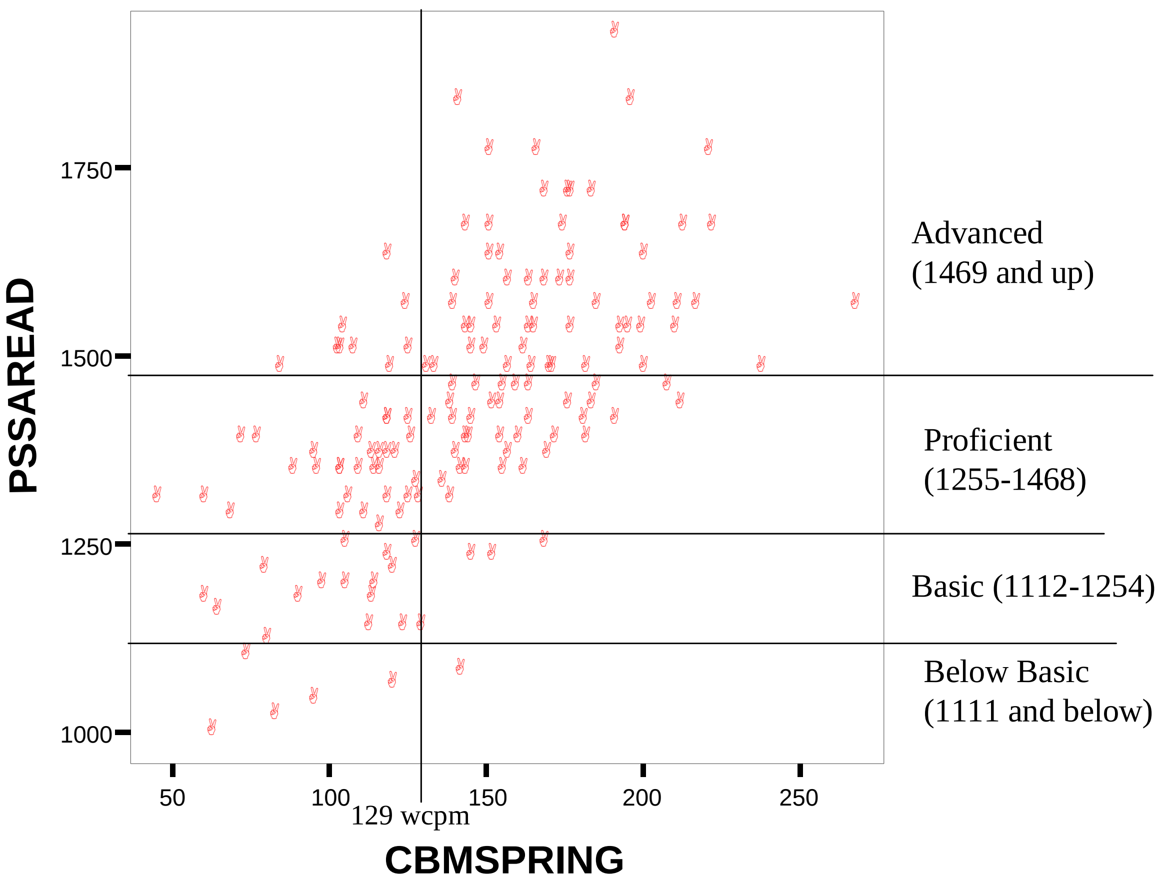
____________   I have questions about this study.

__________________________________   ___________________
Teacher Signature   Date

Please return this to:
Reading Study
Hillview Intermediate Center
482 East Main Street
Grove City, PA 16127
724-458-7570

