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A Comparison of Computer-Based and Multisensory Interventions on At-Risk Students' Reading Performance

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A COMPARISON OF COMPUTER-BASED AND MULTISENSORY INTERVENTIONS ON AT-RISK STUDENTS' READING PERFORMANCE

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Title: A Comparison of Computer-Based and Multisensory Interventions on At-Risk Students' Reading Performance

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Over thirty years of extant literature exists regarding reading instruction, yet consensus in the field continues to diverge in the area of reading intervention. Despite the establishment of research-based programs in all five areas of reading (phonemic awareness, alphabetic principle, fluency, vocabulary, and comprehension), educators continue to implement interventions that do not have an established research base. This study sought to examine the effectiveness of two different reading interventions within a school district. Groups of students who received the Fast ForWord computerized reading intervention, published by Scientific Learning, were compared to other students who received an Orton-Gillingham-based intervention, the Sonday program. A third group of students who received both interventions were also included in the study. Students who did not receive any intervention were utilized as a control group. The interventions were implemented over one school year. Post-test scores were adjusted for pre-test differences using analysis of covariance statistical procedures. Results indicated that no differences existed between groups in the areas of basic reading skills and oral reading fluency, but modest post-intervention differences were found in the areas of word reading, pseudoword decoding, and reading comprehension skills, with the Sonday group demonstrating slightly higher reading comprehension skills than the Fast ForWord group,

and the Fast ForWord group demonstrating slightly higher means in word reading and pseudoword decoding than the other three groups. Participation in both the Fast ForWord and Sonday interventions did not result in higher post-intervention adjusted means. Control participants had the highest post-test adjusted means.

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CHAPTER ONE

INTRODUCTION

Background

Public schools in the United States are currently facing a daunting task: proficiency in reading must be reached by all students by the year 2014. This requirement was put into motion years ago by No Child Left Behind (Fritzberg, 2004), which indicates that schools are accountable for demonstrating that Adequate Yearly Progress (AYP) is being made by all students. All students include subgroups of struggling, as well as disabled readers, and proficiency must be demonstrated in several academic areas, including reading. While instructional and curricular accommodations and modifications may assist schools in "leveling the playing field" for such students, teachers and instructional leaders are in a position to address students' learning needs and attempt to remediate students' reading difficulties to not only ensure the global success of school buildings and districts, but also produce proficient readers.

History and Legislation

In 1965, the Elementary and Secondary Education Act (ESEA) (Fritzberg, 2004) was passed in order to establish more equality in education (Fritzberg, 2004). The Act contained a section titled "Chapter One" at the time (hereafter referred to as "Title One"), which was designed to support remedial programs for children designated as educationally disadvantaged. Fritzberg clarifies disadvantaged students as those below the poverty line or with neither parent possessing a high school diploma (Fritzberg, 2004). At the time, only students who met this designation were eligible for what eventually became known as Title One services. In 1988, the ESEA was reauthorized,

and important changes included the requirement for states to establish benchmarks for schools that were serving Title One students, as well as allowing schools that contain at least 75% impoverished students to be designated as a "Title One school" and implement school-wide remedial reading initiatives. An additional reauthorization in 1994 lowered that percentage from 75% to 50%, and the term Adequate Yearly Progress (AYP) was introduced. States were left to choose how to meet AYP, as well as define their own timelines for when they would be successful in meeting AYP for their students. Only 17 states attempted to implement the AYP process at that time as most states requested and obtained waivers to receive their federal funding. Of the 17 that attempted to reach AYP, they chose to do so by designating a statewide figure, showing improvement as compared to previous performance, or by reducing a gap in achievement between various groups (Fritzberg, 2004).

The ESEA was reauthorized for the third time in January of 2002, and it became known as the "No Child Left Behind" (NCLB) Act (Fritzberg, 2004). While previous versions of the ESEA focused on funding for schools to help disadvantaged students, the major theme of NCLB is standards-based reform and accountability. The act requires that all students demonstrate proficiency, as measured by state tests, in the areas of reading/language arts, mathematics, and science by the year 2014, which is quickly approaching. Within the group of "all students" there are multiple subgroups, which despite their various disadvantages, must also demonstrate proficiency on state measures. The subgroups include minority races and ethnicities, children living in poverty, English Language Learners, and students with disabilities, all of whom, as a group, achieve below their Caucasian, economically advantaged, English-speaking, typical peers (Haskins,

2004; Roach, 2004; Miranda, Webb, Brigman, & Peluso, 2007). If one of the subgroups within a school does not meet AYP standards, then the entire school also does not meet AYP. This is indeed the most challenging aspect of the act (Fritzberg, 2004). Abrams and Madaus (2003) projected that 65% to 85% of schools will fail to make 100% proficiency by 2014. Despite this dismal outlook on academic proficiency of students in America, schools must still attempt to reach these goals as required by the act. The consequences of not meeting AYP may include student and family choice to attend other public schools, thus funneling money away from the home district; districts funding supplemental tutoring services for students in schools that do not make AYP; large, required systemic changes, such as the implementation of a new curriculum, hiring of new staff, or changes in administrative leadership; conversion of public schools to charter schools; and seizure of the schools and district by the state educational agency (Fritzberg, 2004).

The Importance of Reading Skills

Due to the federal mandate, schools have been receiving increasing pressure from their districts, which in turn receive pressure from state organizations, to increase the performance of students on state tests and the number of students who are proficient on state tests (Fritzberg, 2004). Despite the possibility that overemphasis on high-stakes testing places a narrow focus on instruction, reduces teacher autonomy, and decreases instructional time, many schools are still concerned with the true purpose of education—student learning and the graduation of productive members of society (Fritzberg, 2004; Chapman, 2007). Included in the litany of evidence regarding reading research is the notion of how essential reading is for successful life outcomes. As outlined by the

American Federation of Teachers in 1999, today's world is a literate one, and success in academics, employment, and individual self-sufficiency is contingent on reading proficiently. Since reading is a process that facilitates the acquisition of knowledge and thus, learning, reading proficiently is a vital issue in education not only to meet federal accountability measures, but also to enhance life functioning of all American individuals. In her recent study, Music (2012) states that of all juveniles who come into contact with the juvenile justice system, 85% are functionally illiterate. In her study, she cited the Department of Justice, which indicated that the "link between academic failure and delinquency, violence, and crime is welded to reading failure" (p. 723). If inmates receive literacy instruction while incarcerated, they have only a 16% chance of returning to prison, as opposed to a 70% chance if they receive no literacy instruction (Music, 2012). Therefore, it can be concluded that the impact of non-proficient readers on society is immense. Additionally, approximately 25% of adults lack the basic literacy skills required in a typical job (American Federation of Teachers, 1999).

Aside from the negative outcomes of illiteracy, research has indicated that higher rates of employment and monetary rewards in the labor market are positive outcomes of education and literacy (Mok, 1996; Tannock, 2001). Currie and Thomas (2001) completed a study which established a correlation between children's performance on a reading test at age seven with their earnings and likelihood of employment at age 33. Therefore, proficient reading skills should be possessed by all members of the population who are capable of doing so; all persons should be able to read unless the person has a cognitive barrier, such as an intellectual disability, a visual barrier, such as blindness, or any other insurmountable barrier that prevents the person from learning to read. In order

to reach the goal of an entire population of proficient readers, it is important to lay the foundation of effective and appropriate instruction.

Reading Instruction

Negative aspects of schools' focus on accountability include a narrow focus on and a decrease in time of instruction, as well as a reduction in teacher autonomy. In spite of these negativities associated with accountability and high-stakes testing, the origin of these acts and mandates can be viewed as an attempt to address and remediate the issues that exist in the country's current system of education (Madaus & Russell, 2010), and the central belief that schools could be doing a better job at instruction and remediation. In response to these concerns, in 1998 the United States Congress commissioned the Child Health and Human Development section of the National Institutes of Health (NICHD), in conjunction with the United States Secretary of Education, to assemble a panel charged with exploring differing approaches to reading instruction (National Reading Panel, 2001). For two years, the panel reviewed the available research on reading instruction and held meetings across the country. The panel submitted a summary of their findings to the United States Senate on April 13, 2000, which included their findings on the various methodologies of essential components of reading instruction (phonemic awareness, phonics, vocabulary, fluency, and comprehension), as well as other topics, such as teacher preparation and education, independent silent reading, and computerized reading instruction (National Institute of Child Health and Human Development, 2000). The National Reading Panel report afforded the opportunity for all educators and educational agencies to learn about and implement essential components of reading

instruction by providing a summary of appropriate reading instruction, thereby removing the "guesswork" associated with what exactly constitutes effective reading instruction.

Reading Intervention

Foorman (2007) states that the five essential components of reading instruction are also the same essential components to reading intervention, with the differentiation that in reading intervention, the components must be taught with more intensity and explicitness. These efforts may be necessary at intensive levels on a daily basis for a sustained period of time (Woodward & Talbert-Johnson, 2009). A tiered approach that includes increasing levels of intensity of instruction and intervention is an appropriate fit for addressing the needs of the approximately 20% of students who struggle with learning to read. Within such a model, all students are provided core instruction through research-based instructional practices and curricula, and those who do not respond to the initial instruction are provided more intensive instruction and intervention (Carney & Stiefel, 2008). Research has demonstrated that students who receive the additional intervention can greatly benefit from it, and achieve significantly improved reading outcomes (Askew et al., 2002). A response to intervention model is also effective in providing intervention to the most as-risk students who do not respond to core or supplemental instruction (Taylor, Ding, Felt, & Zhang, 2011).

Because of the large percentage of students who struggle with reading, coupled with the pressure for 100% proficient readers from legislation, districts and schools are left to independently select programs that will assist their students. Although much research currently exists on different reading interventions, districts must weigh many factors when making a selection. These factors may include student need, financial

considerations and commitments, personnel availability, proposed fidelity of implementation, and differing opinions of stakeholders. Therefore, districts may face great difficulty when attempting to make an appropriate selection that will best meet their students' needs in the most efficient manner. Resources such as the What Works Clearinghouse and the Florida Center for Reading Research database may serve as a starting point for districts (Edyburn, 2008; Torres, Farley, & Cook, 2012). In addition to systematic and explicit instruction, as well as addressing all five essential components of reading, other areas of effective intervening include the following: small groups of three to six students who possess similar needs, intervention five days a week for at least 30 minutes per day, error correction procedures, and multiple opportunities for students to ask questions (Woodward & Talbert-Johnson, 2009). Additionally, Woodward and Talbert-Johnson (2009) cite the need for data-based decision-making regarding further instruction and intervention for struggling readers. These factors are an added consideration that should be made when choosing appropriate interventions. Often, school personnel must rely on research completed by the developers of programs because it is the only available information. However, these publishers have a vested interest in the program, and they often promote and advertise the program, rather than attempting to gather independently verified empirical evidence (Rouse & Krueger, 2004).

In summary, while there is much research in existence regarding what components make a quality intervention, schools continue to enigmatically select reading interventions for their students. In some districts, an administrator, such as a curriculum director or a federal programs coordinator, may chose the intervention based on a variety of factors, as mentioned previously. A balance of these factors may be a challenge to

those selecting interventions. While districts may wish to address all five areas of reading with one intervention and thus, meet a variety of needs within the student population, not all interventions may fulfill this desire. Many districts also face budget issues and are limited to interventions that are less costly in initial and continued implementation. Instructional fidelity may also be a factor, in that schools may need to select interventions for which they have the personnel to implement. Torgeson, Wagner, Rashotte, Herron, and Lindamood (2010) also cite inadequate teacher training as a variable in choosing various interventions. Although a school system may have the interventions and staff, these staff may not be trained adequately or at all in the interventions. Even though many educators are knowledgeable about interventions, that knowledge is not often applied effectively in school systems (Torgeson, Wagner, Rashotte, Herron, & Lindamood, 2010).

In addition to the above issues in selection of reading interventions, an additional issue is the wealth of reading interventions available for selection. A brief review of the peer-reviewed literature indicates that there are no current studies citing the popularity of specific interventions. Some specific interventions appear more frequently in the literature than others, and include Voyager Passport, Waterford, Corrective Reading, Reading Recovery, Read Naturally, Great Leaps, Open Court, Language for Learning, and Soar to Success. The lack of popularity data may be due to districts using interventions that are specific to the needs of children, and not using one intervention for all students who are struggling with reading. However, some districts may choose to use an intervention that is more "one size fits all" in order to address the needs of a wide variety of reading issues. While one intervention may address a particular area of

reading, another may address several or all five areas of reading. Different interventions may also be presented to students in different ways. Many interventions are teacher-directed, some may also be delivered through technology, such as through a computerized intervention. The school district included in the present study utilizes interventions from two methodologies: Orton-Gillingham and computerized interventions.

Methodologies of reading intervention. Some reading interventions are based on the multi-sensory approach that has been termed the Orton-Gillingham approach. Orton-Gillingham interventions include Alphabetic Phonics, Wilson Reading, Language Basics: Elementary, the Dyslexia Training Program, the Sonday System, and the actual Orton-Gillingham intervention itself (Ritchey & Goeke, 2006; Gillingham & Stillman, 1997).

The Orton-Gillingham methodology of intervention first began in the early 1900s with Dr. Samuel Orton's theories on reading disabilities and their neural origins. Although his original theories about the neurological underpinnings of reading disabilities have been improved and specified, his theories on instructing struggling readers were developed into the Orton-Gillingham methodology of intervention (Ritchey & Goeke, 2006). The intervention was first structured into a curriculum by Anna Gillingham and Bessie Stillman in 1960 in the book, "The Gillingham Manual: Remedial Training for Students with Specific Disability in Reading, Spelling, and Penmanship", which is currently in its eighth addition (Gillingham & Stillman, 1997).

The multisensory approach embedded in the Orton-Gillingham intervention includes remediation of the "Language Triangle" of visual, auditory, and tactile

neurological learning pathways (Ritchey & Goeke, 2006). The explicit instruction included in the program systematically and cumulatively teaches rules related to phonology, phonological awareness, sound-symbol correspondence, syllables, morphology, syntax, and semantics. Students are required to master and overlearn each component before advancing to the next level. The program also provides ongoing assessment for mastery (Ritchey & Goeke, 2006).

The Orton-Gillingham methodology of intervention is relevant to the current study because an intervention that is based in the methodology, the Sonday program, has been implemented for over seven years in the district included in the study. Teacher training was conducted specific to the Sonday program, which is based on Orton-Gillingham theory and methodology. Ongoing training for new staff is completed using teacher trainers from within the district. The lessons within the Sonday program are highly scripted and structured, with systematic presentation based on the needs of the student or small group of students. Included in the literature review for the current study is information on the absence of research specific to the actual Sonday program, though research regarding the methodology behind the Sonday program does exist.

The Sonday program is based in the Orton-Gillingham methodology of multi-sensory learning, and includes practice and drill in the underpinnings of learning to reading, including phonics, phonemic awareness, and fluency. Vocabulary and comprehension practice are included in each lesson. Thirty-six levels are contained within the Sonday System 1 intervention. Every third reading level concludes with a mastery check to gauge students' learning and guide the pace of instruction (Winsor Learning, 2008).

Some districts have chosen to integrate technology into their methods of intervening by choosing computerized interventions for students in need of additional support. Torgeson et al. (2010) indicated that such interventions have the capability of providing highly specialized instruction and practice, and that such computer technology can and is being used as part of many districts' solutions for at-risk students. Nicolson, Fawcett, and Nicolson (2000) also support the use of computer-aided learning programs as efficient and cost-effective. There can be a relatively low-cost commitment for some computerized interventions in the long-term, and they can be implemented with fidelity when monitored correctly (Torgeson et al, 2010). Nicolson et al. (2000) list specific advantages of computerized interventions when working with children with reading problems. They include immediate feedback, self-paced learning, non-judgmental performance, and predictability. Additionally, computerized interventions can provide "over-learning" opportunities for children, can be a new source of motivation, and can be fun (Nicolson et al., 2000).

An example of a computerized intervention is the one included in this study, the Fast ForWord products published by Scientific Learning Corporation. The products are advertised to not only improve participants' reading skills, but also provide "brain fitness" in order to improve the cognitive processes associated with reading, including memory, attention, processing, and sequencing. The possible advantage to using the software—that it improves these aspects of a student's skills and that the technology can be used to intervene with large groups of children in an efficient way—is ideal for school districts. However, there is a lack of independent research on the actual software that

districts purchase that demonstrates great gains in students' reading skills. The current study seeks to research this.

Statement of the Problem

The school district included in this study is currently implementing two different interventions across the three existing elementary buildings, the Fast ForWord and Sonday interventions. Issues surrounding the implementation of these interventions include a lack of reason and support for choosing each of the interventions, as well as a lack of opportunity to determine the effectiveness of each intervention for elementary readers.

Students participating in each intervention are selected by reading specialists within the district. Students receiving the Sonday intervention span kindergarten through fifth grade, and students assigned to the Fast ForWord program may be in grades one through six. The students participating in the present study are in grades one through three. The lowest readers, as determined by beginning of the year Dynamic Indicators of Basic Early Literacy Skills (DIBELS) scores, are assigned to each intervention based on their lower scores. Students who do not receive intervention also have at least one DIBELS score below the benchmark. Although students are not randomly assigned to intervention groups, the methodology for selecting which students receive which intervention is left to the discretion of the reading specialists, who choose the students and groups differently across buildings. Therefore, the assignment is somewhat unsystematic, but cannot be defined as random assignment. Also, students in different grades begin the interventions on different levels according to their skill strengths and needs, which are determined by the Reading Progress Indicator (RPI) score for Fast

ForWord, and the reading specialist's discretion for the Sonday program. Most students in grades one and two begin in the Fast ForWord language products, and most students in grade three begin in the Fast ForWord reading products, unless they are lacking foundational skills and need to start with a more basic product. The levels within the Fast ForWord reading products do not correspond to grade levels.

In order to determine the effectiveness of district-selected interventions for struggling readers, the present research sought to examine the two interventions and the student growth and progress in reading associated with each one. In order to accomplish this, the implementation of two different reading interventions within the school district was examined. Students who received the Fast ForWord (Scientific Learning Corporation, 2009) computerized reading intervention, published by Scientific Learning, were compared to other students who received an Orton-Gillingham-based intervention, the Sonday program (Winsor Learning, 2008). Students who received both interventions were a third group in the study. A fourth group of students who did not receive any intervention were utilized as a control group. All students included in the study were struggling readers.

The interventions were implemented across the fifth to the 35th week of the 2012-2013 school year, for a total of 30 weeks. This period of time exceeds the protocol recommended by the publishers of Fast ForWord, which specifies a formula for the minimum number of weeks, depending on how long each day the students participate in the program, that students must take part in order to achieve desired results. For the 30 minutes a day, five days a week that district students participated in the program, they were required to participate for a minimum of 12 to 16 weeks. If students would have

participated for more time each day, the number of required weeks would have been less (e.g., 90 minutes a day requires four to seven weeks of participation) (Scientific Learning Corporation, 2009). The Fast ForWord intervention group participated in the intervention five days a week as a requirement from the publishers as well. The interventions were implemented for each group by reading specialists within the district, who implemented and monitored student progress throughout the intervention. Students participated individually in the Fast ForWord intervention, with each student at one computer, and each student wearing headphones. Reading specialists could also "plug in" to each student's computer to monitor their performance. For the Sonday intervention, students were instructed by reading specialists in small groups of two to six students per group.

At the conclusion of the intervention period, an individualized, standardized assessment of each student's reading skills was administered by the primary investigator of the study. Additional data, including pre- and post-intervention DIBELS scores, was also analyzed in order to assess student growth in reading skills.

The dependent variable in the study is students' reading achievement. This was selected as the dependent variable because of the focus on reading achievement through No Child Left Behind and the need for 100% proficiency by the year 2014. It was also chosen as the dependent variable because Scientific Learning Corporation, the publishers of the Fast ForWord program, claim that appropriate participation in the program leads to increased reading skills. Also, reading skills are the focus of improvement for the Sonday program. Reading skills were measured through the Initial Sound Fluency, Phoneme Segmentation Fluency, Nonsense Word Fluency, and Oral Reading Fluency

measures of DIBELS, depending on the grade level of the student. The Early Reading Skills, Word Reading, Pseudoword Decoding, Oral Reading Fluency, and Reading Comprehension subtests of the Wechsler Individual Achievement Test, Third Edition (WIAT-III) were also administered individually to each student as a post-assessment. The study also sought to examine the relationships and associations between and among student variables such as sex and grade level to ascertain their impact, if any, on student performance.

