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Evaluating the effects of a reinforcement system for students participating in the Fast Forward language program

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Evaluating the Effects of a Reinforcement System for Students
Participating in the Fast Forward Language Program

by

Catherine C. Wilcox

A thesis submitted in partial fulfillment
of the requirements for the degree of
Master of Arts in Applied Behavior Analysis
College of Graduate School
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ABSTRACT

A computer-assisted language intervention program called Fast ForWord® (Scientific Learning Corporation, 1998) has received a great deal of attention over the past few years. The Scientific Learning Corporation claims that the use of Fast ForWord will improve students' language, reading and learning skills, leading to improved communication skills and increased self-esteem in and out of the classroom. Researchers have explored the effects of Fast ForWord training on reading and spoken language. However, little research has examined the effects on student's reading level and FFW scores when a reinforcement system is used in conjunction with FFW.

This study was conducted in an effort to evaluate the effectiveness of a reinforcement system on increasing daily scores of students participating in the Fast ForWord Language Computer Program. An ABABAB reversal design was used to examine the effects of a reinforcement systems with six participants participating in the

Fast Forward Language Program. Across the skills examined with the six participants, the results did not clearly demonstrate an effect for the reinforcement system. Implications for future research are discussed.

Chapter One

Literature Review

Reading Difficulties

The development of literacy skills in kindergarten and elementary-age students appears to be a national priority in the education for students both with and without disabilities. According to statistics on the literacy skills of children in America, approximately 40% of students cannot read at a basic level (No Child Left Behind, 2002). In response to these alarming statistics, the National Reading Panel conducted a two-year study to determine how students learn to read. They identified the most important components of reading instruction to be alphabetic, fluency, comprehension, teacher Education, and computer Technology. The finding of the panel assisted in the development of Reading First, the literacy component of President Bush's 2001, "No Child Left Behind" Act (NCLB, 2002).

The passage of NCLB has led to the growing increase in the importance of competency-based, proficiency-based, and scientifically based intervention in the United States. This priority has resulted in

the development and evaluation of instructional programs that are intended to meet the needs of all learners.

Historically, the efforts in general education that aim to ensure that all children learn to read in first grade has fallen short for many children with disabilities (Allington & McGill-Franzen, 1992). In fact, learning to read poses real challenges for all students, including children who will eventually become good readers.

According to researchers (Shaywitz, Fletcher, & Shaywitz, 1994; and Lyon, 1995), as many as one in five children have difficulties learning to read. If these children are experiencing reading difficulties continuously in school, it is possible that they could become frustrated which could possibly adversely affect their motivation along with their approach to the task of learning (Smith, 1996). Oftentimes children with limited academic achievement receive special educational services, however, this is only after they have already experienced reading failure and/or general academic failure (Riley, 1994).

Fortunately, most children with reading difficulties can be taught reading and strategies for success in school. However, research suggests that this goal may be better accomplished when reading problems are identified early and additional support is provided to prevent falling behind. By detecting reading problems at a young age, children may likely learn strategies that will raise their reading to

grade level and possibly prevent a widening achievement gap. Many children with learning difficulties have deficiencies in their ability to process phonological information. Therefore, they do not readily learn how to relate letters of the alphabet to the sounds of language (Lyon, 1995). Educators have become more aware that reading comprehension is a prerequisite for the development and improvement of educational practices.

Reading research has contributed to the understanding of reading comprehension processes. Additionally, it seems important that all reading programs be designed and implemented in such a way that they reflect current knowledge about the reading process. Due to the push for evidenced based reading programs, this led to the development of many computer based reading interventions. This development of computer reading programs may prove to be a way for educators to effectively improve educational practices.

Evidence-Based Programs

Within the past decade, there have been tremendous technological innovations in regards to computer-assisted instruction. This seems to be due to the great deal of focus on reading research and the demand from educators looking for effective, evidence-based reading instruction. Combined, this appears to be what has caused an alarming development of products claiming to be "scientifically based."

Since the introduction of computers into educational systems, there seems to be an increasing interest given to their use in assisting with the development of reading comprehension. However, some educational researchers believe that in order to maximize their effectiveness, developers of software should consider concentrating on areas related specifically to teaching (Singhal, 1998).