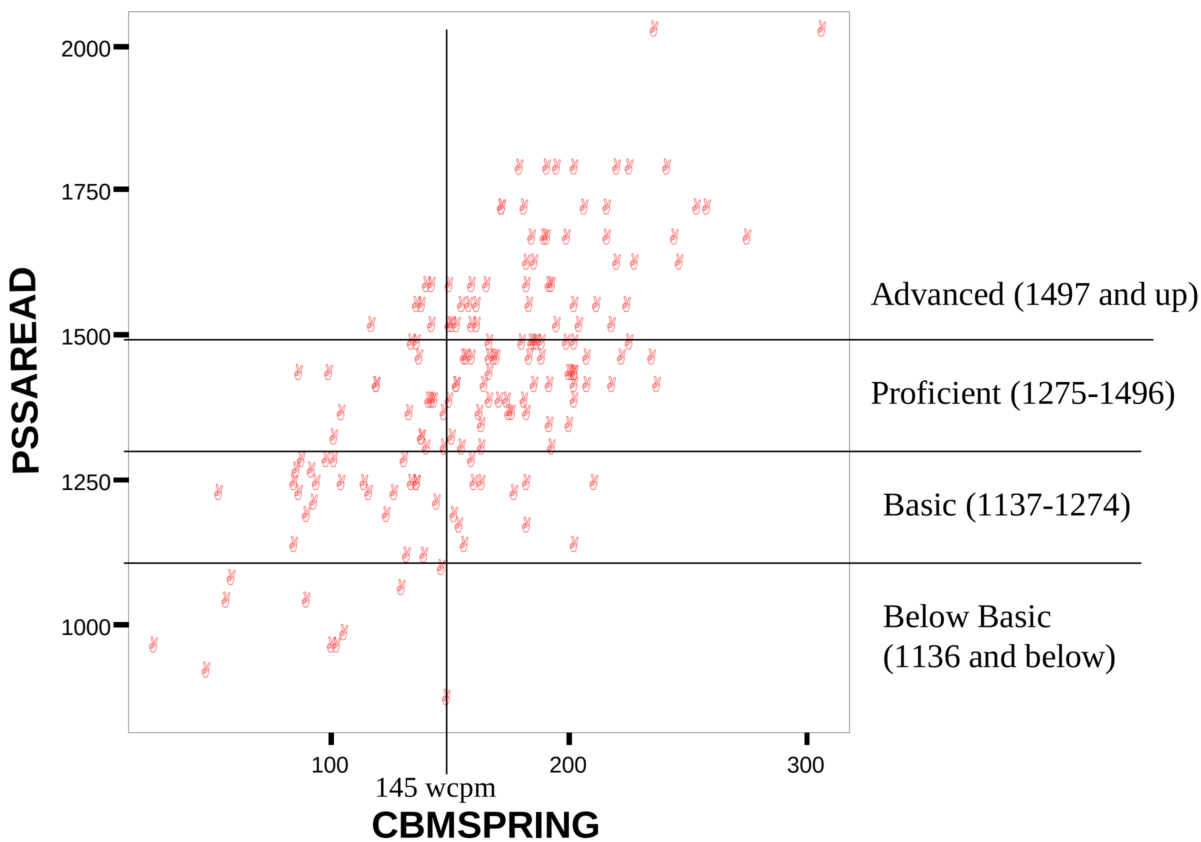
Or the Hillview Intermediate Office

APPENDIX F FOURTH GRADE CORRELATIONS READING FLUENCY/PSSA SCORES



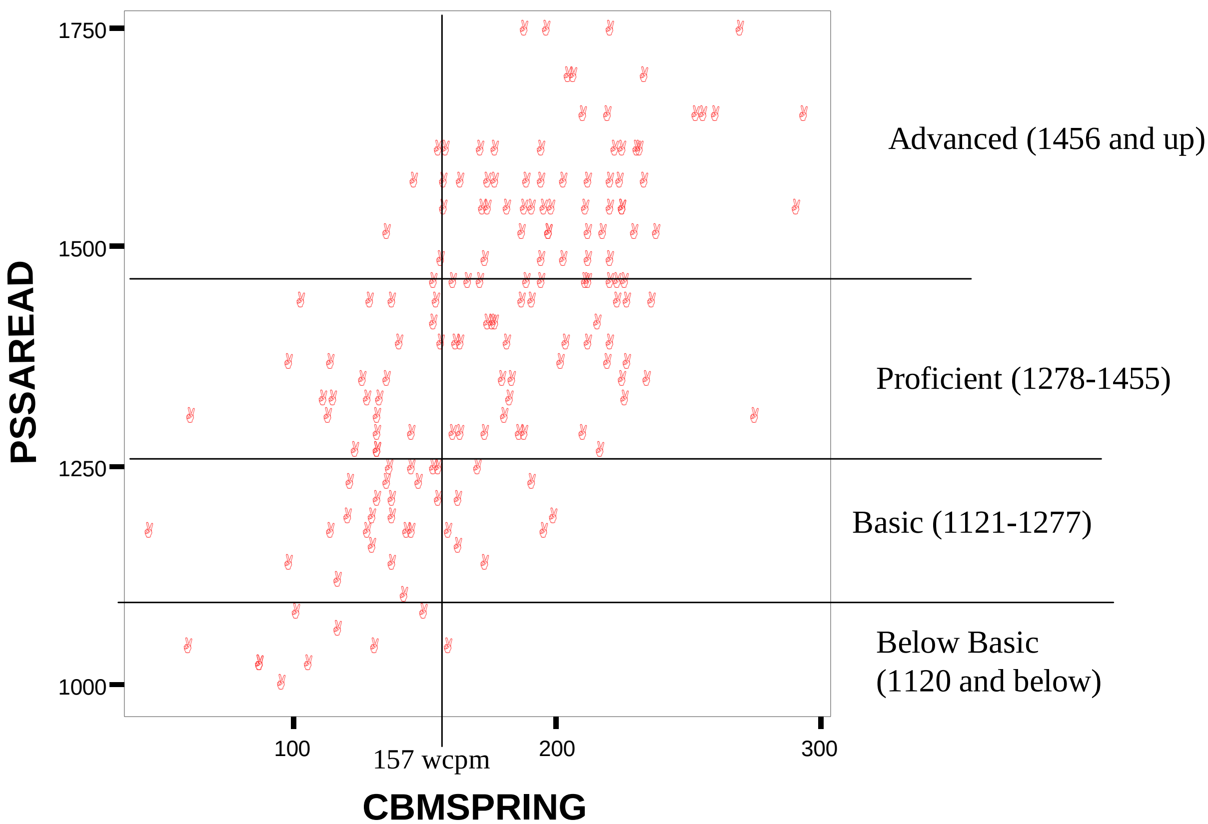
Fourth grade 2007-2008 PSSA and Spring AIMSWeb Reading Fluency Scatterplot