Research Questions and Hypotheses

Research questions and hypotheses include:

1. Are there significant differences in instructional impact among the intervention groups? These groups include the following:
    a. Fast ForWord only
    b. Sonday only
    c. Fast ForWord and Sonday
    d. Control

The hypothesis related to this research question is that all students will make the same amount of progress in reading, regardless of the intervention in which they participate. As indicated in the literature review, this hypothesis is based on the lack of research directly assessing reading skills for students who have participated in Fast ForWord and Orton-Gillingham-based interventions. Multiple studies for each intervention cite control groups making the same gains as treatment groups (Olson, 2011; Goeke & Ritchey, 2006; Loeb, Gillam, Hoffman, Brandel, & Marquis, 2009).

2. Do females or males perform better on the post-test after intervention?

Based on a review of the literature, sex differences will include higher post-assessment scores in reading favoring females over males (Singh, 2008; Logan & Johnson, 2009).

3. Did the interventions bring students to benchmark?

The hypothesis is that subsequent to intervention participation, each group will have similar percentages of students below, at, and above proficiency (Olson, 2011; Ritchey & Goeke, 2006; Loeb et al., 2009).

These research questions were selected in order to determine how the selection of these particular interventions impacted the struggling readers within the district. The research also seeks to determine, assuming an increase in skills is shown, if the students participating would have made this increase even without the intervention due to their regular school instruction or maturation, by comparing the intervention groups to a control group.

Problem Significance

The research questions proposed for this study are relevant to education in general because many districts continuously face the challenge of selection of reading interventions, while giving due consideration to the many factors influencing that decision, such as those mentioned previously. Additional literature concerning the effectiveness of interventions would further assist educators in making these selections. One important consideration when selecting an intervention includes matching the intervention to student need. Districts must carefully consider the plethora of choices available and select one or several interventions, which will address the needs of the students, who will receive the intervention.

This study will help to determine if choosing the interventions in the study would benefit other struggling readers with a variety of reading issues. Unfortunately, the research on the use of Fast ForWord as a reading intervention is lacking, and this study seeks to add to the literature on both Fast ForWord and Sonday by examining their direct impact on students' reading skills. As noted in the literature, there are many scholarly articles denouncing the original research on Fast ForWord, which did not study its direct impact on reading; the current study seeks to accomplish this latter task. Fast ForWord is becoming increasingly popular as an intervention, and there are few studies completed by anyone other than the publisher that provide empirical evidence of the program's effectiveness. Also, the studies appear to focus mostly on students with speech/language impairments rather than reading disabilities. This study hopes to add to the current literature regarding the program's effect on reading achievement.

This problem is of specific significance for school psychologists because they are frequently called upon for instructional consultation when working in school districts, and are often utilized to conduct data analysis and interpret the results. If the field of school psychology has more information about the interventions in this study, school psychologists could speak to their effectiveness when consulting with districts.

This topic is of particular importance to the district implementing the interventions because the school district has invested a significant amount of financial and personnel resources into implementing the Fast ForWord program. No plans to study the effects of the program have been made by district personnel; any progress or plans to investigate the program's effectiveness are anecdotal and subjective in nature, with little effort made to explore effects on reading and confounding variables. Also, the personnel

implementing the intervention have used the program's Reading Progress Indicator, as well as the product and exercise completion percentages as a way to appraise how each student is progressing, when little is known about what exactly these pieces of data indicate and whether they measure actual student progress in reading. The percentages are generated overall for each program and for each exercise and are said to indicate how far along the students are in a particular exercise, indicating that they have learned the skill or skills the exercise is meant to address. Teachers can use these figures to see how quickly students are progressing within each exercise and if the student has any "red flags", which are automatically generated by the program in order to alert the teacher if the student is making little progress. Red flags are also generated when students appear to be randomly responding in the exercises.

In comparison to other studies examining reading interventions, this study strives to provide information to the current literature base regarding the practical implementation of two interventions within a school setting. A fault of previous studies includes an absence of a control group, which the current study includes. Also, many of the previous studies implemented the Fast ForWord intervention in a laboratory setting, or in accordance with a protocol that included a lengthy daily intervention period that is not practical to implement during the school year within a school setting. The present study is also being conducted by a primary investigator who is not involved in the publishing of either intervention program, while previous studies which claimed the effectiveness of the programs had the appearance of partiality due to author involvement in the research.

Definitions of Terms

For the purposes of this study, struggling readers are defined as elementary students who are below the benchmark on at least one Dynamic Indicators of Basic Early Literacy Skills (DIBELS) subtest (Good, Gruba, & Kaminski, 2001). Struggling readers in this study also receive Title One or tutorial reading services within the district, and the services consist of participation in either the Fast ForWord or Sonday intervention.

Meaningful progress in reading is defined as reaching the benchmark on all measures of the DIBELS, as well as achieving average range reading skills on the post-test reading achievement measure (standard scores of 85 or above).

In this study, all speech and language impairments are referred to under the Pennsylvania Chapter 14 educational disability term, Speech or Language Impairment. Based on Part 300 of the Individual with Disabilities Education Act (IDEA) and Pennsylvania's Chapter 14 special education regulations, the educational disability of Speech or Language Impairment is "a communication disorder such as stuttering, impaired articulation, a language impairment, or a voice impairment, that adversely affects a child's educational performance" (Fry Communications, 2012). Within the district of study, students may receive speech and/or language services through an Individualized Education Plan (IEP), or through a tiered methodology of service delivery within a Response to Intervention model. Response to Intervention speech/language services may include small group instruction in the areas of articulation, vocabulary, and pragmatic language.

The Fast ForWord program, as referred to in the current study, includes the Fast ForWord Language intervention, which includes the Language v2 and Language to

Reading v2. The Fast ForWord reading products include Reading Readiness, Reading levels one through five, and Reading Assistant. It does not refer to the Fast ForWord products of Literacy or Literacy Advanced, as these products are designed for students in middle and high school and are not utilized on the elementary level (Scientific Learning Corporation, 2009). Relevant terms utilized by the publishers of the program include the Reading Progress Indicators (RPI), the Progress Tracker system, and the weekly completion, attendance, and participation (CAPS) information. The RPI score is meant to assess a student's progress through each product, as well as provide pre- and post-intervention assessments. The Progress Tracker system is online software that houses all student data, allowing administrators of the program to view student participation and progress within the products. The Progress Tracker system includes the weekly CAPS scores for each student.

Within the scope of this study, the Sonday intervention refers to the Orton-Gillingham-based intervention developed by Arlene Sonday.

Assumptions

Several assumptions were made for this study, including fidelity of implementation of the Fast ForWord and Sonday intervention programs. Although strict procedures for monitoring fidelity were not in place during the study, such as random observations of staff and continuous monitoring of staff during every day of the interventions, fidelity is assumed because the Fast ForWord intervention has computerized fidelity monitoring, Progress Tracker, which is internet-based through the publisher to ensure that students are fully participating five days a week. Personnel from Scientific Learning Corporation track student participation and contact districts if there

appears to be a lapse in individual student participation. It is also assumed that the Sonday intervention is implemented with fidelity because the reading specialists implementing the intervention are committed to their students, meet monthly with school personnel to discuss progress, and are supervised by the building principal. All staff implementing the interventions have received extensive and adequate training in the interventions implemented. Although fidelity of implementation is an assumption, the principal investigator checks fidelity for both interventions by examining the Fast ForWord Progress Tracker, and by doing fidelity checks and consulting with principals on the fidelity of implementation for the Sonday program. No cross-intervention will occur because the two interventions are separate and distinct programs with different presentations—the Fast ForWord program is provided mostly by a computer and the Sonday program is provided by a reading specialist. An additional assumption is that students receive no other reading instruction other than general classroom instruction, which may be provided through whole- or small-group instruction.

Limitations

Threats to internal validity within this study are that students were not randomly assigned to intervention groups, and thus the study was non-experimental in nature. The sample is one of convenience because students are given the intervention due to their difficulties with reading, not random assignment. Also, the control group contains a smaller number of students than the intervention groups. Finally, control over intervention implementation is lacking; there are fidelity data, but strict procedures, such as random observations of staff and continuous monitoring, were not in place.

A threat to external validity is the lack of diversity of the sample, which is approximately 98% Caucasian. Due to the demographics of the district, the results of the study can only be generalized to districts with similar populations. Generalizations also can be made only to populations within a similar region of the country (the northeastern United States), for school districts with approximately the same number of students (about 3000), and to populations with a similar socioeconomic status.

Summary

The importance of reading skills cannot be underestimated. The impact of illiteracy on society has been demonstrated, and the federal requirement for 100% proficient readers is looming within the next year. The pressure on educators to address the needs of all readers is immense, complicated, and difficult because addressing the needs of the majority is no longer sufficient. Even students who struggle greatly to read must have their needs addressed. Laying the foundation with sound, comprehensive reading instruction must then be supplemented with additional intervention based on the needs of individual students. Some school systems may choose to utilize technology as an efficient means to provide intervention to students. School personnel must not only weigh factors such as finance, personnel, and student need when choosing interventions, but must also consider what will actually work to remediate any difficulties students may be experiencing. As highlighted in Chapter One, and as will be detailed in Chapter Two, even if interventions are in usage by other schools, and appear to be supported by some research, they may not hold true empirical evidence backing their effectiveness.

CHAPTER TWO

REVIEW OF THE RELATED LITERATURE

Introduction

The importance of utilizing research-based reading interventions is a prime task for school districts wishing to produce proficient, lifelong readers, while concurrently meeting federal requirements for population-wide proficiency. However, the term "research-based" is conventionally used by many publishers in the market because they have discerned that districts are seeking curricula and interventions regarded as such. When further investigation is pursued, it can be exposed that the research was not valid, was completed by those with a vested interest in the program, or was assumptive in nature. The subsequent literature review seeks to highlight the current body of research on reading in general, sex differences in reading, the core reading series implemented within the district included in the study, computer-based instruction and intervention, the Fast ForWord program, the Sonday intervention program, and outcome measures for the current study. After the review, a need for additional study on the Fast ForWord program that is directly linked to reading skills shall be demonstrated.

The National Reading Panel Report: Implications for Instruction and Intervention

Since one of the "fundamental responsibilities" of schools is to teach all children to read (American Federation of Teachers, 1999), educators should be well informed about the findings of the National Reading Panel and utilize the information for instructional decision-making. As outlined by the National Reading Panel report in 2000, there exists 30 years of research on how children learn to read and also what constitutes effective instruction. Effective reading instruction must contain the five most critical

components of reading instruction, which are all necessary and inextricably linked in order for proficient reading to occur (National Reading Panel, 2000). The five critical components are phonemic awareness, phonics, vocabulary, fluency, and comprehension (National Reading Panel, 2000; Spencer, Garcia-Simpson, Carter, & Boon, 2008). These five elements are also cited and supported by the National Institute of Child Health and Human Development and the National Research Council (Foorman, 2007) as the essential components of reading, and thus need to be a part of reading instruction.

The National Reading Panel report included a summary of multiple experimental studies in each of the five areas of reading, reviewing a total of 418 studies, of which almost half primarily examined reading comprehension (Shanahan, 2003). Studies including students up to 12th grade were included in the examination. Qualitative research and research on second-language literacy were not included in the review. The panel also did not review certain topics with which had also been extensively appraised elsewhere, or if there was insufficient evidence on a particular topic. Although some of the studies reviewed did include subjects with reading disabilities, the panel's primary focus was on instruction of reading, not reading disability (Shanahan, 2003). The panel also had concerns with looking at reading disability due to the broad methodologies of identifying reading disability. The findings summarized in the report included a wealth of information on the best teaching methodologies, techniques, and areas for reading instruction, but also emphasized that the most important component of reading instruction is the teacher's explicit and systematic teaching of reading to students (Shanahan, 2003).

In the area of phonemic awareness instruction, the panel concluded that systematic and explicit instruction in the manipulation of phonemes is a highly effective

method of improving a student's reading skills, and that the impact of this type of instruction lasts well beyond the instruction (NICHD, 2000). They also found that phonemic awareness training helped to improve the spelling skills of both struggling and typical readers. The element of providing the instruction in a small group is key, although the panel did not recommend a specific methodology, concluding that there are multiple ways to teach the skill effectively (NICHD, 2000).

Instruction in phonics, also known as letter-sound correspondence, is also helpful in improving students' spelling skills, although in the studies, more improvement was found for good readers than in poor readers' spelling skills after phonics instruction. The panel concluded that teaching of synthetic phonics (first teaching the sounds, then teaching the blending of the sounds) is most helpful for readers who are disabled or of low socioeconomic status. The panel cautioned that phonics instruction is not sufficient, however, for improving reading; once the letter-sound correspondence is taught, the instruction must also include applying the skills accurately and fluently by putting the sounds together (NICHD, 2000).

The National Reading Panel found that reading fluency is the area most neglected in classroom instruction. The panel found that fluency can be most significantly impacted using guided oral reading procedures, and that the guidance can be provided by a teacher, parent, or peer. Fluency instruction also has a positive impact on all readers, good and poor, and that appropriate fluency instruction not only impacts the reader's fluency, but also word recognition and comprehension skills (NICHD, 2000).

The panel's synthesis on studies examining vocabulary instruction indicated that training in this area leads to gains in comprehension. The integration of incidental

vocabulary learning, pre-teaching vocabulary words, repeated exposure to the vocabulary, and multiple methodologies of teaching the vocabulary were all essential components of vocabulary instruction. The panel also recommended that the age and ability level of the reader must be taken into account as well (NICHD, 2000).

Comprehension of reading was defined by the panel as a complex, cognitive process that requires the purposeful and thoughtful interaction of the reader with the text. A key variable to comprehension is the preparation of the teacher in instruction on comprehension. There was a lack of research noted in how to teach teachers to teach comprehension, although the panel did find that a combination of comprehension techniques was the most effective (NICHD, 2000).

Despite now knowing what needs to be included in reading instruction, educators continue to face challenges in actually implementing effective reading instruction. Within each classroom, a wide spectrum of reading levels may exist, and teachers are expected to address the reading strengths and needs of each student, while also including the five essential components within their instruction (Spencer et al., 2008). Student needs differ greatly within large classrooms of students, and teachers have a difficult task of addressing the strengths and needs of each student within the classroom, which can be formidable in heterogeneous classrooms. Thus, many students may face difficulty because their needs have not been specifically addressed within a large classroom setting.

Because of this dearth of appropriate instruction, it is not surprising that poor and/or inappropriate classroom instruction was cited as one of the most influential causes of children's reading problems by Connor et al. (2009). Two factors, including a lack of appropriate instruction and an insufficient amount of time in reading instruction, are

known to be most prevalent causes of reading failure in children (Connor et al., 2009). As outlined by the American Federation of Teachers (1999), the difficulty of teaching reading has historically been underestimated, and learning to read has been described as a "complex linguistic achievement" that is not natural or easy. Teachers are typically only given a single course in reading methodology in their education programs, which does not adequately prepare them for the complex task of teaching reading (American Federation of Teachers, 1999). Washburn, Joshi, and Cantrell's (2011) more recent study summarizes a growing body of research that indicates that most teachers do not have an adequate and/or accurate knowledge base from which to teach students to read. They state:

> Though teachers may be literate, experienced, and educated in a university setting, they still lack essential knowledge of basic language constructs and structure that is needed to explicitly teach beginning readers as well as effectively assess and remediate struggling readers. (Washburn et al., 2011, p. 23)

The National Center for Education Statistics estimates that in the fall of 2011, there were approximately three to four million certified teachers in the United States. In addition to the already certified teachers, approximately 150,000 teachers are newly certified each year (National Center for Education Information, 2011). Consequently, the nation faces the challenge of not only ensuring that teacher preparation programs adequately prepare new teachers for implementing effective reading instruction, but also addressing the needs of teachers who are already in the classroom. The obligation to meet this challenge is part of the requirements detailed in No Child Left Behind regarding the professional development of teachers (Wolff, McClelland, & Stewart, 2010). Wolff et al. (2010)

found a positive correlation between teacher perception of useful professional development and Adequate Yearly Progress. However, current methodologies for providing teachers with in-service training are lacking. Sailors and Price (2010) cited the failure of professional development to be due to a variety of reasons. The method of delivery of information to teachers is typically given in "one shot" without careful monitoring and thorough follow-up support. Teachers also indicate that they find most in-services and workshops provided by schools to be uninteresting and irrelevant, and most teachers forget approximately 90% of presentations (Sailors & Price, 2010). These data suggest that there is currently a failure within school systems to effectively provide critical training and education to teachers.

Consequently, despite the importance of effective reading instruction, teachers are not adequately prepared to implement appropriate reading instruction, and once they are actually teaching reading, they do not receive the appropriate training to implement research-based practices through professional development efforts. Thus, although 95% of all children can be taught to read, approximately 20% of elementary students in the United States have significant problems learning to read (American Federation of Teachers, 1999). Since professional development for teachers is an area that continues to fall short, systems must exist within schools to address the needs of this large group of students who are having difficulty learning to read. School systems may choose to utilize effective instruction programs and curricula that are easily integrated and implemented by teachers who may not have had and do not have the resources to re-educate teachers in the area of reading. Many districts also are moving toward the utilization of a comprehensive, school-wide framework for instruction and intervention in order to

address the needs of all students, such as Response to Intervention (Lembke & McMaster, 2010).

Indeed, in response to the difficulties with providing reading instruction, many districts are implementing a response to intervention model of instructional delivery. Response to Intervention, also known in Pennsylvania as Response to Instruction and Intervention, is part of a systematic framework of instruction that inserts prevention science into the process of instruction (Lembke & McMaster, 2010). By using ongoing assessment data to drive instructional decision-making, school staff can provide differential instruction and intervention to students who most need it, and also vary the amount provided to groups or individual students (Lembke & McMaster, 2010). School personnel should employ the data-based decision-making process to problem solve and ensure that all students' needs are being addressed. As part of the problem-solving process, instructional leaders within school systems collaborate with and provide support to teachers in delivering appropriate instruction to all students (Lembke & McMaster, 2010). Therefore, a response to intervention model is ideal for supporting teachers who may not have received adequate training in reading instruction.

The methodology embedded within a response to intervention approach can address the strengths and needs of students in a variety of areas using progress monitoring data, while also supporting teachers instructionally using the problem-solving process. As stated previously, one of the causes of students' reading difficulty is insufficient time devoted to reading instruction, which is also addressed within the response to intervention model, with students receiving more support if they show a greater need. The model is also useful in assisting school systems in identifying the

effectiveness of their "tiers" of educational support, as it has been established that 80% of all students should benefit from core instruction, 15% will need additional intervention, and 5% will need intensive, individualized intervention. Schools can use these percentages to determine if their instructional practices are reaching the appropriate amount of students. The Center on Instruction (2006) states that in order to obtain 100% proficiency, schools must go through the bottom 20% of students. The array of instruction and intervention options must be in line with the range of diversity in students (Center on Instruction, 2006).

Sex Differences in Reading

Across the literature, there are consistent findings regarding the differences between males and females regarding reading. Of all of the literature reviewed for the current study, most cite males as typically having more difficulty in reading than females, and most refer to other literature that cites these differences (Singh, 2008; Logan & Johnson, 2009). Singh refers the reader to other supporting literature, including Ben-Shakar and Sinai, 1991; Hyde and Linn, 1988; Lynch, 2002; Nowell and Hedges, 1998; and Pomplun and Sundbye, 1999. Logan and Johnson refer to studies by Baker and Wigfield, 1999; Burnett, 1996; Chapman and Tunmer, 1995; Coles and Hall, 2002; McKenna, Kear, and Ellsworth, 1995; and Millard, 1997. In an introduction to her study, Singh (2008) reviews the possible reasons for the differences. She includes cognitive differences, differing approaches to reading, behavior, and environmental factors among the explanations (Singh, 2008). For example, reading is considered a more appropriate activity for females over males. Also, females prefer fiction and leisure reading over non-fiction and factual materials, which males prefer. The "person oriented materials"

(p. 338) that females prefer require interpreting and reflection of the material, and these skills are more often assessed in reading, thus leading to females' higher performance on reading assessments (Singh, 2008). In her survey study of over 30,000 students, Singh (2008) confirmed the sex differences through her survey. She also found that males perform better on multiple choice assessments in reading, versus open-ended assessments, the latter of which includes a higher performance rate for females. Logan and Johnson (2009) completed a study that assessed reading skill differences in females and males, and found that females are significantly better at reading than males. They also found that females read more at home and borrow books from the library more frequently than males (Logan & Johnson, 2009). They reviewed existing literature in depth, and cited confirmation that gender differences in reading exist across grades, and that the gap between males and females grows wider with age (Logan & Johnson, 2009).