The No Child Left Behind Act (NCLB) is the focus of U.S. federal education policy and has literally jump-started the development of many new reading interventions. Reading First is one of the largest single initiatives within the No Child Left Behind Act and strives to provide children with the foundational skills necessary to become successful readers (Berger, 2003). In response to this, Reading First will provide 6 billion dollars to scientifically based reading efforts. The federal government cannot tell schools specifically what reading programs and assessments to buy. However, the Reading First policy exerts as much influence as it can over the types of reading programs and assessments that will be purchased by schools. The legislation exercises this influence by insisting on "scientifically based reading research" (SBRR). The science it refers to is based upon the principles of rigorous experimental design, which test reliability, validity and efficacy, or the predictive value of reading products and practices.

Despite this, many products that claim to be “scientifically based” have come under a lot of scrutiny. The NCLB focus is on oral language (expressive and receptive language); phonological awareness (rhyming, blending, segmenting); print awareness; and alphabetic knowledge (letter-sound knowledge). This focus may be the reason many companies have developed a variety of educational interventions which include new computer software programs specifically targeted for reading.

Computer-Based Reading Programs

Recent change in the Elementary and Secondary Education Act (ESEA) requires all states to establish high standards of achievement and form a system of accountability to measure these results. In response to this change, many companies are developing and marketing a variety of computer reading interventions. In addition, some companies have made claims that their products will significantly improve the academic performance of its users (Scientific Learning, 2000). Many of these software developments have peaked the interest of educators. This interest may be due to the possibility that they may have an impact on education, on the children that are in need of specialized instruction, and that they may conform to the ESEA requirements.

With this new focus, some parents and teachers of children with reading difficulties may turn from standard reading workbooks to new technology. However, some of the new computer technology may be considered controversial. Many philosophies relating to reading instruction and reading interventions exist and much debate has occurred within the education system in the United States. Often, the type of reading instruction that children receive is narrow in focus and lacking in contextualized instruction (Allington, 1994). Despite this, there has been an increase in the development of computer reading programs. Some of these programs include comprehensive basal reading, literature-based reading, supplemental reading, and reading intervention programs.

One reading program called Headsprout Early Reading, is described as an engaging, internet-based program for young children (ages 4 to 7) that focuses on the fundamentals of reading. The fundamentals of reading described are, phonemic awareness, print awareness, phonics, fluency, vocabulary, and comprehension. The Headsprout Early Reading beginning reading program integrates principles resulting from the scientific investigation of early reading (Layng, Twyman, Stikeleather, 2003).

Much of the research on Headsprout has been conducted by it's developers. However, in 2003 the Florida Center for Reading Research

completed a review of a pilot study for Headsprout Early Reading, that was implemented in a Title I kindergarten class in Seattle. According to a review, the instructors integrated the Headsprout program into the daily schedule. No formal pre-test was administered, nevertheless 100% of the students who completed the 13-37 week program scored above their grade level and 82% of the students scored at an early to mid first grade level. The study indicated that due to the lack of a control, the results do not conclusively demonstrate that the Headsprout program produces the gains in reading independently, or in addition, to the instruction the students received from the classroom. The Florida Center for Reading Research concluded that the design of Headsprout reflects scientific research with an abundance of instructional strategies in phonemic awareness, phonics, fluency, vocabulary and comprehension. In addition, the developers of Headsprout have produced a wide range of evidence that most children participating in the program actually acquire the specific skills the program is designed to teach. However, until there are published studies that employ appropriate control groups, it is yet to be determined if the gains in reading are the result of the Headsprout program, regular classroom instruction, or the two combined (Florida Center for Reading Research, 2003).

Another computer-based reading program is called the Waterford Early Reading. This program is described as a balanced and comprehensive early intervention reading curriculum. The program has three levels for emergent, beginning, and fluent readers. The program is designed to develop literacy early so that children can begin to read at an early age.

Waterford was evaluated in a study by Patterson, Henry, O'Quin, Cetrano, and Blue (2003). The researchers conducted a year-long, mixed methods study of the effects of a computer-based reading program on the reading achievement of students in 16 (8 experimental, 8 control) kindergarten and first-grade classrooms. To assess student literacy, the researchers used Clay's (1993) observation survey. This survey was used to secure an assessment that was independent of the curriculum and materials. Results from this study indicated that the Waterford program did not generate any statistically significant effects on reading or early literacy (Patterson et al., 2003).