APPENDIX G FIFTH GRADE CORRELATIONS READING FLUENCY/PSSA SCORES



Fifth grade 2007-2008 PSSA and Spring AIMSWeb Reading Fluency Scatterplot

APPENDIX H SIXTH GRADE CORRELATIONS READING FLUENCY/PSSA SCORES



Sixth grade 2007-2008 PSSA and Spring AIMSWeb Reading Fluency Scatterplot

APPENDIX I PICTURE BOOK EXAMPLE ‘AS'

APPENDIX J PICTURE BOOK EXAMPLE ‘OPEN’

APPENDIX K PICTURE BOOK EXAMPLE ‘THANK’

APPENDIX L THIRD GRADE DYSLEXIC CATAGORIZATIONS

ID #	Fall RCBM	<47.38	Fall Accuracy	<87.50%	Disability Subtype
3.1	12	Below	54.50%	Below	M-type
3.2	18	Below	78.30%	Below	M-type
3.3	18	Below	78.30%	Below	M-type
3.4	18	Below	72.00%	Below	M-type
3.5	21	Below	75.00%	Below	M-type
3.6	29	Below	76.30%	Below	M-type
3.7	29	Below	85.30%	Below	M-type
3.8	30	Below	81.10%	Below	M-type
3.9	32	Below	82.10%	Below	M-type
3.10	32	Below	86.50%	Below	M-type
3.11	33	Below	80.50%	Below	M-type
3.12	34	Below	81.00%	Below	M-type

Fall 08-09 Reading CBM and Accuracy Rates and Disability Subtype Classifications for 3rd grade

APPENDIX M FOURTH GRADE DYSLEXIC CATAGORIZATIONS

ID #	Fall RCBM	<67.36	Fall Accuracy	<91.68%	Disability Subtype
4.1	18	Below	64.30%	Below	M-type
4.2	21	Below	72.40%	Below	M-type
4.3	22	Below	88.00%	Below	M-type
4.4	35	Below	85.40%	Below	M-type
4.5	36	Below	85.70%	Below	M-type
4.6	38	Below	82.60%	Below	M-type
4.7	41	Below	89.10%	Below	M-type
4.8	41	Below	89.10%	Below	M-type
4.9	41	Below	85.40%	Below	M-type
4.10	44	Below	84.60%	Below	M-type
4.11	45	Below	95.70%	At	P-type
4.12	46	Below	95.80%	At	P-type

Fall 08-09 Reading CBM and Accuracy Rates and Disability Subtype Classifications for 4^{th} grade

APPENDIX N FIFTH GRADE DYSLEXIC CATAGORIZATIONS

ID #	Fall RCBM	<83.03	Fall Accuracy	<92.55%	Disability Subtype
5.1	19	Below	65.50%	Below	M-type
5.2	40	Below	93.00%	At	P-type
5.3	40	Below	80.00%	Below	M-type
5.4	41	Below	87.20%	Below	M-type
5.5	49	Below	90.70%	Below	M-type
5.6	52	Below	88.10%	Below	M-type
5.7	53	Below	89.80%	Below	M-type
5.8	55	Below	96.50%	At	P-type
5.9	57	Below	95.00%	At	P-type
5.10	58	Below	96.70%	At	P-type
5.11	64	Below	95.50%	At	P-type
5.12	64	Below	97.00%	At	P-type

Fall 08-09 Reading CBM and Accuracy Rates and Disability Subtype Classifications for 5th grade

APPENDIX O SIXTH GRADE DYSLEXIC CATAGORIZATIONS

ID #	Fall RCBM	<105.47	Fall Accuracy	<94.22%	Disability Subtype
6.1	18	Below	75.00%	Below	M-type
6.2	22	Below	68.80%	Below	M-type
6.3	42	Below	85.70%	Below	M-type
6.4	44	Below	91.70%	Below	M-type
6.5	45	Below	97.80%	At	P-type
6.6	49	Below	92.50%	Below	M-type
6.7	72	Below	91.10%	Below	M-type
6.8	80	Below	96.40%	At	P-type
6.9	81	Below	97.60%	At	P-type
6.10	85	Below	93.40%	Below	M-type
6.11	85	Below	98.80%	At	P-type
6.12	86	Below	97.70%	At	P-type

Fall 08-09 Reading CBM and Accuracy Rates and Disability Subtype Classifications for 6th grade