Although there is a wealth of literature to indicate sex differences in reading, recent studies completed within the past few years calls the previous literature into question. In 2010, Below, Skinner, Fearrington, and Sorrell completed a study that examined that DIBELS scores of males and females in kindergarten through fifth grade. Although they found small but statistically significant differences favoring females in kindergarten and fourth grade students, but no differences in other grades, with fifth grade males and females scoring only an average of one word correct per minute on fluency measures (Below et al., 2010). Wang, Algozzine, Ma, and Porfeli published a study in the Journal of Educational Psychology in 2011 which examined the reading rates of second grade students. In their study, they found that although females scored better on reading achievement measures, there were no statistically significant differences in the

growth rate of subjects' reading rate in second grade (Wang et al., 2011). Most recently in 2012, Limbrick, Wheldall, and Madelaine examined the reading skills of male and female subjects and found that there were no statistically significant differences between the sexes on their performance on the various reading measures. They also discovered that gain differences, similar to the 2011 study, were negligible (Limbrick et al., 2012).

Core Reading Program: Macmillan/McGraw-Hill's *Treasures*

Within the district included in the current study, the newest version of Macmillan/ McGraw-Hill's *Treasures* reading series is utilized for all students included in the general education reading curriculum. A review of the empirical, peer-reviewed literature indicates that no such research currently exists regarding this specific reading series. The program is based on research on reading, but is not research-based. However, the publisher of the *Treasures* series, Macmillan/McGraw-Hill, provides several self-initiated studies on its website, http://mheresearch.com. The first body of research was conducted at the request of the publishers by Westat, Incorporated (Macmillan/McGraw-Hill, 2007). Within this document, the publishers detail the five components of reading, and then establish how the reading series align with the reading components by using detailed examples from the actual series (Macmillan/ McGraw-Hill, 2007). Four studies are also cited by the publisher on its website. A randomized controlled study was also highlighted (Macmillan/McGraw-Hill, 2005). Westat, Incorporated completed an exploratory study that examined the use of story retelling cards on students' reading comprehension. The story retelling cards were not a part of the reading series, but were developed by Macmillan/McGraw-Hill staff. In the study, interviews of teachers, observations, and subtests from the Woodcock-Johnson Tests of Achievement, Third

Edition were utilized as outcome measures. The conclusion of the study was that the cards can increase students' reading comprehension skills (Macmillan/McGraw-Hill, 2005).

Macmillan/McGraw-Hill (2010) also cited a non-randomized controlled study completed by Empirical Education, Incorporated. This study utilized a review of student performance records, which included performance on state reading tests. The publisher noted a positive impact on overall literacy scores (Macmillan/McGraw-Hill, 2010).

The publisher's website also includes a section on "single-subject research," but information contained in this section included "author monographs" of activities cited as research-based which were described by the authors of the series. The activities included activities for vocabulary, effective comprehension instruction, instruction for English Language Learners, differentiated instruction, and reading fluency (Macmillan/McGraw-Hill, 2010).

On the *Treasures* website, two studies citing evidence of effectiveness were also detailed in descriptive reports (Frechtling et al., 2007 & Frechtling et al., 2007). Both studies indicated that the *Treasures* reading series has positive effects on students' reading. Both studies examined teacher and parent surveys, as well as DIBELS data, for a large number of students, and utilized Reading Triumphs and Treasure Chest in addition to the Treasures reading series, which are aimed at assisting struggling readers and English Language Learners (Frechtling et al., 2007 & Frechtling et al., 2007).

In summary, the *Treasures* publishers have made an attempt to demonstrate the effectiveness of the series on students' reading, but have yet to demonstrate an empirical

research base with peer-reviewed, randomized controlled studies published in scientific journals.

Computerized Instruction and Intervention

The use of technology in providing instruction and intervention in schools has existed since the early 1900s. Ramdoss et al. (2011) cites usage referred to in the literature in 1926, 1956, and 1968, the latter of which was completed by B.F. Skinner. However, since the 1980s, great advances in computer technology have been made. Advances include synthesized speech that is acoustically sound and accurate, multiple methods of user feedback into the program, and multimedia presentation of information (Nicolson et al., 2000). These advances have also increased the flexibility of the use of technology in schools (Ramdoss et al., 2011). The National Reading Panel report refers to the examination of studies leading to the conclusion that the use of a computer is more effective than traditional instruction when teaching vocabulary, and overall, the panel cited promising aspects of computer technology for reading instruction, although specific instructional uses were lacking and needed further research (NICHD, 2000).

In 2000, Nicolson et al. completed a study to examine if a computer-based approach to reading support would benefit students who did not respond to a more traditional, individual, curriculum-based approach. They attempted to replicate previous studies that utilized a program called the Reader's Interactive Teacher Assistant (RITA), which is based upon the concept of Intelligent Teaching Assistant (ITA), a term for any computer program that presents materials adapted to meet the needs of each individual learner (Nicolson et al., 2000). Within their study, 272 students were given either traditional reading instruction or reading instruction supplemented with the RITA system,

or were within a control group. The RITA system includes various reading exercises that are not described in detail by the authors (Nicholson et al., 2000). Activities in which the students could participate were suggested by the computer program and then the students' teachers were required to select which activities in which the students actually participated. They found that children who participated in a computer-based program gained educational benefit from participation, but that the gains were less for older students as well as students who were the lowest in initial reading skills (Nicolson et al., 2000). One strong advantage to utilizing the computer-assisted intervention was that the students who participated demonstrated significantly higher enthusiasm and commitment to the computerized intervention than a traditional intervention (Nicholson et al., 2000). Additional advantages to computerized intervention are cited by Gillam, Crofford, Gale, and Hoffman (2001). They indicated that computer-assisted instruction has increased in popularity because it facilitates the provision of individualized instruction for multiple students at the same time (Gillam, Crofford, et al., 2001). In their exploratory study, they cited the advantages of using the computer as a primary means to intervene, with personnel providing support only as needed (Gillam, Crofford, et al., 2001).

One of the important characteristics of effective computer-aided intervention includes the presence of adults to provide further guidance while the intervention took place. Nicholson et al. (2000) further expounded on this and noted that technology must be an integral part of the teaching process, not a replacement. The computer should implement the part of instruction that is not necessary for humans to provide and for which technology is better suited—keeping students motivated with engaging, repetitive,

and non-judgmental feedback that is given instantaneously, as well as providing efficient and automatic progress monitoring (Nicolson et al, 2000).

The idea of the computer supplementing, not supplanting, teacher instruction was also supported by Van Dusen and Worthen (1995), who indicate that this can be the biggest obstacle for teachers—integrating the technology into their teaching. Within their *Educational Leadership* article, Van Dusen and Worthen reviewed two studies they had previously completed in school districts. Based on the data from their studies, which included focus group interviews, structured classroom observations, and student achievement data, they concluded that integrating technology into the classroom is beneficial if implemented properly (Van Dusen & Worthen, 1995). Benefits to appropriate implementation include increased time-on-task within the classroom, extensive available materials within a computerized system, effective assessment and data reporting, and personalized instruction adapted to the needs of the user (Van Dusen & Worthen, 1995). Appropriate implementation must include a plan for how to include the technology within instruction, sufficient hardware on which to use the technology, adequate opportunity and time allotted to utilizing the technology, and assistance to teachers in how to integrate the technology into their teaching, which should include supportive and knowledgeable administrators (Van Dusen & Worthen, 1995).

The use of drill and practice with a computer was cited as particularly important for children with significant reading problems or disabilities because the repeated practice can be used to build basic reading skills that many of these children are lacking (Torgeson & Barker, 1995). Within the Torgeson and Barker article, they reviewed several computerized intervention programs and attempted to replicate previous studies

on the programs. In one of their replication studies, they used the programs Daisy Quest, Hint and Hunt, and a math computer program. In their study, they were able to replicate an increase in the students' word reading skills, with the Daisy Quest intervention group demonstrating the most improvement (Torgeson & Barker, 1995). They also replicated studies using the SPEED and Hint and Hunt interventions, but were unable to reproduce significant differences between the intervention groups because all of the intervention groups produced equal gains (Torgeson & Barker, 1995). The authors noted that the results of their replication studies were limited because of the small samples and short-term usage of the interventions (Torgeson & Barker, 1995).

Sands and Buchholz (1997) indicate the multisensory advantage of computerized interventions for students, particularly those with different learning styles, because the programs can integrate visual, auditory, and motoric features. Computerized programs can also allow for individual pacing regarding the instructional level and content, as well as adapting quickly to student progress or lack thereof (Sands & Buchholz, 1997; Gillam, Crofford, et al., 2001). The cost-effectiveness of using computerized intervention was also established, with a great lessening of teacher preparation time being one of the most cost-saving factors (Nicolson et al, 2000). Another cost-saving aspect of the utilization of technology for intervening is that computers are commonplace in schools and homes (Ramdoss et al., 2011).

Additional research cites the importance of any computer software being used as a supplement to instruction rather than a replacement of core instruction (Torgeson et al., 2010). Two different groups of studies highlighted by Torgeson et al. (2010) address the use of computer software while taking supplement versus supplant into account. In the

Torgeson et al. studies, the researchers utilized two cohorts of first grade students with reading difficulties. The students within each cohort were randomly assigned to one of three groups: Read, Write and Type (RWT); the Lindamood Phoneme Sequencing Program for Reading, Spelling, and Speech (LiPS), and a control group. The RWT intervention included writing and spelling activities to increase children's alphabetic reading skills. The LiPS program is designed to provide explicit phonemic awareness instruction through discovery and labeling of articulatory gestures. The computerized programs were demonstrated to be more effective and with more positive results when they were used as a supplement to instruction. However, when the programs supplanted instruction, the results demonstrated no discernible impact in student reading skills (Torgeson et al., 2010).

Given the possible advantages to districts in selecting a computerized intervention instead of a traditional one, many schools may choose a computerized intervention such as the Fast ForWord program in addressing the needs of their struggling readers. The following section will provide a synthesis of the research on the Fast ForWord program in order to delineate why schools may choose it as an intervention.

The Fast ForWord Intervention Program

The following section includes a description of the Fast ForWord intervention program, with a review of the theoretical basis as well. As stated in Chapter One, the relevant program components include both language and reading products, as well as the Reading Assistant product.

Before beginning the products, each student must participate in pre-testing with an instrument in the program that provides a reading skills assessment and the Reading

Progress Indicator (RPI) benchmark score. The assessments within the product were developed by the Bookette Software Company, and the publishers indicate that they are correlated with nationally normed instruments, such as the Woodcock Reading Mastery Test, and are valid and reliable. The publisher encourages users to use the RPI to assess how students are progressing within the product in which they are participating. There are four levels to the RPI, which are divided as follows: K-1, grades 2-3, grades 4-6, and grades 7 and above. Students must meet a specific set of criteria to move from one product to the next, which include either a "switch flag" from the computer program, or a "complete flag" with less than 750 minutes on the product. They must then take the RPI assessment as a post-assessment before entering the next product. The assessment takes approximately 30 minutes. Students may only participate in one Fast ForWord product at one time (Scientific Learning Corporation, 2009).

The "Progress Tracker" system within the software provides staff implementing the program with reports on student progress and implementation fidelity. Staff can view the percentage of completion for the exercises in which students are participating. Scientific Learning (2009) states that students who progress more quickly through the exercises usually have the greatest benefit from the product. Points are listed in order to motivate and reward students for participation; they do not measure where a student is within an exercise or the completion of the exercise. The RPI reading level gain distribution and assessment scores are reported in grade equivalents and national percentile rankings, which can be obtained weekly from the Progress Tracker system.

Weekly achievement reports show the students' completion, attendance, and participation information (CAPS), and can be provided to other school personnel or

parents. Certain flags appear in the program if a student needs to be more challenged (i.e., switched to a more difficult product), if the student has completed a product, or if the product the student is on is too difficult. The publishers encourage users to use extrinsic motivation and rewards for students in addition to the ones provided within the exercises, which include visual and verbal praise. As the participant progresses through each exercise, the tasks become increasing complex, and often have "fluency rounds" where the latency in responding is a factor in earning points and progressing through the exercise (Scientific Learning Corporation, 2009). Within the district included in the study, the reading specialists have created "Fast Cash" for student participation and progress, which the students can redeem in a "store" within the classroom. The staff also uses "high score of the day" and "beat the principal's score" bulletin boards to motivate students.

The Fast ForWord Language products begin with the Language v2 product. Within Language v2 are seven exercises that target basic speech sounds and the essential skills for learning to read. Three sound exercises present auditory information to participants in a "pre-word" format, such as frequency sweeps, phonemes, syllables, and digitally-enhanced speech sounds. The words and sentences have been "acoustically modified" by stretching and emphasizing certain sounds; the original intent of the program when it was first created was to emphasize the rapidly changing phonetic parts of natural speech with which children with language and reading problems have difficulty. The four word exercises present words in isolation or within sentences, beginning with a low level of linguistic complexity and increasing as the participant progresses within the exercises. Students listen to the exercises on the computer through

headphones must use a computer mouse to click on the correct responses. The sound exercises are Sky Gym, Moon Ranch, and Hoop Nut, and the word exercises are Whalien Match, Robo Dog, Ele-Bot, and Space Commander (Scientific Learning Corporation, 2009).

In the Language to Reading v2 product, five exercises are included in order to provide participants with additional practice on the skills targeted in the Language v2 product. The product continues to use acoustically modified speech sounds, and as in the Language v2 product, the exercises become more difficult as the participant advances, with sounds presented progressively faster with progress. The Language to Reading v2 product also reinforces letter recognition, visual tracking, and a left to right reading pattern. Within the Language to Reading v2 product, one sound exercise is Jumper Gym, and four word exercises are Tomb Trek, Polar Planet, Cosmic Reader, and Paint Match (Scientific Learning Corporation, 2009).

Scientific Learning Corporation (2009) markets its Fast ForWord reading products as exercise for the brain to help participants process information and learn more efficiently. They are also marketed as a way to develop and strengthen memory, attention, processing rate, and sequencing skills, which are all essential cognitive skills for learning and reading (Scientific Learning Corporation, 2009). The first reading product, Reading Readiness, includes six exercises that are meant to work together to develop foundational cognitive skills in the context of essential pre-reading skills, including letter recognition and letter naming, phonemic awareness, understanding of the alphabetic principle, and letter-sound associations. The six exercises within Reading

Readiness are Inside the Tummy, Hungry Tummy, Packing Pig Goes to Work, Packing Pig Has Lunch, Coaster, and Houdini (Scientific Learning Corporation, 2009).

Reading levels one through five include extensions of the Reading Readiness product, and focus on developing reading skills. In Reading Level 1, the exercises are again said to work on the cognitive processes of memory, attention, processing, and sequencing in the context of earlier basic reading skills, such as phonemic awareness, decoding, appreciation of print, and motivation for reading. The six Reading Level 1 exercises are Bear Bags, Magic Rabbit, Flying Fish, Quail Mail, Bedtime Beasties, and Buzz Fly (Scientific Learning Corporation, 2009).

In the Reading Level 2 product, the exercises are designed to consolidate early reading skills with the application of phonics and decoding strategies. Improvement of word reading, comprehension of easily decodable words, and recognition of high frequency words are the focus of Reading Level 2. The exercises in this product are very similar to the ones in Reading Level 1, but with more complex and higher level skills. Reading Level 2 includes Bear Bags: More Lunch, Magic Bird, Fish Frenzy, Leaping Lizards, Ant Antics, and Dog Bone (Scientific Learning Corporation, 2009).

The next product in the reading series is Reading Level 3, which builds on reading knowledge and fluency. The focus of the exercises is word sounds, word forms, and spelling conventions in order to develop the participant's vocabulary and comprehension skills. More advanced work with letter sounds, phonemes, and spelling continues in this product. Some of the exercises have the participants reading sentences and paragraphs. The exercises in Reading Level 3 are Scrap Cat, Chicken Dog, Canine

Crew, Twisted Pictures, Book Monkeys, and Hot Hat Zone (Scientific Learning Corporation, 2009).

Reading Level 4 is designed to expand the participant's reading skills with exercises on word origins, word forms, sentence structure, and punctuation. The exercises involve spelling words, picking responses that best represent a word or instruction, completing sentences and paragraphs, and comprehending paragraphs. Reading Level 4 includes the Jitterbug Jukebox, Hoof Beat, Stinky Bill's Billboard, Lulu's Laundry Line, Book Monkeys: Book Two, and Goat Quotes exercises (Scientific Learning Corporation, 2009).

The final product within the reading software is Reading Level 5. This product expands on the four products before it, adding more complex skills in the areas of phonics, decoding, spelling, and vocabulary, and comprehension strategies, including constructing and organizing paragraphs in story building exercises. The five exercises in Reading Level 5 are Wood Works, Gator Jam, Lana's Lanes, Quack Splash, and Toad Loader (Scientific Learning Corporation, 2009).

In addition to the language and reading products, the Fast ForWord software also has an expanded component called Reading Assistant. The Reading Assistant product provides a one-on-one reading coach to participants using guided oral reading and speech recognition technology. There are four grade levels that have age-appropriate selections for participants. The participant enters their own library in the program, listens and follows along while reading silently, answers questions about the reading, and then learns unfamiliar vocabulary words. Subsequently, the participant reads the selection aloud with feedback and guided oral reading support from the speech recognition software

within the program. Longer passages are chunked into several parts. At the end of the reading, there is a quiz to assess the participant's overall comprehension of the passage (Scientific Learning Corporation, 2009).

Creation and Theoretical Basis of the Fast ForWord Program

In 1996, two separate studies were published in the prominent journal, *Science*, by the two researchers who developed the Fast ForWord program, Michael Merzenich and Paula Tallal. The Merzenich et al. (1996) study was initiated due to previous studies with primates regarding cortical plasticity and learning. The researchers wanted to apply learning principles that had been utilized to create rapid brain changes in the primates to humans (Gillam et al., 2001). Merzenich et al. (1996) theorized that children with "language-based learning impairments" (LLI) have difficulties rooted in temporal processing deficits, which manifest as difficulty identifying specific speech sounds, particularly when the sounds are presented in rapid succession. These difficulties may be rooted in abnormal perceptual learning that leads to abnormal language learning, or muffled acoustic input, early in the child's life (Merzenich et al, 1996).

The researchers in the Merzenich study sought to alter the impairments in temporal (auditory) processing skills of LLI children through practice with modified acoustics. Thus, a prototype of the Fast ForWord program was created in two audiovisual "games" that were meant to produce a high level of attention and enthusiasm from students within two highly repetitive learning tasks. The first game required the student to reproduce the order of a sound sequence on a touch screen, with variable octaves and frequencies. The second game included identifying the sequence position for a consonant-vowel pair. Both games began at a level that the LLI children in the study

could easily distinguish, which was slower in duration of sound and transition between sounds. The tasks were then altered trial-by-trial to work the children towards normal performance levels. Included in the games were audio and visual feedback for "hits" and "misses" (Merzenich et al., 1996). In addition to the two games, children in the study also rotated through eight other speech and language exercises individually administered by clinicians (Gillam, 1999).

In the first trial the researchers completed, the sample size included seven children with LLIs. The authors described this small sample as demonstrating severe delays in receptive and expressive language, average non-verbal intelligence, marked temporal processing deficits, and reading deficits. No further information was given as to how these descriptors were determined for the sample group. The second trial included 22 children matching the same description of the children in trial one, but they were divided into two groups based on non-verbal and receptive language abilities (Merzenich et al., 1996). Children in one group participated in the previously administered exercises using acoustically modified speech, while children in the other group received natural speech materials and played video games that were not adapted to be auditory-speech training games (Gillam, 1999). Subjects participated in a total of five to ten hours in each task over a period of 20 days. Both intervention groups were reported to make significant gains from the program, and that the students who received the acoustically modified speech intervention had more significant gains, particularly in the area of temporal processing (Gillam, 1999). The researchers concluded that based on the results of the study, the children had substantial remediation of their fast-speech-element recognition deficits, and that in turn, "temporal processing deficits of LLI children can be overcome

by training" (Merzenich et al., 1996). They specified that the six weeks of participation in the program led to neural reorganization that caused an increase in the skills to perceive fast-changing acoustic input, and that this increase in skills led to large gains on standardized language assessments (Gillam, Loeb, & Hoffman et al., 2008).