Another study was conducted with at-risk kindergarten class in an inner city and rural Ohio public school. Ten subtests of reading skills that were grouped into a total of four categories (e.g., alphabetic comprehension, literacy familiarity, phonemic manipulation, and verbal language fluency), were given to 76 kindergarten students (42 of them

were assigned to a treatment group, 34 were assigned to a control group). The treatment group was given the *Waterford Early Reading Program* as part of its regular reading instruction, and the control group did not receive the Waterford Early Reading Program. Prior to the study, there were no specific differences in the groups. Following the study, the results indicated that the experimental group that received the Waterford Early Reading Program performed significantly better on the post-test than the students in the control group on the majority of the tasks (Hecht, 2002).

Instructional scholars may agree that computer interventions have become appealing to both educators and researchers within the last decade. Many teachers may also agree that computer interventions appear to be a new and fun way for young children to learn concepts and processes that in the past were delivered via books within the traditional classroom (Embi & Hussain, 2005).

One particular program that is described as an effective computer based adaptive training method for ameliorating the fundamental speech reception and language comprehension problems of children with language and learning impairments is Fast ForWord Language, developed by the Scientific Learning Corporation (Merzenich, et al., 1996).

Over the past few years, this computer program has attracted considerable attention in the media as well as from educators and speech and language professionals (Gillam, Loeb, & Friel-Patti, 2001). In 2001, More than 65,000 students in nearly 2,400 school districts across the country have received training using one or more of the Fast ForWord software products (Scientific Learning Corporation, 2002). The Scientific Learning Corporation has conducted several research studies in attempt to demonstrate the effectiveness of the program. The Scientific Learning Corporation claims that the development of the Fast ForWord Language Program has made an enormous positive impact on students with reading difficulties (Scientific Learning Corporation, 2000).

Scientific Learning describes their product as a computer-based reading intervention program that is said to rapidly develop the language and listening skills known to be pre-requisites for higher-level reading (Scientific Learning Corporation, 2002). The program was initially developed for pre-reading children, and students who were in need of the development of basic language and listening skills, which are said to be the building blocks for reading. The program allows students to be actively engaged on computers while at the same time listening through headphones. In addition, students use the computer mouse as they interact with the Fast ForWord Language

exercises. With each click of the mouse, Scientific Learning claims that Fast ForWord Language software adapts to the individual student's progress while providing efficient, targeted training.

The Fast ForWord program has gained a lot of attention from special educators welcoming the opportunity to supplement their own school-based interventions. The Program consists of a total of seven computer "games" in which participants "play" five games each day as automatically determined by the software (Scientific Learning Corporation, 2000). The participants are required to play the games for a total of 100 minutes per day. When the student has demonstrated a mastery of skills required for the first level of the game for several successive turns, the software automatically advances the individual to the next level. The student's performance is continually monitored and saved by the program so that the level of game play is challenging for the individual.

There are five levels of play for each game. The first level of each game incorporates auditory stimuli. Signals are digitally manipulated to increase the duration and intensity of certain phonemic or transition elements that have been previously identified to cause processing problems. Although Fast ForWord was originally sold to professionals in private practice, the Scientific Learning Corporation has placed a growing emphasis on selling the product to public schools.

In 2001, 76 percent of their total revenues came from sales to public schools (Scientific Learning, 2002). However, the Fast ForWord program is not generally targeted to an entire class, but rather to students identified as having learning difficulties. The Fast ForWord intervention is often administered as a pullout program (where the students are pulled from their regular classroom instruction).

Research on Fast ForWord

The Scientific Learning website currently includes the following statement: "Developed by leaders in brain research, Fast ForWord Language helps students simultaneously cross-train multiple skills and adapts each exercise based on a student's progress to improve language and reading skills" (Scientific Learning Corporation, 2001). Research has reported gains in reading for students participating in Fast ForWord over the past several years. The most well known research studies on the Fast ForWord program are two articles published in 1996 in *Science* (Merzenich, et al, 1996; Tallal, et al., 1996). Merzenich's research reported significant gains in language comprehension and expression through the use of Fast ForWord (Merzenich et al., 1996).