Tallal, who was also one of the researchers in the Merzenich study (and vice versa), completed additional research using the same two groups of subjects who participated in the Merzenich study (Tallal et al., 1996). In this portion of the literature, Tallal et al. sought to link the interventions completed within the two trials to significant increases in subjects' receptive language skills. Since LLI children have difficulty identifying millisecond elements within typical speech, the researchers, as indicated in the previous study, synthetically extended syllables in order to improve students' phonological discrimination. In this article, the pre- and post-tests that were given to the subjects were specified, which were assessments of following auditory commands, auditory discrimination tasks, a comprehensive language evaluation, and the Tallal Repetition Test. It was also indicated that the training exercises in which the subjects participated were conducted for three hours a day, five days a week within a laboratory setting. In the second trial, subjects had three and a half hours of training five days a week, and also completed one to two hours a day, seven days a week of exercises within their own homes (Tallal et al., 1996).

Based on the data that Tallal et al. (1996) collected for this research, children in the study who began one to three years behind their same-age peers in speech and language skills (based on the pre-tests) made approximately two years of gains, and all seven of the children met or exceeded the normal limits in speech discrimination and

language comprehension, based on their performance on the post-test measures. It was clarified that the children did not likely gain two years of language skills during the intervention period, but that they had possessed the skills prior to the intervention but were unable to apply them to normal listening and speaking situations.

Within Tallal et al. (1996), several connections between language and reading were made. The research connecting early language delays and later reading disabilities was cited. The authors also stated that 20% of children possess speech/language impairments despite experiencing normal exposure to language. This figure is parallel to the population of children who struggle with learning to read, which is also 20% (Tallal et al., 1996).

The preliminary software that eventually became Fast ForWord gained popularity due to the initial Merzenich and Tallal studies, and was beginning to be publicized in the media as a "cure" for dyslexia (Hall & Moats, 1998). The developers of the software touted its effects on both language and reading impaired children, even though at that time, no independent studies establishing positive effects on reading skills had been published (Hall & Moats, 1998; Olson, 2011). In 1998, two years after the initial studies with the preliminary software, the company Scientific Learning Corporation, which was established by the original researchers, began marketing the software as the Fast ForWord program. The program was highlighted in *Time* magazine in 1999 as a controversial computer program that has seen some positive effects, particularly for those with central auditory processing disorder (Greenwald, 1999). It was also featured in *Newsweek* magazine as a program that actually rewires the brain, and the article even delved into the program as one that can help English Language Learners (Begley, 2000).

From its inception forward, controversy surrounding the theoretical basis of the program existed, and it persists to this day.

Fast ForWord and Language Impairments

Since the publishing of the Fast ForWord software, there has been literature reflecting on the theoretical basis of the program, as well as attempts to replicate the original results advertised in the first two studies by Merzenich and Tallal. This portion of the literature review examines these studies, which all included school-age children of broad average cognitive ability.

Veale (1999) reviewed the literature leading up to the development of the software, most of which includes studies completed by Tallal as co-author, and all completed with subjects having speech/language impairments. She also conveyed the advantages and disadvantages of the program. Advantages were listed as ease of data collection, ability to precisely deliver auditory information, child-friendly design that encourages participation, stimuli control, use by certified administrators only, and a "strong research history". Disadvantages included expense, recommended pre- and post-test language measures, quantitative analysis of results instead of qualitative, the availability of the product before efficacy was fully published, and intervention without direct involvement of the professional administering it (Veale, 1999). Overall, despite the disadvantages stated, the Veale article appeared to support the use of Fast ForWord for those with speech and language impairments.

In the same journal issue as the Veale article, Gillam (1999) offered an alternate point of view. He questioned the theoretical basis of the Fast ForWord program by proposing that there are other alternative causes for language difficulties in childhood,

aside from those caused by temporal processing deficits. The foundational research on the Fast ForWord program asserts these deficits as the only cause of language difficulties. Gillam also questions the validity of the premise that the Fast ForWord program changes the cortex of the brain and strengthens neural connections, mostly because the original research based this assumption on the neurophysiological structure of primates' brains, which he asserts is limited in comparison to humans. Another contention of the program made by Gillam was that in the original Merzenich and Tallal studies, the subjects had a total intervention time of four to five hours per day, while children, who participate in the published Fast ForWord products, participate for much less time per day than this. Also, children using the current product do not receive individualized client-to-clinician exercises and do not participate in at-home exercises. When the group receiving the modified speech stimuli was compared to the group who received normal speech exercises, the results were enhanced. Gillam summarizes: "These results are quite interesting, but clinicians and parents should be aware that they do not demonstrate the efficacy of the Fast ForWord program" (Gillam, 1999, p. 366).

Gillam (1999) also critiques a large field study with 500 subjects completed by the program developers, which cannot be located in a peer reviewed journal. Questionable characteristics of the study included the comparison of the subjects in the study, all of which widely varied in their demographic data, the interpretation of post-test results, and numerous threats to both internal and external validity, including failure to incorporate a control group or delayed treatment group, as well as a lack of pre- and post-test language samples. An additional question regards the publishers' assertion that the program is meant to service anyone with a language issue, reading deficit, or spelling

problem, including those with diagnoses such as Attention-Deficit/Hyperactivity Disorder and Autism Spectrum Disorders; they conclude this because students with such diagnoses were included in the 500 subject field study. Gillam cautions, however, that this has not been thoroughly studied to the point that causal relationships cannot be made regarding language improvements for such children.

In the August 2001 issue of the *American Journal of Speech-Language Pathology*, a clinical forum was generated on the topic of Fast ForWord. The forum included an introduction to five studies on Fast ForWord, including case studies and within-subject experimental design studies conducted through independent research laboratories. The purpose of the organizers of the forum was to provide data on the outcomes of the Fast ForWord program that was not supplied by the publishers of the program (Friel-Patti, Loeb, & Gillam, 2001).

As the first study reviewed for the clinical forum on Fast ForWord, a case study with five language-impaired subjects from a private school who were given the Fast ForWord intervention was published by Friel-Patti, DesBarres, and Thibodeau in 2001. The authors indicated that the study was performed in order to determine if the program shows promise. The purpose was not to establish the efficacy of the Fast ForWord program, nor to generalize to the entire population. The students participated in the Fast ForWord intervention until they reached 90% completion on five out of seven exercises, or until they plateaued in performance for ten days before the six-week trial ended. The former completion criterion is one promoted by Scientific Learning Corporation. They also note as part of their study that the original research studies completed by Merzenich and Tallal reported age-equivalent scores, which used in isolation are misleading when

attempting to interpret progress. The results of the intervention with the five participants generated mixed results. Three of the five subjects demonstrated modest changes in language skills, but the changes were noted in subtests, not in overall performance on language measures. No clinically significant changes in language sample measures were indicated for any of the subjects. Also, the authors indicated that two subjects who met the Scientific Learning dismissal criterion were not the same subjects who demonstrated the most change within the study. Therefore, it can be said that there is evidence to suggest that using the dismissal criterion suggested by the publishers as an indicator of progress is not valid (Friel-Patti, DesBarres, & Thibodeau, 2001).

The second study in the Fast ForWord clinical forum involved case study examination of language changes in four children, who participated in the Fast ForWord program at home (Loeb, Stoke, & Fey, 2001). These authors were primarily concerned with previous studies on Fast ForWord reporting gains in standardized test scores, which they posited are not equivalent to making gains in the spontaneous use of language. They were also concerned that the intervention is suggested as a method to improve reading skills despite no empirical data to support this notion. Also, although the publishers of Fast ForWord indicate that it can be used at home, there are also no data to support this claim, which the authors wanted to examine in their study.

The children participating in the study all had previously diagnosed speech/language impairments. They participated until they achieved a 90% completion rate on five of the seven games, unless they did not achieve this at the six to seven week point in the intervention (although parents could continue with the program beyond the intervention). Their participation ranged from 32 to 45 days over the course of six to

seven weeks. Three of the four children in the study did complete the program. The researchers administered the same measures as in the original Merzenich study, and additionally administered pre- and post-measures assessing various aspects of reading, including the Woodcock Reading Mastery Test—Revised, the Gray Oral Reading Test—3, and the Test of Phonological Awareness Skills. In summary, three of the four subjects completed the program, and all of them made some gains in the standardized testing measures, although the results were generally "far less dramatic than those reported by Merzenich and Tallal" (Loeb, Stoke, et al., 2001, p. 228). One of the most significant findings of the study was that many of the language skills indicated no change, and some skills even declined. When the data were examined, there were no consistent patterns of gain across the four subjects. The results on the reading assessments were greatly varied, and no positive effects could be concluded as a result of this study (Loeb, Stoke, et al., 2001).

The third study highlighted in the clinical forum on Fast ForWord involved studying language changes on several children, who participated in either the Fast ForWord or Laureate Learning Systems Software program (Gillam, Crofford, et al., 2001). The researchers wanted to determine if "training" with four speech/language impaired children in the Fast ForWord program would result in gains that were pragmatically relevant, as well as compare the program to another computer-based intervention. The Laureate Learning Systems Software consisted of a series of exercises similar to the Fast ForWord exercises, packaged together by the authors. Pre- and post-assessments included the Oral and Written Language Scales (OWLS) and a spontaneous language sample. The intervention persisted for a period of 20 days across four weeks,

with five 20-minute exercises per day. The four children participating in the study were randomly assigned to either the Fast ForWord or the Laureate Learning System software.

Although the programs were comparable in that both had seven similar exercises with visual rewards, elements of goal attack strategies, criteria to reach the next level within an exercise, and multiple skills targeted each day, they were somewhat different. The exercises within the Fast ForWord program used in this study focused on discriminating and remembering sequences of non-speech sounds, phonemes, and syllables, as well as discriminating words comprehending sentences. The program also used modified auditory stimuli. The other intervention, the Laureate Language Systems software, focused more on word, sentence, and story aspects of language, and did not alter speech stimuli. Results indicated that although none of the four children reached the 90% completion dismissal criterion, they all had significantly higher scores on the OWLS post-assessment, and made gains on language sample measures, regardless of the program in which they participated (Gillam, Crofford, et al., 2001).

The fourth study included in the Fast ForWord forum centered on psychoacoustic performance (Thibodeau, Friel-Patti, & Britt, 2001). The same subjects utilized for the Friel-Patti, DesBarres, and Thibodeau case study were participants in this psychoacoustic performance study. This study also had a control group of five students with typical speech/language skills. The authors for this study found evidence in the literature to support the theory that students with speech/language impairments have difficulties rooted in temporal processing. Therefore, they wanted to study temporal processing through the use of masking and frequency-sweep discrimination with the subjects. While the students in the treatment group were participating in the Fast ForWord intervention

over a five- to six-week period, they all were tested in the masking and sweep hearing evaluations. Post-intervention, there were no significant differences between the groups regarding any of the psychoacoustic tasks. The two children who performed the best on the psychoacoustic tasks also reached the highest level of performance out of all of the subjects in Fast ForWord; however, these two children also had the least speech/language impairment. Aside from the improvement in these two subjects, the researchers concluded that the intensive auditory training in the Fast ForWord program did not result in change in temporal processing or language skills (Thibodeau et al., 2001).

The fifth and final study within the Fast ForWord forum again investigated temporal processing (Marler, Champlin, & Gillam, 2001). Three of the seven participants in this study were also subjects in the Gillam et al. study regarding Fast ForWord and the Laureate Language Systems software. Based on the results of this study, the authors concluded that there were no improvements in temporal processing that could be linked to participation in either of the programs (Marler et al., 2001).

As summarized by Gillam, Loeb, and Friel-Patti (2001), all of the children in the five studies within the Fast ForWord forum benefitted somewhat in regards to language skills due to participating in an intervention, whether it was Fast ForWord or another computerized intervention. No changes in temporal processing were noted as a result of the Fast ForWord intervention. The authors of this summary cautioned that the five studies were not completed to prove or disprove efficacy, but rather that further research with large-scale, randomized clinical trials would be necessary to accomplish this task (Gillam, Loeb, & Friel-Patti, 2001).

Several other studies outside of the *American Journal of Speech-Language Pathology* forum examined the impact of Fast ForWord on language skills. In 1995, Cohen et al. expanded on some of the forum studies by utilizing a larger sample of 77 children, who had severe mixed receptive-expressive speech/language impairments. Subjects in the study received speech/language services in their schools or from outside providers. The study was completed across several centers, with blind assessment of outcome, meaning that the post-assessments were administered by speech and language pathologists who were not part of the research study. Three groups in the study included one group receiving Fast ForWord as a home-based intervention, another group completing computer-based activities at home with unmodified speech stimuli, and a control group. Pre- and post-assessments were completed nine weeks and six months following the study, and included the Clinical Evaluation of Language Fundamentals—Third Edition, the Test of Language Development—Primary—Third Edition, and the Phonological Assessment Battery. The subjects participating in the Fast ForWord and other computer activities completed a training regime compliant with Scientific Learning Corporation's guidelines. The results of the study were that all three groups made significant gains in receptive and expressive language, and thus there was no additional therapeutic benefit for participation in the Fast ForWord or other generic computer games (Cohen et al., 2005).

In February 2008, Gillam et al. completed a three-year randomized controlled trial of the Fast ForWord program in an attempt to replicate the original results from 1996 studies in the *Science* journal. They also wanted to improve on the research of Cohen et al. and include more subjects and those beyond just a mixed receptive-expressive

language impairment, as well as measure the direct effects of changes in temporal auditory processing, which the other studies measured indirectly. The subject group included 216 children with language impairments who received one of four treatments, namely the Fast ForWord intervention, academic enrichment consisting of educational computer games, computer-assisted language intervention consisting of computerized language games without modified speech, or individualized language intervention provided by a speech/language pathologist. Subjects were randomly assigned to one of the four groups. Children receiving the computerized interventions participated for one hour, 40 minutes a day until the subject reached the 90% dismissal criterion; however, none of them reached this criterion, and they all participated until the last day of the intervention session. The intervention time was part of a summer program that was three and a half hours a day, which also included group activities, recess, and a snack break. The average attendance rate for all subjects was 28 out of 30 total days. The on-site research coordinators for the study were the only ones that were not blind to the randomized treatment assignments; the principal investigators, data collectors, data analyzers, and safety and monitoring team members were all blind to participant names, identification codes, and treatment assignments. Parents of the children in the study were also blind to treatment assignment (Gillam et al., 2008).

Assessments were conducted in four stages, first as pre-tests, next as post-tests six weeks after the pre-test, third at three months after the interventions, and finally six months post-intervention. The assessments included the Comprehensive Assessment of Spoken Language (CASL), a backward masking test, the Token Test for Children, and the Blending Word subtest of the Comprehensive Test of Phonological Processing

(CTOPP). Similar to the Cohen et al. (2005) study, the Fast ForWord intervention was no more effective in increasing general language or temporal processing skills than any of the other interventions. Again, the subjects improved significantly overall in language and auditory processing skills at all three post-test assessments. The only exception was the subjects' performance on the Blending Words subtest of the CTOPP; children in the two computerized language intervention groups had more significant improvement in this aspect of phonological awareness than the students in the academic enrichment and individualized language intervention groups. The authors concluded that the results of their study question the original Merzenich and Tallal theories that temporal processing difficulties underlie language impairments, and that exercises with acoustically modified speech improves language skills. They called for similar research that includes a no-treatment control group in order to conclude equal ineffectiveness for all of the treatment groups (Gillam et al., 2008).

A summary of the studies examining the impact of the Fast ForWord intervention on language difficulties is the studies have yielded mixed results, far less dramatic gains than the original *Science* journal studies, no differences between intervention groups, no improvements in temporal processing skills, and no benefit of the Fast ForWord program over other computer games.

Fast ForWord and Reading Difficulties

Although the original Merzenich and Tallal studies asserted that an increase in language skills would equate to improved reading skills, many of the previous research studies that examined subjects with language impairments either questioned this assumption or touched on some aspect of reading skills in order to gain some data on this

assertion. However, several studies have focused their research on the impact of Fast ForWord on children specifically with reading difficulties. The following section will review the literature on this topic.

In 2001, Hook, Marcaruso, and Jones asserted that children with word identification issues often have difficulties with phonological processing. Some research has suggested that these skills are related to the temporal auditory processing skills previously highlighted in this literature review. However, Hook et al. (2001) call in to question the theory that phonological processing difficulties are due to temporal auditory processing and perception deficits, and indicate an alternative theory, that phonological coding difficulties instead lead to phonological processing deficits. An illustrative example provided was that children with reading difficulties could not discriminate the difference between the /ba/ and /da/ syllable pairs, but could discriminate between /ba/ and /sa/; both include rapidly changing consonant transitions but are different in phonetics (Hook et al., 2001).

In the Hook et al. (2001) study, the researchers studied the impact of Fast ForWord on children with reading disabilities, including its effect on phonemic awareness, semantics, syntax, and rapid naming. They also examined the subjects' receptive and expressive spoken language and verbal working memory skills. Treatment groups included eleven subjects in the Fast ForWord group, nine subjects in an alternative treatment group (an Orton-Gillingham intervention), and an eleven-subject control group. Children participated in the Fast ForWord intervention for two months during the summer, for five days a week, approximately two hours per day. They participated until the 90% completion rate on five out of seven exercises was reached, or

until an "obvious plateau" was reached, which indicated a range of completion of 22 to 44 days. Children receiving the Orton-Gillingham intervention participated for five weeks, one hour a day for five days a week. The Orton-Gillingham intervention was administered one-on-one, and focused on a multisensory approach incorporating alphabetic code, systematic and explicit presentation of concepts, consistent review of previous concepts, and an emphasis on rule procurement and application.

All subjects were assessed pre-treatment, immediately following treatment, and one and two years post-treatment. Assessments included the Lindamood Auditory Conceptualization Test (LAC), the Test of Language Development (TOLD), three subtests from the Woodcock Reading Mastery Test—Revised (WRMT-R) (Word Identification, Word Attack, and Passage Comprehension), the Test of Written Spelling, Third Edition (TWS-3), the test of Rapid Automatic Naming and Rapid Alternating Stimulus (RAN-RAS), and the Numbers Reversed subtest from the Woodcock-Johnson Test of Cognitive Abilities, Revised (WJ-R) (Hook et al., 2001).

Results of the research were that the children in the two treatment groups made gains in phonological awareness immediately after the interventions. These results were found despite the fact that the subjects, who participated in Fast ForWord, received almost double the amount of intervention time as the Orton-Gillingham group. However, only the children in the Orton-Gillingham group made improvements in word attack skills, and neither group made gains in word identification, spelling, or verbal working memory. The children did not improve in rapid automatic naming skills immediately after the intervention period, but did two years post-treatment, indicating that their naming speed increased due to maturation. Unfortunately, the gains achieved by the

subjects who received Fast ForWord were not maintained two years after the intervention. The researchers found that the percent completion rate was irrelevant in determining the effectiveness of the Fast ForWord program. They concluded that participation in the Fast ForWord program was not justified given the large amount of intensive treatment required by the program. A limitation of the study recognized by the researchers included the small sample size (Hook et al., 2001).

An additional study exploring the impact of Fast ForWord on reading also examined its impact on subjects' oral language competency and classroom behavior (Troia & Whitney, 2003). The researchers in this study equate children with language disorders and reading difficulties because they believe that both groups have difficulty with identifying, discriminating, and ordering speech stimuli that are temporally cued, and provide supportive literature that both agrees and disagrees with Merzenich and Tallal's temporal processing deficit theories. Although they give credit to the theory, they indicate that temporal processing alone cannot account for children's difficulty with auditory processing. Their study aimed to determine whether any positive treatment outcomes could be attributed to the Fast ForWord intervention rather than maturation, classroom instruction, or regression to the mean by implementing the intervention with a group of subjects and comparing them to a control group who received no intervention. The subjects included 37 school-age children, who received services for low academic achievement, received Title 1 services, or were eligible for special education services. Subjects were assessed pre- and post-intervention with the Listening Comprehension and Oral Expression subtests of the OWLS, the age-appropriate subtests of the CTOPP, and the Letter-Word Identification and Word Attack subtests of the Woodcock-Johnson

Psychoeducational Battery—Revised (WJ-R). The Social Skills Rating System (SSRS) was also administered to the children's teachers in order to rate classroom behavior (Troia & Whitney, 2003).