Tallal designed a series of games such as "Simon Says," in which the participants were required to follow spoken commands. Soon after, the researchers modified the commands using a computer

algorithm that stretched the speech by 50% and emphasized rapidly changing speech components, such as short consonant sounds, by making them louder, a formula that according to Tallal, should make the speech easier for language impaired children to understand. This study consisted of seven children with language-learning impairments received 3 hours of language intervention per day, 5 days per week, for a total of 4 weeks. The participants were ages 5-9. All participants were described as having typical nonverbal intellectual abilities, delays in receptive and expressive language development, and reading difficulties. The participants played two Fast ForWord activities, Circus Sequence, and Phoneme Identification. In addition, the participants received eight additional individual speech and language activities that were conducted by clinicians that were previously trained. These language exercises included "acting out commands in a Simon Says format with props; pointing to pictures or colored blocks in response to commands; repeating verbatim syllables, nonsense words, real words or sentences; and pointing to pictures corresponding to spoken words" (Tallal et al., 1996).

In addition, children in this study completed 1 to 2 hours of listening homework every day. Performance on the Circus Sequence and the Phoneme Identification improved during the 4-week period (Merzenich et al., 1996). However, performance on the other eight

language intervention exercises was not reported. The participants showed an improvement on the Tallal Repetition Test, an auditory perception task that requires you to represent the sequence of two tones that are presented with progressively shorter durations (Tallal et al., 1996).

In another study, the participants consisted of 22 language-impaired children with normal IQs. They were divided into two groups that were matched for nonverbal intelligence and receptive language abilities. Both of the groups attended daily laboratory sessions for 3 hours, played computer games, received direct clinician-to-client intervention, and received 1 to 2 hours of listening homework per day. The difference in each group was the presentation of the auditory stimuli. One group played revised versions of Circus Sequence, Phoneme Identification, Old MacDonald's Flying Farm, and Phonic Match while listening to modified speech. The second group "received equivalent language training but with natural speech materials," and they "played video games rather than these adaptive auditory-speech training games" (Merzenich et al., 1996). At the end of 4 weeks of training, a battery of language tests (e.g., The Token Test for Children, Diagnostic Auditory Discrimination Test, Goldman Fristoe Test of Articulation) showed improvement in both groups. However, the experimental group did significantly better as they gained 1 to 2 years

worth of language ability during the 4-week training period. After being tested again 6 weeks after the end of the training, the improvement maintained (Tallal, 1996).

Although both studies produced positive results, both studies were conducted with a small sample size. Therefore, it would be difficult to generalize the results of the studies to variety of populations. Due to so many treatments during both studies, it seems difficult to conclude whether the improvement in scores after the training were direct result of the Fast ForWord intervention.

Based upon the years of research conducted by Merzenich and Tallal, the Fast ForWord computer programs were developed. These programs were designed to increase auditory processing skills in children with spoken language disability. Much of the research states that Fast ForWord provides training in auditory, perceptual, and spoken language comprehension skills that are believed to be critical to academic success (Scientific Learning, 2000). However, in a review article, Gillam (1999), states, "because of the rising popularity of this procedure and the impressive claims concerning its effectiveness, there is a need for well-controlled clinical trials that are conducted by investigators who were not involved in developing the program and who have no financial interest in Scientific Learning Corporation."

Furthermore, despite the claims made by Scientific Learning, one research study, conducted by Toria (2004), evaluated the effectiveness of the Fast ForWord computer on language skills and academic achievement for migrant students with limited English proficiency. The study used a pretest–posttest design with a no-contact control group. All of the students in this study were potential candidates for participation in a local field trial of the Fast ForWord intervention program for migrant students. Ninety-nine students were in the Fast ForWord treatment condition (out of a total of 269 students who participated in the field trial), and 92 were in the control condition (Toria, 2004). During the study, five areas were examined; English language proficiency, oral language competence, phonological processing, basic reading, and classroom behavior. The Fast ForWord group achieved significantly greater gains than the control group in only one area, basic reading. The results indicated that there were very few significant differences between the treatment group that received the Fast ForWord intervention and the control group that did not receive the intervention.

Miller, et. al. (1999), a Scientific Learning Corporation researcher, conducted a study to evaluate the effect of Fast ForWord with approximately 450 students from 9 elementary schools. The students were chosen from grades K-2. The students were evaluated on three

outcomes measures: the Test of Auditory Comprehension of Language, Revised Edition (TACL-R); the Phonological Awareness Test (PAT); and Single Word Reading (WJRWD); (Letter-Word Identification Subtest, Woodcock-Johnson Psycho-Education Battery-Revised) (Miller, et. al., 1999). Miller reported significant treatment effects for the Fast ForWord participants, both for the sample as a whole and for English as a Second Language (ESL) students. However, it appears that Miller excluded some students in the treatment group who did not actually complete the entire program. Therefore, this may have introduced sample selection bias into their results.

In 2001, Hook, Macaruso, and Jones conducted an experimental evaluation of Fast ForWord. The study consisted of eleven children with reading disabilities between the ages of 7 and 12 that were selected to participate in Fast ForWord. Nine of the children were diagnosed with reading disabilities. These nine were matched with another group of children on age, IQ, phonemic awareness ability, and reading level. The matched group was assigned to complete activities from the Orton Gillingham multi-sensory alphabetic training program. In addition, eleven children identified as poor readers, were matched on the same criteria, and served as a no-contact control group. The results show that both the Fast ForWord group and the Orton Gillingham group made significant and equivalent gains in phonological

awareness. However, neither group demonstrated significant gains in word recognition. The Orton Gillingham group achieved higher posttest scores in decoding than the Fast ForWord group. This finding appears to be significant because of the fact that the Fast ForWord group received more than double the amount of intervention time (56 hours) than the Orton Gillingham group (25 hours). In addition, the Fast ForWord group and the no-contact control group both showed gains in phonemic awareness and all aspects of reading (word recognition, decoding, and comprehension) when examined over a 2-year period following the intervention. Although the students in Fast ForWord group displayed immediate gains in oral language, the gains in oral language were not maintained 2 years later (Hook, Macaruso, & Jones, 2001).

In another study, Hamilton (1995) examined the effect of computer-assisted instruction on the reading achievement of third through sixth grade students. This study examined 23 students randomly selected (out of 41) who received computer-assisted instruction and 23 students randomly selected (out of 28) who did not receive computer-assisted instruction. The results indicate that the student scores were not affected by the use of computers during the Fast ForWord Program. There were no significant differences between the control group and the Fast ForWord group.

In summary, it appears that additional research may need to be conducted in order to examine the efficacy of Fast ForWord in improving reading skills in children with reading disabilities.

Reading Motivation

Many studies have reported that the use of potential reinforcing consequences, in schools, such as certificates, stickers, ribbons, toys, and snacks can have an increase in children's motivation to read (Jensen, Papp, & Richmond, 1998; McKnight, 1994; Voorhees, 1993).

Cameron, Pierce, Banko, and Gear (2005) assessed how the use of rewards/reinforcers had an impact on student motivation when the students were rewarded for their achievement while learning a specific activity, for performing at a specific level on a test, or for both. The results showed a significant increase in student motivation when they were presented with a reward for their behavior.

Positive reinforcement occurs when a behavior is followed immediately by the presentation of a stimulus and, as a result, occurs more often in the future (Cooper, 1998). This argument also draws upon the concept of Operant Conditioning (Cooper, 1998). The idea is that depending on what happens after a student engages in certain behaviors, they may be likely to engage in similar behavior in the future. The use of positive reinforcement may increase the probability that the student will, once again, engage in the preferred behavior.

One suggested method used to motivate students, in an attempt to increase their academic achievement, is to institute a rewards system based directly on student academic performance. This idea suggests that educators may need to incorporate the use of rewards in instructional activities that may stimulate students' interest specifically in the subject matter. Again, this theory is based on the principal of behavior known as operant reinforcement (positive reinforcement). The use of positive reinforcement has been incorporated directly into the design of many of the computer programs. Perhaps one of the most important outcomes in software education today has to do with the "game like" activities and potential for immediate reinforcement. These strategies may provide instructional designers with new methods for engaging learners.

During the development of Fast ForWord, the Scientific Learning Corporation designed their software to incorporate immediate reinforcement. Each of the Fast ForWord activities provide the participant with immediate feedback with the use of lights, bright flashes, sounds, and pictorial accumulation of points throughout each activity, all of which may be reinforcing to the learner. Also, each of the Fast ForWord activities have a similar motivating "game like" appearance while at the same time each seek to teach important reading skills. In addition, the company suggests that to the use of

additional reinforcers by educators in conjunction with the Fast ForWord program could be motivating to the student.