The treatment group, a total of 25 students receiving the Fast ForWord intervention, was removed from their classrooms during language arts to participate for 100 minutes per day, five days a week, for approximately ten weeks. The results of the study were similar to those found by Hook et al. in 2001. They found that the Fast ForWord group made significantly greater, but limited, gains in oral language, phonological processing, and classroom behavior. Although the Fast ForWord group had improved oral expression, their listening comprehension did not show a sizeable improvement, which the researchers found concerning due to the Fast ForWord program marketing for improvements in receptive oral language and auditory processing skills. Other than these gains, increases in pre- and post-assessment scores were the same for the two groups. The authors detailed several limitations in their research, including a non-representative sample of students with disabilities, a lack of random assignment to treatment groups, and a low completion rate for participants (Troia & Whitney, 2003).

In 2004, Rouse and Krueger completed a study with 374 school-age students in 17 schools, with 197 students receiving the Fast ForWord intervention and 177 control subjects. Students were randomly assigned from a group of the lowest readers to either the intervention or control group, using within-school random assignment. Subjects in the Fast ForWord group were required to complete at least 30 days of intervention, as well as at least 80% on the majority of the exercises. Pre- and post-assessments were selected to measure both reading and language skills, and included a computerized test

owned by Scientific Learning Corporation called Reading Edge, the receptive language portion of the CELF-3, assessments from the Success for All reading curriculum, and student performance on state standardized reading tests. The results indicated that even though some aspects of the subjects' language skills improved due to the Fast ForWord program, the improvements did not translate into improvements in broad language or actual reading skills. The results also led the authors to conclude that there is no large impact or benefit to computerized instruction. Overall, they summarized that in comparison to the large treatment gains claimed by the developers of Fast ForWord, the likely outcomes are much smaller. They also cite the significant financial and personnel commitment required to implement and maintain the program as a barrier to usage, and that any positive effects of the program are outweighed by these required committments (Rouse & Krueger, 2004). Pokorni, Worthington, and Jamison (2004) completed a study comparing Fast ForWord to two other interventions, Earobics and the Lindamood Phoneme Sequencing Program (LiPS). The study focused on students, who had both speech/language impairments and reading difficulties. Students who were receiving speech/language services through special education and were more than one year below grade level in reading (according to school records and teacher reports) were included in the study. The 54 subjects were randomly assigned to one of the three interventions, and participated in the intervention for three one-hour sessions per day, five days a week, for 20 days during a summer program, which also included lunch, a snack, and recreational activities. Trained speech/language pathologists administered all of the interventions. Assessments given at four to six weeks before the intervention, as well as six to eight weeks post-intervention, included the two subtests from the Phonological Awareness Test

(PAT), three subtests of the CELF-3, and four subtests from the Woodcock Language Proficiency Battery—Revised (WLPB-R) (Letter-Word Identification, Passage Comprehension, Word Attack, and Spelling). The results of the intervention six weeks after their completion indicated that Earobics and LiPS were more effective in improving only phonological awareness in the areas of blending and segmenting than the Fast ForWord program. None of the interventions had an impact on language or reading skills overall. A conclusion and limitation of the study, the authors stated, was that phonemic awareness training should be coupled with other activities that develop alphabetic principle (Pokorni et al., 2004).

In 2009, an additional study examining the impact of Fast ForWord on both language and reading impaired children was undertaken by Loeb, Gillam, Hoffman, Brandel, and Marquis. The sample was created from the subjects in the Gillam et al. study in 2008, and thus, the design was quasi-experimental and subjects were not randomly assigned to the interventions. The sample included 103 children with both language and reading impairments, who were selected due to their additional difficulties with reading. They defined poor reading skills as being at or below the 25th percentile on any of the three subtests of the Woodcock Reading Mastery Test, Revised (WRMT-R). Subjects were assigned to one of four intervention groups—Fast ForWord, a computer-assisted language intervention, individualized language intervention, or an attention control computer program. The computer-assisted language intervention included selected activities from Earobics and the Laureate Learning software program. In the individualized language intervention, clinicians targeted semantics, syntax, narration, and

phonological awareness. In the attention control computer program, activities included computer games in math, social studies, and science (Loeb et al., 2009).

Over the course of three summers, three cohorts of children participated in one intervention for six weeks. Each of the 30 sessions was three and a half hours, five days a week. Children participated in crafts, games, recess, and snacks as well. Pre- and post-assessment procedures were given before treatment, immediately after treatment, and six months after treatment. Assessment procedures included the Elision and Blending Sounds in Words subtests from the CTOPP, three subtests from the WRMT-R (Word Attack, Word Identification, and Passage Comprehension). The examiners administering the assessments were blind to treatment assignment. Data analysis indicated that the three treatment groups of Fast ForWord, computer-assisted language intervention, and individualized language intervention resulted in significant gains in the phonological awareness skill of sound blending, as compared to the attention control computer games group. Long-term gains at six months post-intervention were of a medium effect size and insignificant. Significant changes in reading skills were not found in any of the four groups. The authors suggested that the three interventions, which produced gains, could be supplemented with interventions in sight word recognition and decoding in order to produce significant changes in reading skills (Loeb et al., 2009).

A summary of the research on the impact of Fast ForWord on reading skills indicates results similar to the research on Fast ForWord and language skills. Studies indicated the same gains made as with other interventions, limited gains, no overall impact on language or reading skills, and no significant changes in reading skills. Studies that did find gains in children participating in Fast ForWord, albeit similar to other

interventions, noted that at six months and two years post-interventions, the gains were not maintained. Even in the study which demonstrated modest gains, the authors noted that the time and personnel commitments required by the program outweigh the program benefits.

Fast ForWord and Brain Imaging

There were several studies from the literature that examine the correlation between certain methods of brain imaging and the Fast ForWord intervention program. It is significant to review such studies because the developers of Fast ForWord use results from brain imaging studies to tout the effectiveness of the program. One such study was conducted by Lajiness-O'Neill, Akamine, and Bowyer in 2007. Previous studies utilizing functional neuroimaging indicate that when reading or completing reading-related processes, the systems of the brain that need to be activated include an anterior system involving the inferior frontal gyrus, which is necessary for decoding, a posterior system in the left temporoparietal region for phonological processing or assembled phonology (the "phonological loop"), and a posterior system in the inferior occipitotemporal region responsible for skilled, fluent reading, specifically automatic word recognition. Some subjects with a diagnosis of dyslexia have activation of other occipitotemporal regions that may be compensatory in nature (Lajiness-O'Neill et al., 2007).

Lajiness-O'Neill et al. (2007) sought to study potential changes in neural magnetic sources following an intervention program that focused on temporal processing skills, such as the Fast ForWord intervention program. Magnetoencephalography, or MEG, is a brain imaging procedure used to locate electrical activity by detecting magnetic fields. The study was a single-subject case design with a fourth grade, nine-

year-old child diagnosed with developmental dyslexia. The subject was also noted to have superior cognitive ability and early language delay. It was noted that despite receiving a diagnosis of developmental dyslexia from one of the authors of the study, the subject did not receive special education services and had not in the past. Prior interventions that the subject did not respond to included individual tutoring using an Orton-Gillingham-based approach, as well as classroom accommodations. Aside from the MEG procedure, the subject also participated in assessments of cognitive ability and academic achievement at baseline and three months following the completion of the Fast ForWord program. Assessments included the Wechsler Abbreviated Scale of Intelligence (WASI) and the Woodcock-Johnson Tests of Achievement-Third Edition (WJ-III Ach).

After the subject participated in Fast ForWord for 100 minutes a day, five days a week, for eight weeks, she demonstrated improvements in achievement on subtest scores for passage comprehension and spelling. The researchers also determined that the subject had shifts in magnetic sources, and that certain systems became more localized and less diffuse, suggesting a more efficient use of the phonological loop following intervention. It was concluded that interventions such as Fast ForWord may impact the spatiotemporal activation of individuals following remediation, including changes in systems activated during reading. The authors did recognize the limits of research with a single subject in their discussion (Lajiness-O'Neill et al., 2007).

Two additional brain imaging studies involving Fast ForWord were reviewed in the literature. It is important and worthy to note that both of the following studies included as authors Fast ForWord program developers and Scientific Learning

Corporation co-founders Tallal and Merzenich. In the Temple et al. (2003) study, 32 children, 20 of whom were diagnosed with dyslexia, participated in Fast ForWord for 100 minutes a day, five days a week, for an average of about 30 days. Interestingly, the authors termed the Fast ForWord intervention "behavioral remediation" for the purpose of this study. Subjects in the Fast ForWord intervention were matched with control participants. Pre- and post-assessments included the Woodcock Reading Mastery Test, Revised (WRMT-R) Word Identification, Word Attack, and Passage Comprehension subtests, the Clinical Evaluation of Language Fundamentals, Third Edition (CELF-3), and the Rapid Naming subtest of the CTOPP. Results indicated changes in both reading skills and neural activation areas and activity. Subjects had increases in activation in areas of the brain associated with typical readers. Individual variability between subjects was noted, and the authors did not report if the changes endured over time.

The Gaab, Gabrieli, Deutsch, Tallal, and Temple study completed in 2007 yielded similar results. This study included 22 children with developmental dyslexia and 23 matched control peers. The researchers noted significant improvements in language and reading skills coupled with improved activation in rapid auditory processing after five 20-minute training sessions per day, five days a week for eight weeks. The authors concluded that remediation can effectively nurture neural plasticity. A disclaimer at the end of the study noted that while Tallal was a co-author on the study, she did not participate in the data collection, subject training, or data analysis (Gaab et al., 2007).

In summary, out of the three studies reviewed that examined the use of Fast ForWord and brain activity, only one demonstrated modest results, and the study was one of single-subject design. The other two studies included more subjects but also had one

of the original authors of the Fast ForWord program as an author of each study. These results are best concluded by citing Rouse and Krueger's important consideration when interpreting the results of brain imaging studies. They stated, "There is little evidence that responses detected in brain images translate into measurable changes in relevant skills and behaviors, such as reading ability" (Rouse & Krueger, 2004, p. 325).

Orton-Gillingham-Based Intervention

A group of students in the current study participated in an alternate intervention, the Sonday program, which is based upon Orton-Gillingham principles, and another group received both Sonday and Fast ForWord intervention. Therefore, a review of related literature regarding this approach was completed. Although no specific research on the actual Sonday program exists in the peer-reviewed literature, there are several studies that utilized the Orton-Gillingham approach in their research.

The Sonday System intervention is published by the company, Winsor Learning, Incorporated. It was developed by Arlene Sonday, who is the founder of the Academy of Orton-Gillingham Practitioners and Educators, the only Orton-Gillingham credentialing association. The Sonday System contains the required elements of essential reading instruction and intervention identified by the National Reading Panel. It is also endorsed as a reading intervention by the National Center for Learning Disabilities and the International Dyslexia Association (Winsor Learning, 2011). The intervention program includes the Let's Play Learn intervention for pre-reading skills in younger children, the Sonday System 1, which focuses on foundational and beginning reading skills, and the Sonday System 2 for more advanced reading skills such as fluency and comprehension.

The group of students receiving the Sonday intervention in the current study receives the Sonday System 1 intervention.

The Orton-Gillingham approach includes the following essential components: individualized, multisensory, alphabetic phonics, synthetic/analytic, systematic and logical, sequential, cumulative and integrated, cognitive, fluency, communicative, and emotionally sound (Gillingham & Stillman, 1997). Lessons that utilize the Orton-Gillingham approach must include a review of letters and sounds previously learned, an introduction to the new symbol and sound, lists of individual words that are read aloud, dictation of new and previously learned sounds, dictation of words and sentences using only the phonemes already learned, and oral reading (Florida Center for Reading Research, 2006). This is based on the original theories of Dr. Orton and Ms. Gillingham, who believed that basic skills are hierarchical and should be implemented with a "bottom up" approach, with an emphasis on developing automaticity of skills (Rose & Zirkel, 2007). Rose and Zirkel (2007) also stated that the originators of Orton-Gillingham methodology asserted it should be the sole reading instruction for struggling readers and advised against the use of supplemental reading instruction aside from their methods.

Ritchey and Goeke completed a comprehensive review of the literature regarding Orton-Gillingham in 2006. Of the twelve studies in their review, seven are relevant to the current research study because they used elementary-age students as subjects; others are not related because they used older students. The results for the relevant studies indicated some positive effects for word reading, decoding/word attack, and comprehension skills, but in only five of the twelve studies, which they found surprising, given the reported popularity of the Orton-Gillingham approach. Improved skills were

noted when Orton-Gillingham was used for general education whole-class instruction, and in a specialized intervention setting outside of the classroom. Some studies did not demonstrate positive effects, leading the authors to conclude that the research on Orton-Gillingham is inconclusive (Ritchey & Goeke, 2006). They also cited numerous methodological concerns, including a lack of rigorous and systematic methodology, unfounded claims of causality, treatment procedures that were not well defined, and wide variations in treatments across the studies (Rose & Zirkel, 2007).

A study conducted after Ritchey and Goeke's review was completed by Scheffel, Shaw, and Shaw in 2008. They studied the implementation of an Orton-Gillingham program, the Institute of Multi-Sensory Education (IMSE) supplemental reading program. The program was provided for 30 minutes a day in addition to a 90-minute reading block, with 224 first grade students across three schools. The conclusion of the study was that children, who received the supplemental IMSE intervention, increased in phonemic awareness and alphabetic principle skills in comparison to 476 control group students (Scheffel et al., 2008).

In summary, and as stated in the Ritchey and Goeke review of studies, the research on an Orton-Gillingham approach to instruction and intervention is mixed.

The Language-Reading Connection

As indicated in Chapter One, speech/language impairments can include difficulties with articulation, expressive language, receptive language, pragmatic language, or a combination of these difficulties. A review of the related literature indicates that there are numerous studies examining the correlation between speech/language and reading difficulties. The following review will explore different

theoretical approaches as well as the connections between these difficulties. Also, due to the assumptions made by some authors regarding the connection between language and reading difficulties, as well as the fact that some of the studies examined various aspect of both language and reading, a review of the literature on this connection is also relevant.

Duff, Fieldsend, Bowyer-Crane, and Hulme (2008) refer to the high comorbidity of speech/language disorders and reading difficulties, in that reading difficulties are commonly experienced by children with speech/language difficulties. Within their review of relevant literature supporting this connection, numerous studies and supporting literature are cited (Bishop & Snowling, 2004; Botting, Simkin, & Conti-Ramsden, 2006; Nathan, Stackhouse, Goulandris, & Snowling, 2004; Catts, Bridges, Little, & Tomblin, 2008; Snowling, Bishop, & Stothard, 2000; Storch, & Whitehurst, 2002). Within these studies, each set of authors provide further support from the literature connecting language and reading skills. Bowyer-Crane, Snowling, Duff, and Hulme (2011) also state that oral language skills support the development of both phonological awareness and reading comprehension. Therefore, due to these underpinnings, the connection between children with speech and language impairments and reading difficulties is not unfound (Bowyer-Crane et al., 2011). In their review of the literature, Bowyer-Crane et al. (2011) found that children continue to experience persistent reading difficulties even when their primary language difficulties have been resolved, suggesting a long-term impact of early language difficulties on reading skills (Bowyer-Crane et al., 2011). They also highlight from the literature that students with isolated speech difficulties have a

better long-term prognosis than students with both speech and language or just language difficulties (Bowyer-Crane et al., 2011).

Raitano, Pennington, Tunick, Boada, and Shriberg (2004) further examined the reading difficulties of students with isolated speech issues, and found that the factors leading to poorer reading outcomes were persistence of speech difficulties, as well as comorbid language impairments. They concluded that students with a history of isolated speech difficulties should not be ignored, and attributed the variability of reading success for students within this group to the heterogeneity of issues that may exist within children with speech difficulties (Raitano et al., 2004).

Within the literature on the connection between language and reading, different theoretical models behind the connection are explored. Bishop and Snowling (2004) describe reading disability and speech/language impairment as manifestations of the same underlying problem, but with differing degrees of severity. They indicate that in this theoretical model, reading disabilities are a manifestation of poor phonological processing, and that speech/language impairments can also be caused by this same manifestation, or they can occur without phonological impairment, and thus are better termed as children with poor comprehension skills (Bishop & Snowling, 2004). The addition of phonological processing deficits to existing language skills places children at a greater risk of reading failure (Snowling & Bishop, 2000). Botting, Simkin, and Conti-Ramsden (2006) further explore this theory, and state that phonological ability alone does not equal skilled reading; the addition of language comprehension is necessary for a person to be a skilled reader. The conclusion of their study was that children with speech/language impairments are likely to experience literary problems, and vice versa—

that children with reading problems experience difficulty with language skills beyond phonological awareness (Botting et al., 2006).

Nathan et al. (2004) completed a study that examined the impact of early speech/language difficulties on later reading skills. Their subjects included preschool students, whom they monitored into early elementary grades. Within their study, they found that children with just speech difficulties had better literary outcomes than those with combined speech/language issues. However, they also found that children whose speech difficulties persisted into later childhood were more likely to have reading problems later in their early elementary years (Nathan et al., 2004).

Within a longitudinal study, Catts et al. (2008) established the importance of foundational language skills for later successful reading achievement. They studied a group of children identified as having language impairments in kindergarten, and monitored their word recognition and reading comprehension skills in to grades 2, 4, 8, and 10. The group of students was compared to a control group of children without language impairments. In support of the deficit model of reading growth, they found that children with language impairments demonstrated lower initial reading achievement followed by growth parallel to their non-language impaired peers. In other words, the students began with a gap in reading skills and did not have accelerated growth in their reading achievement, never "catching up" and performing at a commensurate level to their typical peers (Catts et al., 2008).

Two additional studies examined the impact of early speech/language impairments on later reading skills. Storch and Whitehurst (2002) found that students with speech/language impairments in preschool continued to have reading problems over

time, but that their reading issues changed from initial difficulties with phonology, to later also having comprehension difficulties, suggesting that the impact of phonological and speech/language impairments manifest into later difficulties with more complex and higher level reading skills (Storch & Whitehurst, 2002). Stothard et al. (1998) also examined the long-term impact of speech/language impairment in preschool children. They found that even if the initial difficulties with speech/language were resolved, the students continued to demonstrate poorer phonological processing and overall literacy skills, despite demonstrating vocabulary and language comprehension skills commensurate to typical peers (Stothard, Snowling, Bishop, Chipchase, & Kaplan, 1998).

In summary, the literature supporting a connection between speech and language issues and reading skills is consistent. Children with speech and/or language issues are at a high risk for both starting out as poorer readers and having continued issues with reading. The impact of language difficulties is a greater risk factor for later issues with literacy.

Intervention Fidelity

One important factor within the subject of intervention is fidelity of intervention implementation. Bianco (2010) describes fidelity of implementation as the provision of an intervention or instruction as it was intended to be provided". Within her article, she cites a lack of research studying implementation of interventions (Bianco, 2010). Indeed, a review of the literature indicates that there are few studies examining degree of fidelity and treatment outcome. Gresham, MacMillan, Beebe-Frankenberger, and Bocian (2000) stated that although the degree of fidelity is directly related to the degree of intervention outcome, few studies actually examine fidelity. They stressed the importance of

researchers begin able to demonstrate that the interventions implemented were not modified or changed, and that accuracy and consistency with intervention implementation is essential for being able to establish correct conclusions in research (Gresham et al., 2000). They reviewed intervention studies from a five year period of time and found that only 18.5% of the studies actually measured fidelity (Gresham et al., 2000). Although the research is deficient on fidelity, including its importance and how studies have measured it, it is still important for others to attempt to establish fidelity within their studies. Otherwise, it is difficult to believe conclusions made by authors that the results found are in direct result of the intervention implemented.

Outcome Measures

Dynamic Indicators of Basic Early Literacy Skills (DIBELS)

The DIBELS assessments are indicators that measure the progression and development of early literacy skills. For the current study, the most updated and recent version of the DIBELS measures, DIBELS Next, was utilized. The DIBELS subtests can be used to identify students that are in need of additional intervention, as well as evaluate the effectiveness of interventions implemented with students. The reliability and validity of the DIBELS measures has been well established by the developers through a series of studies cited in Good, Gruba, and Kaminski's chapter about DIBELS in *Best Practices in School Psychology* (Good et al., 2001). Reliability ranges from .65 to .98 depending on the use of single or multiple probes, and validity, including concurrent and predictive validity, ranges from .36 to .81. All measures demonstrate sensitivity to growth over time (Good et al., 2001). The DIBELS measures include Initial Sound Fluency, Phoneme Segmentation Fluency, Nonsense Word Fluency, Oral Reading Fluency, Retell, and Daze

measures, which total all five areas of reading referenced previously. For the current study, the applicable DIBELS measures were Phoneme Segmentation Fluency, Nonsense Word Fluency (which contains two areas, Correct Letter Sounds and Whole Words Read), Oral Reading Fluency (which includes Words Read Correctly and Accuracy), and Daze.

The Phoneme Segmentation Fluency measure of DIBELS is a measure of phonological awareness. The student is required to fluently segment words with three or four phonemes into individual sounds. The examiner reads a word aloud to the student and the student is required to say each sound individually, receiving one point for each sound segmented within one minute. Phoneme Segmentation Fluency is administered to kindergarten and first grade students in the fall, winter, and spring (University of Oregon, 2013; Dynamic Measurement Group, 2011).

The DIBELS Nonsense Word Fluency measure assesses the student's knowledge of the alphabetic principle and phonics, including letter-sound correspondence. The student is given a sheet of randomly presented vowel-consonant or consonant-vowel-consonant pseudowords (words that are not real) and is asked to say the individual sounds in the words or read the whole word. One point is given for each sound said within one minute. Because reading the word fluently is more important than knowing the individual sounds, more weight is given to whole words read rather than individual sounds read. The Nonsense Word Fluency measure is given in the fall, winter, and spring to students in kindergarten, first, and second grade (University of Oregon, 2013; Dynamic Measurement Group, 2011).

Oral Reading Fluency, which includes both the number of words read correctly in one minute, as well at the accuracy of the student's reading, is a measure of the student's skills in alphabetic principle, letter-sound correspondence, reading accuracy, reading fluency, and comprehension. Benchmark assessments are administered in the fall, winter, and spring to students in first through sixth grade. If words are omitted, misread/substituted, or a student hesitates for longer than three seconds, an error is counted. If a student corrects him or herself within three seconds, it is not counted as an error (University of Oregon, 2013; Dynamic Measurement Group, 2011).

The fifth DIBELS subtest relevant to the current study is called Daze. Daze is a modified cloze passage assessing reading comprehension. Cloze passages, titled as such to be an abbreviation of the word "closure", are short reading passages with certain words deleted and replaced with a blank. The reader is required to replace the missing words while reading the passage. This type of assessment is meant to assess the reader's usage of context clues and assess the reader's comprehension of the passage (Weber State University, n.d.). The Daze passages for the DIBELS assessment, instead of having blanks for the student to read the word, have three choices, and while reading, the student must select the correct word of the three. One word in each choice box contains the correct word, while the other two are distractors. The students read the passages to themselves silently and choose the correct word by circling it with a pencil (University of Oregon, 2013; Dynamic Measurement Group, 2011).

The DIBELS measures are already utilized within the district in the study as benchmark and progress monitoring measures. District-wide benchmark assessments using DIBELS was implemented approximately eight years ago in order to implement a

universal screening process for all students within the district. The DIBELS assessments are appropriate measures to use, both for the district and in the current study, due to their psychometric properties, the efficiency of administration, clearly defined benchmarks and instructional recommendations, and the availability of multiple forms for each measure (Good et al., 2001).

The Wechsler Individual Achievement Test, Third Edition (WIAT-III)

As reviewed in the Mental Measurements Yearbook in 2009, the WIAT-III is a diagnostic achievement test that is meant to serve several purposes. The instrument can be used for identifying strengths and weaknesses, informing decisions about eligibility for services, assisting in the diagnosis of Specific Learning Disabilities, and helping to design instructional objectives and interventions for students. The average reliability co-efficients for the third edition of the WIAT are .80 or higher, and the composite reliability estimates mostly exceed .90. The instrument is also valid in content and convergent evidence, as well as differentiation between special groups. There is a moderate to high correlation between the WIAT-III and the WIAT-II, as well as between the WIAT-III and the Wechsler ability assessments, indicating strong convergent evidence. When studies of special groups were conducted as the instrument was validated, there were significant differences between special groups, which include students with disabilities and gifted students, and matched controls, for all composites and subtests, indicating that the instrument is valid for informing decisions regarding diagnosis, placement, and services.

The WIAT-III subtests relating to reading skills include the five subtests of Early Reading Skills, Pseudoword Decoding, Word Reading, Oral Reading Fluency, and Reading Comprehension. This instrument and its relevant subtests were chosen as a post-

assessment for the current study for several reasons. One, the measures can be individually administered to students, which allows for more sensitivity of the instrument in establishing strengths and needs. Two, the assessment provides standard scores for each area, comparing students to the national norm group and establishing a useful piece of data for the primary investigator. Third, the five subtests can be administered by the primary investigator in 20 to 45 minutes per student, providing efficiency of usage in relation to the current study.

The Early Reading Skills subtest of the WIAT-III includes several areas relevant to developing reading skills, including letter naming, letter-sound correspondence, phonological awareness, and word reading. The student is asked to identify letters, generate words that rhyme with a given word, identify initial and final sounds, blend sounds, and identify a picture that corresponds with a given sight word. Students in preschool to grade three can be given the Early Reading Skills subtest (Pearson, 2009).

The WIAT-III Reading Comprehension subtest can be given to students in grades one through twelve. Students are asked to read a variety of passages, including fiction, informational text, advertisements, and instructional passages. Students may choose to read aloud or silently, and are not timed when reading. After the passage is read, students are orally questioned by the examiner and must provide an oral response to both literal and inferential questions (Pearson, 2009).

The Word Reading subtest includes a list of words without context with increasing difficulty, which is given to the student and read aloud. The student's speed of reading is timed and calculated by the word read at 30 seconds, and the accuracy is measured through the student reading the word correctly or incorrectly (Pearson, 2009).

The WIAT-III Pseudoword Decond subtest also measures both speed and accuracy, but with pseudowords that are not real words, also with increasing difficulty.

The WIAT-III Oral Reading Fluency subtest measures the speed, accuracy, and fluency of a student's oral reading skills. The student must read the passages aloud and is timed while reading. A comprehension question is asked at the conclusion of the passage. The student's reading fluency is calculated by the number of words read correctly per minute (Pearson, 2009).

CHAPTER THREE

PROCEDURES

Introduction

In order to investigate the research questions, data were collected regarding participants' pre- and post-intervention assessments, which included fall 2012 Dynamic Indicators of Basic Early Literacy Skills (DIBELS) benchmark scores, spring 2013 DIBELS Oral Reading Fluency scores, as well as individually administered achievement test scores, which were administered to participants in the spring of 2013. Between the pre- and post-tests, participants joined one intervention, two interventions, or no intervention, the latter of which constituted the control group for the study. All participants also received regular classroom instruction in reading and language arts. It was assumed that all students included in the study progressed normally through their corresponding grade level throughout the school year relevant to the study. At the time of the pre-test, the students were at the beginning of their first, second, or third grade school year, and at the post-test, the students were at the end of their first, second, or third grade school year.

Design

The design of this study is non-experimental in nature because participants were not randomly assigned. All participants in the study shared a common characteristic: each had one or more scores below the benchmark on the fall benchmark assessment of the DIBELS. Thus, all participants were defined, for the purpose of this study, as struggling readers. How the prospective participants were divided into the intervention or control groups was left to the discretion of reading specialists in the district.

Participants who demonstrated a higher level of need, as evidenced by more than one DIBELS score below the benchmark, were assigned to one of the three intervention groups, while students with less of a need were included in the control group. The control group of students receiving no intervention was offered intervention through either participation after the study or through a summer reading program. Students in need after the interventions were completed for the study were then given the opportunity to participate in the Fast ForWord or Sonday program, or they were offered general reading support and the Sonday program through a summer reading program.

Population

The population of interest in this study was elementary-age children, ranging from approximately six to nine years of age, who were struggling readers. Struggling readers, for the purpose of this study, were defined as students who had not met the benchmark on at least one measure of the DIBELS assessment. The school district, a suburban district approximately 15 miles south of the city of Pittsburgh, in southwestern Pennsylvania, contains approximately 3000 students from kindergarten through 12th grade. Most students within the district are Caucasian, with less than 5% of the students designated as non-Caucasian in race (Pennsylvania State Data Center, 2012). Less than one percent of the students are English Language Learners, with approximately ten students out of roughly 3,000 receiving services. Within the district, approximately 11% of students are eligible for free or reduced lunches (Pennsylvania Department of Education, 2013). Ten percent of the population is identified as educationally disabled and receiving special education services; within the ten percent of educationally disabled students, 37% are identified as having a Specific Learning Disability, 27% have a Speech or Language

Impairment, 9% have an Autism Spectrum Disorder, 10% have an Emotional Disturbance, and 13% fall under the educational disability of Other Health Impairment (Pennsylvania Department of Education, 2013).

Sample

Participants targeted for this study included children ranging in age from six to nine years of age. This age range was chosen for the study because it is the approximate age of students in first through third grades. Kindergarten students were excluded from the sample because no kindergarten students received the Fast ForWord intervention. Fourth and fifth grade students were excluded from the subject pool because the students receiving the Sonday intervention in these grades also received other reading interventions, which may have included the Read Naturally and Rewards interventions. Sixth graders were excluded because they only received Fast ForWord and did not receive any other reading intervention, such as Sonday, and thus a Sonday and combined intervention group would not have existed for sixth graders. Participants included both male and female students. In order to be included in the study as a participant, all participants required at least one score below the benchmark on the fall benchmark assessment of the DIBELS. Students who had been recently assessed and therefore had already been given the Wechsler Individual Achievement Test, Third Edition (WIAT-III) reading subtests, were excluded from the study. Any participants known to be receiving any additional reading interventions, either within the school setting or outside of school, were to be excluded from the study, but no such participants existed. Participants required parental consent, as well as informed assent, in order to participate. Although 149 prospective participants were targeted for participation, exclusions and lack of

parental consent to participate led to a total number of 87 participants included in the study.

Assignment

The participants included in the study were assigned to different interventions or the control group by reading specialists employed by the school district in the fall of 2012. Data used by the reading specialists to assign the participants to different interventions were the fall benchmark DIBELS assessments. The reading specialists assigned participants to the Fast ForWord, Sonday, or both intervention groups. A fourth group of participants who were not included in either intervention, but had at least one below benchmark score on the DIBELS assessment, were assigned to a control group by the principal investigator. Any participant who received additional reading tutoring or other reading intervention outside of the school district would have been excluded from the study, but no such participants emerged. Students began receiving the interventions in approximately the sixth week of the school year, and continued receiving intervention until either withdrawn by the parent, exited by the reading specialist, the student moved, or the school year ended. All of the participants in this study received the interventions until the end of the 2012-2013 school year, approximately the first week of June 2013. Any student data that had concerns with individual fidelity of implementation within any of the intervention groups would also have been excluded if such concerns had emerged. Tables 1 and 2 are an itemization of the number of participants included in the study, divided by intervention group, sex, and grade.

Table 1

Number of Participants in Study by Grade and Intervention Group

Intervention Group	Grade 1 n	Grade 2 n	Grade 3 n	Total in Group n
Fast ForWord	8	10	8	26
Sonday	6	6	5	17
Both	8	1	10	19
Control	8	7	10	25
Total in Grade	30	24	33	87

Note. n = number of participants

Table 2

Number of Participants in Study by Grade and Sex

Grade	Sex		Total by Grade
	Male	Female	
1	16	14	30
2	15	9	24
3	18	15	33
Total by Sex	49	38	87

Procedures

In the fall of 2012, all students in the sample's school district in grades one through three were given the DIBELS assessments as a fall benchmark as part of the school district's typical school practice. Students who scored below the benchmark were then assigned to the Fast ForWord, Sonday, both interventions, or control groups, and thus became the subjects in the study. The lists of specific students were given to the principal investigator by the reading specialists in each building. Beginning in

approximately the fifth week of school, and throughout the fall 2012, winter 2012-2013, and spring 2013, subjects in the intervention groups received the corresponding intervention or interventions. Fidelity of implementation of the Fast ForWord program was monitored through the Progress Tracker online program, which is part of the Fast ForWord product. This was completed by the principal investigator in conjunction with the reading specialists. The Progress Tracker program monitored student participation in the program and flagged any students who were not participating according to protocol (i.e., not enough minutes a day or days per week), as well as students who were carelessly or randomly responding. Fidelity of implementation for the Sonday program was completed using a generic fidelity checklist, completed by the examiner with the reading specialists, and included monitoring of days per week the intervention was implemented, progression through the Sonday lessons, and administration of mastery checks. Part of the fidelity monitoring for the Sonday program also included supervisory records of the reading specialists by the building principals. These records included classroom observations completed by the principals, as well as supervisory evaluations of the teachers.

Toward the conclusion of the intervention period, parental consent was attempted for all students on the initial subject list provided to the examiner by the reading specialists, with exclusions made for students who lacked fidelity for their intervention, withdrew from intervention, or received additional reading intervention within the intervention period. Fidelity data were gathered off of the Progress Tracker website by the district reading specialists, and any concerns with fidelity were flagged and the primary investigator was notified. One student had fidelity concerns due to participation

in the intervention, which was caused by excessive absenteeism, and was thus excluded from the study. No students participating in the Sonday intervention were reported to be a concern with fidelity of implementation by the reading specialists during monthly meetings, and no principals reported concerns with intervention implementation to the primary investigator. Only four students targeted for possible participation were excluded due to withdrawing from or changing interventions in the middle of the school year. No students were excluded due to receiving additional reading intervention during the study.

The parent consent included permission to analyze individual DIBELS data and to administer the individualized reading achievement post-assessments. The total subject pool included 149 students. Of the 149 students for whom parental permission was attempted, a total of 87 parents responded and gave consent for participation. Once parental permission was obtained, the principal investigator collected fall 2012 DIBELS benchmark scores as well as spring DIBELS Oral Reading Fluency scores from the online DIBELS database. The DIBELS scores included fall benchmark scores for Phoneme Segmentation Fluency, Nonsense Word Fluency (both Correct Letter Sounds and Whole Words Read), and Oral Reading Fluency (both Words Read Correctly and Accuracy), depending on the measures appropriate for each grade. Third grade participants' fall Daze scores were also collected. During the last two weeks of the 2012-2013 school year, all participating subjects were individually administered the reading subtests from the Wechsler Individual Achievement Test, Third Edition (WIAT-III) by the principal investigator, which included the Early Reading Skills, Pseudoword Decoding, Word Reading, Oral Reading Fluency, and Reading Comprehension subtests.

The standard scores for each subtest were calculated using the scoring software from the publisher of the WIAT-III, PsychCorp.

Statistical Analysis

Data analyzed include the pre-intervention DIBELS scores, as well as post-intervention DIBELS Oral Reading Fluency and WIAT-III reading subtest scores. In order to answer the research questions, multiple analyses of variance and covariance were chosen as the statistical procedures. In order to control for the effects of unwanted variables, or covariates, analysis of covariance was utilized. The data were analyzed using analysis of covariance in order to which group was the highest on the five subtests of the post-assessment, and to determine sex differences. In order to answer the third research question, chi-square analyses were performed.

CHAPTER FOUR

RESULTS

Introduction

The focus of the current study was to compare two interventions, a computerized intervention versus a multisensory reading intervention, and the impact of these interventions on subjects' reading achievement in grades one, two, and three. Also of interest was a third intervention group, which contained subjects receiving both of the interventions. A fourth group that received no intervention served as the control group. Specific research questions posed by the current study, along with their respective hypotheses, are as follows:

1. Are there significant differences in instructional impact among the intervention groups? These groups include the Fast ForWord, Sonday, combined Fast ForWord and Sonday, and control groups.

   Hypothesis 1: The hypothesis for this research question is that all students will make the same amount of progress in reading, regardless of the intervention in which they participate (Olson, 2011; Goeke & Ritchey, 2006; Loeb et al., 2009).

2. Do females or males perform better on the post-test after intervention?

   Hypothesis 2: Based on a review of the literature, sex differences will include higher post-assessment scores in reading favoring females over males (Singh, 2008; Logan & Johnson, 2009).

3. Did the interventions bring students to benchmark?

Hypothesis 3: Each group will have similar percentages of students below, at, and above proficiency. Similar to the hypothesis for research question one, this hypothesis is based on the literature, which found limited impact for these interventions (Olson, 2011; Ritchey & Goeke, 2006; Loeb et al., 2009).

Summary of Statistical Analyses for Research Question One

Pre-Test Measure: Dynamic Indicators of Basic Early Literacy Skills (DIBELS)

Although parent permission to administer the post-test and utilize participants' DIBELS scores as the pre-test measure was attempted for 149 participants, parent permission was granted for a total of 87 participants, with 49 males and 38 females. Thirty first grade children participated in the study, as well as 24 second grade participants and 33 third graders. A total of 26 participants who received the Fast ForWord intervention were included, as well as 17 participants who received the Sonday intervention, 19 participants who received both the Fast ForWord and Sonday interventions, and a control group of 25 participants.

Pre-test data included a possible five DIBELS assessments, including Phoneme Segmentation Fluency (PSF), Nonsense Word Fluency (NWF)—Correct Letter Sounds (CLS), Nonsense Word Fluency (NWF)—Whole Words Read (WWR), Oral Reading Fluency (ORF)—Words Read Correctly (WRC), Oral Reading Fluency (ORF)—Accuracy, and the DIBELS Daze measures. Within the tables and analyses in Chapter Four, PSF refers to the number of phonemes the subject correctly segments within one minute. CLS refers to an aspect of the NWF assessment, and is the number of correct letter sounds the subject identifies within one minute. WWR is the number of whole

words the subject reads after segmenting sounds within one minute, and is the other aspect of the Nonsense Word Fluency assessment. ORF contains two aspects, Words Read Correctly (WRC), which is the number of words the subject correctly reads from a passage in one minute, as well as Accuracy, which is the accuracy of a participant's passage reading within one minute (calculated as a percentage based on the number of words read correctly divided by the total number of words read).

PSF is only given to students in first grade for the fall benchmark assessment, and according to standardization, it is not administered thereafter. The NWF assessment is given to first graders for all three benchmark assessments (fall, winter, and spring), and to second grade students at the fall benchmark assessment. ORF is administered for the winter and spring benchmarks for first grade, and all three benchmarks for second and third grade students. Third grade students also are given the Daze subtest.

Because not all assessments are available in all three grades, not every assessment was given to every student for the fall benchmark DIBELS assessment, which was utilized as this study's pre-test measure. Table 3 includes the number of participants who received each pre-test DIBELS assessment, as well as whether their scores were well below benchmark, below benchmark, or at/above benchmark.

Table 3

Number of Participants Per Intervention Group by Pre-Test DIBELS Score

	Phoneme Segmentation Fluency (n=29)			
Intervention Group	1 (Well Below Benchmark)	2 (Below Benchmark)	3 (At or Above Benchmark)	Total
Fast ForWord	2	3	2	7
Sonday	4	1	1	6
Both	3	1	4	8
Control	4	0	4	8
Total	13	5	11	29

Nonsense Word Fluency/Correct Letter Sounds (n=53)

Intervention Group	1 (Well Below Benchmark)	2 (Below Benchmark)	3 (At or Above Benchmark)	Total
Fast ForWord	6	5	6	17
Sonday	5	5	2	12
Both	6	3	0	9
Control	6	4	5	15
Total	23	17	13	53

Nonsense Word Fluency/Whole Words Read (n=53)

Intervention Group	1 (Well Below Benchmark)	2 (Below Benchmark)	3 (At or Above Benchmark)	Total
Fast ForWord	5	1	11	17
Sonday	5	3	4	12
Both	0	6	3	9
Control	1	6	8	15
Total	11	16	26	53

Oral Reading Fluency/Words Read Correctly (n=58)

Intervention Group	1 (Well Below Benchmark)	2 (Below Benchmark)	3 (At or Above Benchmark)	Total
Fast ForWord	2	13	4	19
Sonday	10	1	0	11
Both	9	2	0	11
Control	0	5	12	17
Total	21	21	16	58

Oral Reading Fluency/Accuracy (n=58)

Intervention Group	1 (Well Below Benchmark)	2 (Below Benchmark)	3 (At or Above Benchmark)	Total
Fast ForWord	1	6	12	19
Sonday	7	2	2	11
Both	7	3	1	11
Control	0	3	14	17
Total	15	14	29	58

Daze (n=34)

Intervention Group	1 (Well Below Benchmark)	2 (Below Benchmark)	3 (At or Above Benchmark)	Total
Fast ForWord	2	4	3	9
Sonday	3	0	2	5
Both	8	2	0	10
Control	1	5	4	10
Total	14	11	9	34

In addition to different assessments administered at various grade levels, each assessment is typically measured with a number indicating the respective score for the area being measured. For example, oral reading fluency in second grade ranges from zero to 36 words correct per minute in the "well below benchmark" category, 37 to 51 in the "below benchmark" category, and 52 and above for the "at or above benchmark" category. These numbers change within the grade level throughout the school year. For example, the "well below benchmark" range changes from zero to 54 for second graders in the middle of the year, to zero to 92 for second graders at the end of the school year. Also, due to an increase in the difficulty of the content and readability level of the DIBELS reading probes, different numbers mean different levels of performance. Thus, an oral reading fluency score of 15 at the beginning of second grade does not have the same meaning as an oral reading fluency score of 15 at the end of second grade because the probe difficulty increases throughout the school year to reflect the increasing demands of reading. It would not mean that the student maintained their level, but rather that they decreased in their reading skills. Table 4 includes the ranges of scores per grade, level, and subtest. The benchmark information is available to the public on both the University of Oregon and DIBELS.net websites.

Former, not recommended goals were utilized during the school year of the study. There is currently disagreement between the publishers of DIBELS and the University of Oregon Center on Teaching and Learning on which set of goals are best utilized when making instructional decisions about which level of supports students need. The University of Oregon completed a new data analysis from a national sample of students, and produced a set of new, "recommended" benchmark scores. However, the publishers

of DIBELS disagree with this and recommend that "former" goals continue to be used. The reading specialists within the district of study utilized the former goals, and thus these are the benchmark goals reported for the current study (University of Oregon, 2013; Dynamic Measurement Group, 2011).

Table 4

Fall DIBELS Score Ranges by Grade Level, Level of Performance, and Subtest

DIBELS Assessment	Grade 1			Grade 2			Grade 3		
	Well Below BM	Below BM	At or Above BM	Well Below BM	Below BM	At or Above BM	Well Below BM	Below BM	At or Above BM
PSF	0-24	25-39	40-81	--	--	--	--	--	--
CLS	0-17	18-26	27-143	0-34	35-53	54-143	--	--	--
WWR	N/A	0	1-50	0-5	6-12	13-50	--	--	--
WRC	--	--	--	0-36	37-51	52-275	0-54	55-69	70-300
Accuracy	--	--	--	0-80	81-89	90-100	0-88	89-94	95-100
Daze	--	--	--	--	--	--	0-4	5-7	8-51

Note. "--" indicates that the assessment is not administered at that grade level

Multiple Analyses Of Variance

In order to test the hypothesis for research question one, data analysis consisted of two phases. The first phase included multiple analyses of variance (ANOVA) to determine if differences existed between the four intervention groups. Of particular importance was whether the four groups differed in their initial placement criteria variables, the pre-test DIBELS scores. If no differences existed, then the assumption would be made that the groups were equivalent from the beginning. If there were differences between one or more of the DIBELS scores, then the assumption would be made that there are differences between groups, and thus covariates would emerge as possible causes of differences between groups. If one or more differences existed, post-hoc analyses would be calculated in order to determine which groups had significant

differences. The covariates would then be used to adjust the participants' performance on the post-test, the five Wechsler Individual Achievement Test, Third Edition (WIAT-III) reading subtests.

Using the SPSS software, multiple one-way analyses of variance were computed using the DIBELS pre-test subtests as the dependent variables and the four intervention groups as the factor. Significant differences ($p < .05$) were found within the following four subtests: NWF—Correct Letter Sounds, ORF—Words Read Correctly, ORF—Accuracy, and Daze. No significant differences existed between the groups on the DIBELS measures of PSF and NWF—Whole Words Read. Table 5 lists the significance of the between-groups variance on the DIBELS subtests.

Table 5

Significance of Variance Between Groups on DIBELS Pre-Test Subtests

DIBELS Subtest	Significance (*p*)	F
Phoneme Segmentation Fluency	.062	3.035
Nonsense Word Fluency - Correct Letter Sounds	.040*	2.989
Nonsense Word Fluency - Whole Words Read	.085	2.342
Oral Reading Fluency - Words Read Correctly	.000***	18.258
Oral Reading Fluency - Accuracy	.000***	9.830
Daze	.003**	5.712

Note. *$p < .05$, ** $p < .01$, *** $p < .001$; $df = 3$ for all subtests

This analysis demonstrates that there are differences between the four intervention groups on four of the DIBELS measures. In order to determine exactly which groups are significantly different, post-hoc comparisons were made using the Tukey HSD.

Differences were found between groups as follows in Table 6, with the corresponding level of significance.

Table 6

Differences Between Intervention Groups on DIBELS Pre-Test Subtests

DIBELS Subtests	Intervention Groups	Significance (*p*)
NWF—Correct Letter Sounds	Fast ForWord and Both	.046*
ORF—Words Read Correctly	Fast ForWord and Sonday	.010**
	Fast ForWord and Both	.013*
	Fast ForWord and Control	.009**
	Sonday and Control	.000***
	Both and Control	.000***
ORF—Accuracy	Fast ForWord and Sonday	.005**
	Fast ForWord and Both	.005**
	Sonday and Control	.001**
	Both and Control	.001**
Daze	Both and Control	.002**

Note. * $p < .05$, ** $p < .01$, *** $p < .001$

Comparisons indicate that on NWF—Correct Letter Sounds, the Fast ForWord group was higher than the combined intervention, or "Both" group. On ORF—Words Read Correctly, the Fast ForWord group was higher than the Sonday and Both groups, and the Control group was higher than the other three groups, Fast ForWord, Sonday, and Both. On the ORF—Accuracy measure, the Fast ForWord group was higher than the Sonday and Both groups, and the Control group was higher than Sonday and Both

intervention groups. On the Daze measure, Control subjects scored higher than the Both intervention group. Although there were differences in pre-test scores between these groups on these measures, the only significant differences existing between multiple groups occurred on the two DIBELS ORF subtests, ORF—Words Read Correctly and ORF—Accuracy.

Due to the multiple, significant differences between groups on the ORF—Words Read Correctly and ORF—Accuracy subtests, these measures were utilized as covariates when analyzing the post-intervention assessment. By using these two measures as covariates, the post-intervention means were adjusted to account for pre-test differences in participants. Differences between the groups on the other DIBELS measures were not significant, and thus the other DIBELS subtests, including NWF, PSF—Correct Letter Sounds, PSF—Whole Words Read, and Daze, were not utilized as covariates. In conclusion, it can be said that the participants in each group had significant differences in their oral reading fluency skills, both in number of words read correctly in one minute and in their accuracy, at pre-intervention, but they had similar phoneme segmentation, decoding, and comprehension skills before the interventions.

Post-Test Measure: Wechsler Individual Achievement Test, Third Edition (WIAT-III) Reading Subtests

The post-test measure was administered to 87 participants for whom parent permission for participation was obtained. The post-intervention assessment included the five reading subtests from the WIAT-III, which are Early Reading Skills, Reading Comprehension, Word Reading, Pseudoword Decoding, and Oral Reading Fluency. For the participants' performance on each measure, a standard score is reported. Standard

scores for each subtest have a mean of 100 and a standard deviation of 15; thus, the average range includes standard scores from 85 to 115. Scores of 84 and below are considered below average, while scores of 116 and above are above average.

Multiple Analyses of Covariance

To answer the first research question, which questioned the differences in instructional impact among the different intervention groups, and in order to control for differences in participants based on pre-test data, multiple analyses of covariance, or ANCOVA, were utilized as the statistical procedure. These analyses were completed using the SPSS program. ANCOVA provided adjustments for the post-test scores to help ensure that any post-test differences were a result of the various interventions and not a residual effect of the pre-test differences among the groups of participants. The two covariates were the DIBELS subtests of ORF—Words Read Correctly and ORF—Accuracy, which are the two Oral Reading Fluency subtests. These data were used as a part of the ANCOVA analysis of the post-test WIAT-III measures in order to eliminate the variance among the groups at pre-test.

On the first post-intervention subtest measure, the WIAT-III Early Reading Skills subtest, the analysis indicated no significant differences among groups, F (3, 50) = .624; p = .603. Therefore, hypothesis one, positing no differences among groups, was confirmed in regard to the participants' skills in this area of reading. The Early Reading Skills subtest measures basic skills such as letter and sound identification, rhyming, initial and final sound identification, blending sounds, and sight word knowledge. Table 7 lists the adjusted means for the post-test on the WIAT-III Early Reading Skills Subtest.

Table 7

WIAT-III Early Reading Skills Post-Test Means Adjusted for Pre-Test Differences

Intervention Group	Adjusted Means	Standard Deviation
Fast ForWord	102.358	2.988
Sonday	98.770	4.070
Both	98.389	4.046
Control	96.598	3.572

Note. Adjusted means reported as standard scores.

The second subtest for the post-intervention assessment was the WIAT-III Reading Comprehension measure. The analysis indicated a significant difference between the intervention groups, F (3, 50) = 3.94; p = .013. Thus, the hypothesis that no differences would exist among groups could not be confirmed in the area of reading comprehension and must be rejected. Pairwise comparisons of differences among groups indicate that the Fast ForWord and Control groups differed significantly, the Sonday and Both groups differed significantly, and the Both and Control groups differed significantly when considering the participants' reading comprehension skills, as shown in Table 8.

Table 8

Differences Between Intervention Groups on WIAT-III Reading Comprehension Post-Test

	Fast ForWord	Sonday	Both	Control
Fast ForWord	--	NS	NS	X (p = .038)
Sonday	NS	--	X (p = .016)	NS
Both	--	--	--	X (p = .005)

Note. NS = no significant difference; X = significant difference between two groups

Table 9 specifies the adjusted post-test means by intervention group for post-test performance on the WIAT-III Reading Comprehension subtest. Results indicate that the Control group performed better than the other three groups. Also, the Sonday group performed better than the Fast ForWord and Both group. Finally, the Fast ForWord group performed better than the Both group.

Table 9

WIAT-III Reading Comprehension Post-Test Means Adjusted for Pre-Test Differences

Intervention Group	Adjusted Mean	Standard Deviation
Fast ForWord	95.067	1.689
Sonday	97.638	2.301
Both	90.508	2.287
Control	100.545	2.019

Note. Adjusted means reported as standard scores.

When considering the WIAT-III Word Reading subtest, the analysis again indicates an overall main effect for group and thus, significant differences among the intervention groups, F (3, 50) = 4.872; p = .005. Pairwise comparisons demonstrated differences between the Control group and all other intervention groups, including the Fast ForWord, Sonday, and Both groups. Hypothesis one is rejected because group differences do exist in participants' word reading skills. Table 10 lists the group differences, while Table 11 lists adjusted post-test means for post-intervention WIAT-III Word Reading scores. Results indicate that the Control group performed better than the other three groups, The Fast ForWord group performed better than the Sonday and Both groups, and the Sonday group had a higher performance than the Both group.

Table 10

Differences Between Intervention Groups on WIAT-III Word Reading Post-Test

	Fast ForWord	Sonday	Both	Control
Fast ForWord	--	NS	NS	X (p = .006)
Sonday	NS	--	NS	X (p = .013)
Both	--	--	--	X (p = .001)

Note. NS = no significant difference; X = significant difference between two groups

Table 11

WIAT-III Word Reading Post-Test Means Adjusted for Pre-Test Differences

Intervention Group	Adjusted Mean	Standard Deviation
Fast ForWord	95.382	2.414
Sonday	93.176	3.288
Both	87.764	3.268
Control	105.833	2.886

Note. Adjusted means reported as standard scores.

The fourth WIAT-III reading subtest administered as a post-test after the interventions was the Pseudoword Decoding subtest. When the ANCOVA analysis was computed, similar results were found among groups as the Word Reading subtest, F (3, 50) = 5.250; p = .003. All three intervention groups, Fast ForWord, Sonday, and Both, were statistically different in adjusted post-intervention scores than the Control group. In the area of participants' pseudoword decoding skills, the hypothesis that no differences would exist after the intervention between each group is rejected. The group differences are listed in Table 12, while Table 13 lists adjusted post-test means for post-intervention WIAT-III Pseudoword Decoding scores. Results again indicate that the Control group

had the highest performance, while the Fast ForWord group performed better than the Sonday and Both groups. The Sonday group performed better than the Both group.

Table 12

Differences Between Intervention Groups on WIAT-III Pseudoword Decoding Post-Test

	Fast ForWord	Sonday	Both	Control
Fast ForWord	--	NS	NS	X (p = .006)
Sonday	NS	--	NS	X (p = .010)
Both	--	--	--	X (p = .000)

Note. NS = no significant difference; X = significant difference between two groups

Table 13

WIAT-III Pseudoword Decoding Post-Test Means Adjusted for Pre-Test Differences

Intervention Group	Adjusted Mean	Standard Deviation
Fast ForWord	93.158	2.355
Sonday	90.713	3.207
Both	85.178	3.187
Control	103.560	2.814

Note. Adjusted means reported as standard scores.

The final WIAT-III subtest administered to the participants post-intervention was the Oral Reading Fluency subtest. ANCOVA analysis determined that no significant differences existed among the intervention groups' adjusted post-test scores, with $p > .05$ ($p = .179$); $F (3, 50) = 1.7$; N.S. Therefore, the hypothesis that no differences would be found between groups on the post-test measure is accepted for the area of oral reading fluency. Table 14 lists the adjusted post-test means for oral reading fluency on the post-test.

Table 14

WIAT-III Oral Reading Fluency Post-Test Means Adjusted for Pre-Test Differences

Intervention Group	Adjusted Mean	Standard Deviation
Fast ForWord	94.352	2.137
Sonday	89.950	2.910
Both	89.778	2.893
Control	98.765	2.554

Note. Adjusted means reported as standard scores.

The hypothesis related to the first research question stated there would be no significant differences between the intervention groups, or between the intervention groups and the Control group. This hypothesis is rejected because of the results of the ANCOVA, which established the presence of differences between groups for the WIAT-III subtests of Word Reading, Pseudoword Decoding, and Reading Comprehension. The hypothesis of no differences between groups was confirmed for the subtests of Early Reading Skills and Oral Reading Fluency. Table 15 lists all of the adjusted means for the three subtests with significant differences between groups, and Table 16 includes the two subtests with no significant differences for comparison purposes.

Table 15

Adjusted Post-Test Means for WIAT-III Subtests with Significant Differences Between Groups

Intervention Group	Word Reading	Pseudoword Decoding	Reading Comprehension
Fast ForWord	95.067	93.158	95.067
Sonday	97.638	90.713	97.638
Both	90.508	85.178	90.508
Control	100.545	103.560	100.545

Note. Adjusted means reported as standard scores.

Table 16

Adjusted Post-Test Means for WIAT-III Subtests with No Significant Differences Between Groups

Intervention Group	Early Reading Skills	Oral Reading Fluency
Fast ForWord	102.358	94.352
Sonday	98.770	89.950
Both	98.389	89.778
Control	96.598	98.765

Note. Adjusted means reported as standard scores.

Summary of Statistical Analyses for Research Question Two

The second research question addressed sex differences in post-intervention outcomes. The question was, do females or males perform better on the post-test after intervention than male students? The hypothesis for this research question was based on the literature, which indicates that females perform better in reading than males (Singh, 2008; Logan & Johnson, 2009). Thus, analysis examining whether differences exist

between males and females is an important factor when considering these results. The hypothesis was that the outcomes for females would be more favorable in general. Table 17 indicates the number of participants by sex and intervention group.

Table 17

Number of Participants by Sex and Intervention Group

Sex	Fast ForWord	Sonday	Both	Control	Total
Male	15	10	13	11	49
Female	11	7	6	14	38
Total	26	17	19	25	87

The second research question was answered using two-way analysis of covariance (ANCOVA) to determine if significant differences exist by sex. Each WIAT-III subtest score was analyzed using a two-way ANCOVA on SPSS. For the WIAT-III Early Reading Skills subtest, results indicated no significant effect for sex, F (1, 46) = 3.492; N.S., and no interaction effect for group and sex, F (3, 46) = 1.051; N.S. Thus, there were no significant differences in the adjusted post-test results for males and females on the WIAT-III Early Reading Skills subtest.

Analysis of participants' adjusted WIAT-III Reading Comprehension subtest scores indicated an overall main effect for sex, F (1, 46) = 4.605; p = .037, but no interaction effect for group and sex, F (3, 46) = .818; N.S. The mean WIAT-III Reading Comprehension score for male participants was 94.028, while the female participants' mean was 98.254, a mean difference of 4.226 favoring females over males. An examination of the differences between adjusted post-test scores for males versus females by intervention indicates that females scored higher than males in every intervention

group, although some of the higher mean scores were marginal (only one standard score point), thus the insignificant interaction effect.

On the Word Reading adjusted subtest scores of the WIAT-III post-test, there was no effect for sex or interaction, F (1, 46) = .414; p = .523, and F (3, 46) = .243; p = .866, respectively. No differences between the two sexes were found for the WIAT-III Pseudoword Decoding subtest, F (1, 46) = .009; p = .924, and no interaction effect for group and sex was evident, F (3, 46) = .724; p = .543. This demonstrated no sex differences on the performance of male versus female participants on the WIAT-III Word Reading and Pseudoword Decoding subtests, as well as no interaction effects.

When male versus female participants' performance on the WIAT-III Oral Reading Fluency subtest was analyzed, there was a significant difference between the performance of males and females on this post-intervention subtest, F (1, 46) = 8.899; p = .005, although no interaction effect was found, F (3, 46) = .914; p = .422. The mean WIAT-III Oral Reading Fluency score for males was 90.085, while females scored a mean of 97.354, a 7.269 standard score point difference favoring females over males. Regardless of intervention, females scored higher than males.

In summary, the impact of participants' sex was demonstrated for the participants' performance on WIAT-III Reading Comprehension and Oral Reading Fluency subtests, and no interaction effects were found. The answer to the research question is that significant differences were found between males and females for the subtests of Reading Comprehension and Oral Reading Fluency, and for both measures, females scored higher than males. Table 18 includes a summary of the mean scores for

males and females by WIAT-III reading subtest, and Table 19 includes a summary of the significant effects for group and sex.

Table 18

Adjusted Mean Scores for WIAT-III Subtests for Male and Female Participants

Sex	Early Reading Skills	Reading Comprehension	Word Reading	Pseudoword Decoding	Oral Reading Fluency
Male	95.916	94.028	94.846	92.983	90.085
Female	102.537	98.254	96.788	92.702	97.354
Difference	6.622	4.226*	1.943	.281	7.269**

Note. Mean score reported as standard score.
a. * $p < .05$, ** $p < .01$, *** $p < .001$

Table 19

Summary of Significance for Group, Sex, and Interaction Effects

WIAT-III Subtest	Group Effects	Sex Effects	Interaction Effects
Early Reading Skills	NS	NS	NS
Reading Comprehension	.011*	.037*	NS
Word Reading	.010**	NS	NS
Pseudoword Decoding	.009**	NS	NS
Oral Reading Fluency	NS	.005**	NS

Note. NS = not significant
a. * $p < .05$, ** $p < .01$, *** $p < .001$

Summary of Statistical Analyses for Research Question Three

The third research question concerned whether the interventions brought students to benchmark. In other words, did the interventions implemented for the treatment groups close the reading gap existing within the struggling readers. The hypothesis for

this research question was that the students who received interventions would continue to score below the benchmark, despite receiving treatment. In order to answer this question, a chi-square analysis was conducted for the participants' spring, end-of-the-school year DIBELS Oral Reading Fluency scores. Table 20 lists the DIBELS benchmark score ranges for Oral Reading Fluency per grade.

Table 20

Spring DIBELS Oral Reading Fluency Score Ranges by Grade Level and Level of Performance

Grade	Well Below Benchmark	Below Benchmark	At or Above Benchmark
First	0-31	32-46	47-250
Second	0-64	65-86	87-275
Third	0-79	80-99	100-300

First, the scores were recoded because each grade consists of different DIBELS Oral Reading Fluency benchmark scores. The benchmark, or words read correctly, for first grade students at the end of first grade is 47 words correct per minute. In grade two, the benchmark score is 87 words correct per minute, and third graders must read 100 words correct per minute to meet the benchmark. To recode the scores, any scores that were well below and below the benchmark were coded as zero, or below benchmark. Scores at or above the benchmark were coded as one, or benchmark. A total of 86 participants' DIBELS spring Oral Reading Fluency scores were recoded; a score was not available for one student.

The results of the Pearson chi-square analysis for DIBELS spring Oral Reading Fluency scores indicated significance (χ^2 (3) = 32.068, p = .000). Of the 86 participants

participating in the spring DIBELS Oral Reading Fluency assessment, 57% did not meet the benchmark, while 43% of the participants did; thus, participants were more likely to score below benchmark on the spring Oral Reading Fluency DIBELS assessment than below the benchmark. Data were then fragmented into two groups of participants, those who received a treatment and those who did not. Of the 61 total students who participated in an intervention, 45 remained below the benchmark post-intervention, including the group of students that received two interventions. This is a total of 74% of the students, who despite receiving treatment, continued to score below the benchmark in oral reading fluency. Of the control participants, who received no treatment, only four remained below the benchmark at the end of the school year on the DIBELS Oral Reading Fluency measure, indicating that 84% of the control students met the benchmark. The reader is directed to the most important piece of qualitative data answering research question number three: a large number of students, despite receiving intervention or interventions, continued to perform below the benchmark after a year of treatment.

Summary

Significant differences were not found among intervention groups in the reading skill areas of early reading skills and oral reading fluency, as measured by the WIAT-III reading subtests. Differences among groups were statistically significant for word reading, pseudoword decoding, and reading comprehension skills, as measured by the WIAT-III reading subtests. Sex differences existed among groups for reading comprehension and oral reading fluency as measured by the WIAT-III, but no interaction effects were evident through data analysis. Finally, almost 75% of the participants who

received treatment remained below the benchmark on spring DIBELS Oral Reading Fluency, despite one school year of intervention or multiple interventions. Hypothesis one, which predicted no differences between groups, was rejected based on the adjusted post-intervention scores for Reading Comprehension, Word Reading, and Pseudoword Decoding, and was confirmed for Early Reading Skills and Oral Reading Fluency. Hypothesis two, which projected sex differences in post-intervention scores favoring females over males, was confirmed for Reading Comprehension and Oral Reading Fluency, but was rejected due to no sex differences in adjusted post-intervention scores for Early Reading Skills, Word Reading, and Pseudoword Decoding. The third hypothesis, which indicated that participants would continue to score below the benchmark after the intervention period, was confirmed due to 74% of students receiving intervention continued to score below the benchmark on the DIBELS spring Oral Reading Fluency assessment.

CHAPTER FIVE

DISCUSSION

This study sought to compare two different interventions' effects on the reading achievement skills of elementary students who were struggling with one or more aspects of reading. Initially, the study proposed to compare a computerized intervention to a multisensory intervention, as well as a control group, but as the study progressed, an additional group emerged due to the combination of the computerized and multisensory interventions for a fourth group of participants. Thus, the study examined the comparison of four groups across the course of a school year: a Fast ForWord intervention group, a Sonday intervention group, an intervention group composed of participants who received both the Fast ForWord and Sonday interventions, and a control group of participants receiving no intervention. Questions posed for this research included the impact of the interventions on the participants' reading skills, whether there were any sex differences between the groups, and whether the interventions increased the participants' reading skills to a proficient level. Despite the two seminal studies on Fast ForWord citing marked differences in participants' language skills, and the claims of the publishers that Fast ForWord is an effective reading intervention, the current study questioned these claims, based primarily on other research citing the program's lack of or minimal effectiveness, including Gillam's 1999 critique of the original research, as well as five small sample studies published in the American Journal of Speech and Language Pathology in 2001. The five studies from 2001 produced mixed results, far less dramatic gains than the original two Fast For Word Studies, and similar gains made by different

intervention groups (Friel-Patti, DesBarres, & Thibodeau, 2001; Loeb et al., 2001; Gilliam et al., 2001; Thibodeau et al., 2001; and Marler et al., 2001).

In order to answer the research questions and confirm or deny the hypothesized results, multiple analyses of covariance were completed. This procedure allowed the investigator to adjust for pre-test differences in participants' reading scores before the intervention occurred. Pre-test differences were found between groups on the DIBELS measures of NWF—Correct Letter Sounds, ORF—Words Read Correctly, ORF—Accuracy, and Daze subtests. Reading specialists within the school district used their professional judgment to place students into intervention groups or decide that participants would receive no intervention. Variances between school buildings, grades, and knowledge of each subject were likely factors that were taken into account when students were assigned into each of the four groups. Thus, it would be expected that there would be variance between the groups. Students with fewer DIBELS pre-test scores below benchmark were more likely to be placed in the control group receiving no intervention, and students with multiple pre-test scores below benchmark were likely placed into the treatment group in which participants received two interventions, as they were most likely deemed as "more in need" of intervention than other participants. Students with a high level of need could not be excluded from intervention and were placed into an intervention group based on their respective needs. Although protections were afforded to the control group, including participation in an intervention after the study and a summer reading program, it was still necessary to provide interventions for students who were more in need due to more than one below benchmark pre-test subtest score.

Words Read Correctly and Accuracy, which were the two Oral Reading Fluency measures on the DIBELS pre-test, were found to be significant and thus were covariates factored into the post-test data analysis. As stated previously, even though better readers were placed into the control group, the four study groups only differed significantly on the two Oral Reading Fluency measures, indicating that all participants had very similar skills in segmenting phonemes, decoding, and comprehension. Although NWF—Correct Letter Sounds and Daze subtest had difference in pre-test scores, the differences were not significant enough to utilize these subtests as covariates. Using the two Oral Reading Fluency measures as covariates allowed the investigator to control for the differences in groups on the two Oral Reading Fluency measures. Therefore, any differences found after data analyses in the post-test are not due to the pre-test differences between each group's reading fluency skills.

Once the data analysis was completed, analysis of covariance indicated group differences in participants' Word Reading, Pseudoword Decoding, and Reading Comprehension skills on the WIAT-III post-intervention measure. Therefore, it can be concluded that the interventions had some reasonable impact on participants' reading comprehension, word reading, and pseudoword decoding skills. In the area of reading comprehension, the participants receiving no intervention at all had the highest mean score (standard score = 100.545), with the Sonday participants as the second highest mean (97.638), the Fast ForWord participants as the third highest (95.067), and the combined intervention group of participants receiving Fast ForWord and Sonday interventions as the lowest overall mean in reading comprehension (90.508). It can be said, then, that participation in two interventions was not found to greatly increase

participants' reading comprehension skills, particularly when considering that the participants that received no intervention at all had a higher post-intervention mean. When considering the estimated means for post-intervention WIAT-III scores measuring participants' word reading and pseudoword decoding skills, the control group had the highest means (105.833 and 103.560), followed by the Fast ForWord group (95.382 and 93.158), then the Sonday intervention group (93.176 and 90.713), and finally the combined intervention group, with the lowest means (87.764 and 85.178). As with reading comprehension, there was no large benefit to participants receiving two interventions, and the Fast ForWord intervention was slightly more beneficial for word reading and pseudoword decoding over the Sonday intervention.

The results yielded through this study are comparable to the outcomes of the study performed by Hook et al. in 2001, which cited similar gains for three groups of Fast ForWord, Orton-Gillingham, and control participants. The small amount of gain in Sonday participants is somewhat similar to the research review completed by Ritchey and Goeke in 2006, which indicated mixed results for various studies, leading the researchers to conclude that the true impact of Orton-Gillingham interventions is inconclusive because some large studies did not demonstrate any positive impact. Sheffel et al. (2008) found in their study that Orton-Gillingham methodology increased participants' phonemic awareness and alphabetic principle skills, but in the current study, Fast ForWord had more of an impact on participants' decoding skills than Sonday. Also, it is important to mention again that participants in the current study who received no intervention performed better on the post-test than any of the treatment groups, even when Sonday was combined with Fast ForWord.

No group differences were indicated between the participants' WIAT-III Early Reading Skills and Reading Fluency. A lack of group differences in participants' Early Reading Skills is concerning, due to both the Sonday and Fast ForWord interventions being marketed as interventions to address the more basic skills of reading. However, these results are similar to those found by Troia and Whitney in 2003, which compared Fast ForWord and control groups. They found no large benefit to the Fast ForWord intervention due to limited gains, and the gains between groups were similar (Troia and Whitney, 2003). Pokorni et al. (2004) also found that Fast ForWord did not impact overall reading skills, and other interventions were more beneficial for the development of phonemic awareness than Fast ForWord. An additional, quasi-experimental study in 2009 also had similar results to the current study, finding no significant changes in participants' reading skills (Loeb et al., 2009).

Sex differences were found between males and females in Oral Reading Fluency and Reading Comprehension. Significant differences were found between the performances of males and females for these two post-test subtests, with females scoring higher on both subtests. No interaction effects were noted, indicating that neither sex scored better in one intervention group than the other. Thus, there was no evidence found to suggest that overall, it would be more beneficial for students who are male to participate in Fast ForWord, or to support females participating in Sonday, for example. Although the literature review included several studies that indicated females perform better in reading than males (Singh, 2008; Logan and Johnson, 2009), the data from these analyses do not necessary implicate that females are better readers than males in the areas of fluency and comprehension, but rather that in general, their performance on the post-

test was higher. Also, more recent research in the field suggests that despite years of research supporting sex discrepancies in reading favoring females, there are studies that have emerged which challenge this notion. As cited in the literature review, Below et al., 2010, Wang et al., 2011, and Limbrick et al., 2012 These recent studies call into question the historical research that cites females demonstrating higher reading skills than males, and suggest that further research on the differences in males and females and their reading skills, motivations, and performance on assessments is important to continue.

Implications

Fast ForWord

The results of the current study again, as previous studies have done, question the validity of the publisher's claims that large gains in reading skills can be made when students participate in the Fast ForWord program. The participation protocol of 12 of 16 weeks, five days a week for at least 30 minutes a day was greatly exceeded and provided over approximately 35 weeks of an entire school year, which should have in turn generated even greater gains for participants. However, results did not indicate great gains. Moderately higher gains were made for the Fast ForWord participants in word reading and pseudoword decoding skills over the Sonday and combined interventions, but when qualitatively considering the standard deviation associated with these means, the results are not profound. Also, no statistically significant differences were found for the Fast ForWord participants versus the other two treatment groups and the control group in the areas of basic reading skills and oral reading fluency, indicating students struggling with such skills did not have a great increase in said skills following the intervention. Again, the reader is reminded that the two seminal studies were based on research with

primates, and that they studied language and temporal processing skills; Fast ForWord's impact on actual reading skills was mainly inferred by the publishers.

Considering the expense associated with implementing the Fast ForWord intervention, it appears that, as cited by Rouse and Krueger's study in 2004, in addition to the expense, time and staff commitment outweigh any benefits that the program may offer, particularly when the benefits are minimal and made by all groups, even groups that did not receive Fast ForWord. Although the computerized intervention automatically tracks students' progress, and thus adds some level of convenience, it also removes the teacher as primary, direct instructor and utilizes a computer for the primary delivery of instruction, with the teacher providing assistance as needed. While this may be ideal for some districts with limited staffing availability, it is not ideal for districts, such as the district involved in the current study, with sufficient staff to allow for teacher-to-child direct intervention. Also, although students may enjoy utilizing technology, this particular use of technology does not appear to be beneficial when it is for students who are struggling with reading.

Sonday

The results of the current study also call into question the effectiveness of the Sonday intervention, which has been implemented in the district of study for years due to the anecdotal beliefs of educators that Orton-Gillingham is an effective reading intervention, particularly for students with difficulty in basic reading skills. Because participants who received Sonday or both Sonday and Fast ForWord made similar gains to the Fast ForWord group and a group receiving no intervention, one may question why it would even be necessary to implement an intervention such as Sonday.

Combined Interventions

The group which made the least amount of gains was the combined group of participants that received both Fast ForWord and Sonday. The participants in this group receiving intervention twice every day, as compared to the other two treatment groups who received intervention once a day, yet still made the least amount of gains in most of the reading areas. Even though an argument could be made that the neediest students with the lowest reading skills were selected for the combined group, the analyses utilized provided statistical control to in essence "even" the groups. Therefore, it can be concluded that combining these two interventions is not a benefit to students' reading skills, particularly when their skills may be lower than other students' reading skills.

Proficiency

One of the questions posed in the current study was whether or not participation in an intervention or interventions would raise students to a proficient level in reading. This is an important factor to consider because it is the crux of educational requirements associated with No Child Left Behind. When considering the three treatment groups, three-fourths of the participants still remained below benchmark in oral reading fluency at the end of the school year, despite an entire school year of intervention. It can be concluded that for populations with similar demographics, staffing, and needs, it would not be in the best interest of either the students or the school district to implement these interventions, either singularly or in combination. The idea that they are "better than nothing" can also be discarded as the group that received no intervention made the same gains.

Threats to Internal and External Validity

Several possible threats to the validity of the study must be acknowledged. One threat to internal validity was the quasi-experimental nature of the design; students were not randomly assigned and therefore each group entered the study with existing differences, particularly in oral reading fluency skills. Although a statistical method of control was used to attempt to regulate this, it is still a large, potential limitation that must be considered—that the groups were not evenly placed and as a result, some differences at post-intervention may have been due to the composition of the different groups. Also, because the students in the treatment groups had similar post-test reading scores, the assignment of students based on various characteristics may be questioned. In other words, since it was left up to the reading specialists to assign students to the various groups, perhaps the students with the lowest pre-test scores should have received one intervention twice a day, versus two different interventions each day.

Although the interventions were assuredly implemented with full fidelity, they were implemented by different people within the district. Hence, some natural variations in teaching, particularly with the teacher-implemented intervention of Sonday, may have occurred throughout the course of the school year. Also, differences in regular classroom reading instruction, which all of the participants received, may have occurred due to different students having different teachers, though they all used the same core reading series. Although most of the essential components of reading intervention were encompassed in all treatment groups for this study, including small group instruction, daily intervention for at least 30 minutes, and error correction, the results still did not yield significant gains.

Another consideration is the small range of standard scores in the results. Even though differences existed between groups for three of the five post-intervention reading subtests, the differences were so small that it was difficult to conclude that there was much of an impact when there were differences. The mean standard scores on the post-test WIAT-III reading subtests were also all within the broad average range and thus, someone examining the post-test scores may view the outcome of the study leading to broad average range reading skills for the participants. In conjunction with the WIAT-III reading scores, the spring DIBELS Oral Reading Fluency scores should be considered as well due to the small variation in the post-test WIAT-III scores.

Another factor that may have had an impact on the results is the differences between the pre-test and post-test measures. Students were placed into the four groups based on their fall DIBELS pre-test score, which includes a score or scores in a total of six possible subtest, which is then translated into a proficiency level. The post-test spring DIBELS Oral Reading Fluency score is also translated into a proficiency level. The WIAT-III post-test scores are computer-scored and translated into standard scores. Although the statistical procedures utilized allowed for comparisons between the measures, some of the results may have been impacted by the differences among the measures in scoring, score reporting, interpretation of scores, and task demands for each subtest within each measure. The levels of the various task demands may also have differed between each measure. For example, the readability levels on the three passages administered for DIBELS Oral Reading Fluency may have differed from the readability of the two passages administered for the WIAT-III Oral Reading Fluency. The DIBELS tasks may have included more accurate grade level expectancies than the WIAT-III

reading tasks, or vice versa. Also, what is considered to be below benchmark on DIBELS is compared to standard scores on the WIAT-III subtests, and interpretation of the differences between these reported scores may vary by reader.

The impact of several within-subject variables should also be considered. Several students with speech/language impairments and other educational disabilities, including emotional disturbance and other health impairment, were included in the study. There were not enough of such participants to analyze the direct impact of their results, but these variables may have had an impact on how the subjects performed, both on pre- and post-tests and throughout the school year. For example, a student with emotional or attention issues may have attended less to the interventions, or may have done more poorly on the pre- or post-test due to their emotional or attention issues during the interventions and assessments.

A threat to external validity and concerns participants used in this study, which include only first, second, and third grade students from a non-diverse, suburban school district, who all had some difficulty with reading at the beginning of the school year of study. Thus, generalization may be limited to elementary students of the same demographics. The study was not able to include older students, and consequently the results are limited to students in younger grades.

Future Directions and Recommendations

Fast ForWord continues to become increasingly popular as an intervention that school districts use. The persistent push for technology usage and integration into instruction may further prompt districts to consider utilizing Fast ForWord. School psychologists should use this research, as well as the results of other studies, when

making instructional consultation recommendations for students who are struggling with reading. Further investigation may be warranted, and should improve on existing research including the current study, by randomly assigning students to intervention groups, possibly using a matched pair design with control students. Since the current study only examined students in grades one through three, future research should focus on students who are both younger (preschool and kindergarten students) and older than the participants in the current study. The impact of Fast ForWord and Sonday on students' performance on state testing, such as the Pennsylvania System of State Assessment (PSSA), would be valuable research. Although the current study included only a handful of students that could be deemed as subgroups, another study could include a specific focus on students who have Speech/Language Impairments, are English Language Learners, or are from a low socioeconomic background. Studies controlling for these variables would also be invaluable research as well.

An additional recommendation for future study, which would be interesting to examine for both interventions, would be the interaction of both subjects' teachers and parents and the impact of these interactions on subjects' performance on pre- and post-measures. Because Sonday is much more teacher-directed than Fast ForWord, measuring teacher interaction, as it is almost absent in Fast ForWord, as a possible confounding variable, would add to the literature. Parent involvement could also be measured through parent and teacher surveys, as well as activity checklists and reading logs, in order to determine the impact of parent involvement on the students' performance, both within the interventions as well as on pre- and post-test measures.

Also, future research should examine Scientific Learning Corporation's claims that Fast ForWord improves students' memory, attention, processing, and sequencing skills. There was almost no valid, peer-reviewed literature examining subjects' skills in these areas specifically, and any attempts to measure such skills were completed using brief and general cognitive ability screening measures. Although cognitive ability is believed to be stable across the lifespan, the publishers of Fast ForWord are marketing their product as an intervention that can improve some cognitive skills. In addition to research that measures the impact of Fast ForWord on subjects' cognitive skills and overall ability, a valuable aspect of research could also be a study on Fast ForWord and Sonday that controls for a student's cognitive ability, thus ruling out cognitive skills as a possible confounding variable explaining a subjects' performance both during intervention and on pre- and post-tests. Further research using a similar design is also recommended for Sonday, since previous studies cite mixed results for Orton-Gillingham-based interventions, and this study adds to the inconsistency.

Summary

Previous sections have delineated the importance of raising students' reading skills to proficiency. Even if total proficiency was not a federal requirement, proficient reading remains a skill imperative to a successful life for all individuals. If school districts continue to utilize interventions that do not make a significant difference in students' reading skills, they are failing to provide appropriate instruction to their students, which is an imperative and pivotal charge of all educators. This study continues to call the validity of two popular interventions into question. Although they do not impact a student in a harmful way, they are not likely to help students reach proficiency

in reading. These results also call into question a school district's choice to provide only two interventions for struggling readers, and suggest that a "one size fits all" mentality is not beneficial to students who are at-risk for reading failure. Although the process of choosing a variety of interventions to meet individual student needs in all five areas of reading may be more labor intensive in the beginning, it may greatly benefit at-risk readers by meeting their individual needs in whichever area of areas they are struggling.

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