Developers of educational computer activities may need to aim at building lasting interest in real world applications therefore, they may need to look at how to motivate students to increase their academic achievement. Although the Scientific Learning Corporation incorporates potential reinforcing consequences while the student is on the computer, there is limited research to show the effects of the use of social rewards, tangible rewards, and activity rewards (e.g., verbal praise, stickers, snacks, and free-time) directly incorporated into the Fast ForWord program. Providing reinforcement (i.e., delivering preferred stimuli) contingent on accurate or increased responses has been shown to improve the reading performance of students in both general and special education classrooms (Billingsley, 1977; Holt, 1971; Jenkins, Barksdale, & Clinton, 1978). Therefore, it is possible that programmed consequences for improved performance may enhance the efficacy of reading interventions.

Purpose of the Study

The primary objective of the study was to evaluate the effects of a reinforcement system on the scores of the students participating in the Fast ForWord Language Computer Program. In this study, the following research question was addressed: Does the use of a

reinforcement system have an effect on student scores for the Fast ForWord Language Program? This study sought to examine whether the Fast ForWord computer intervention could be enhanced by combining it with a reinforcement system for students identified as having reading difficulties. It was hypothesized that by adding a reinforcement system to the Fast ForWord intervention, there would be an increase in the student's scores on activities in the Fast ForWord Program that will go beyond that shown for the program without the use of the reinforcement component.

Chapter Two

Method

Participants and Setting

A sample of six children between the ages of 6 and 7 years old were selected to participate in this study. These six students were chosen from a larger pool of students identified by their elementary school to participate in the Fast ForWord Language Program. Students participating in the Fast ForWord Program were identified by their teacher as either having been previously retained or having academic problems in the classroom. All of the students participating in the Fast ForWord training were pulled-out of their daily language arts instruction so they could participate in Fast ForWord. Therefore, Fast ForWord replaced their daily language arts instruction. Participants for this study were sampled from across a range of students chosen from a larger group of students that were selected to participate in the Fast ForWord Program. The students were selected for this study based upon scores on their Comprehensive Test of Phonological Processing (CTOPP; Wagner, Torgesen, & Rashotte, 1999). The six students for

this study were those having the two highest, two middle, and two lowest scores on the Comprehensive Test of Phonological Processing.

The study took place at an elementary school in a large urban district in Southwest Florida. The student population spans from PreK through 5th grade and includes several exceptional education programs totaling 950 students where 76% of the students received free or reduced lunch. The student population is approximately 23% White, Non Hispanic, 42% Black, Non Hispanic, 26% Hispanic, 6% Multi-Racial, 3% Asian Pacific Islander, and .42% American Indian Alaskan Native (Florida Department of Education, 2007). The school made Adequate Yearly Progress in both reading and math for the 2004-2005 school year and received a B grade based on the Florida's state school grading system

Measurement

For this study, data were collected via the internet through the Scientific Learning's website. Students earned points each day while participating in the Fast ForWord Program. The website provided an output of data generated each day which included the number of daily points each participant earns. The number of points the student earned depended on how successful they were with each activity for that particular day. Specifically, the more questions they answered correctly, the higher the number of points they earned. The points

were totaled via the computer as the student progressed through the program. At the end of the session (100 minutes each day), the computer totaled the daily score for points earned.

Each day, the investigator or the room coach downloaded the individual student data from Scientific Learning's database. Once the scores were downloaded, the individual points earned per activity, were transferred by the room coach, with an ink pen, to an individual weekly point sheet.

Dependent and Independent Variables

The dependent variable for this study was the student's daily scores on each of the Fast ForWord activities.

The independent variable for this study was the reinforcement system that was incorporated directly into the Fast ForWord Program. The investigator developed the reinforcement system and called it, "Picks For Points." Depending on their score, each student will have the opportunity to receive rewards for the number of points they earn daily, on a bi-weekly basis. The higher the number of points earned each day, the more picks/rewards from the prize box were earned. A Fast ForWord point sheet was developed in order to determine the number of picks from the prize box (e.g., 2000-2300=One Pick, 2301-3300=Two Picks). Previous scores from the Fast ForWord program

were used to determine the average amount of points a student could possibly earn.

The Fast ForWord computer program is designed to be an immediate, intensive intervention for students in grades K-12. Students participated on computers while at the same time they listened through headphones. The students used the computer mouse as they interacted with each of the Fast ForWord Language exercises. The training software consisted of seven exercises, each of which appeared to the student as a computer game. Each day, the students had the opportunity to choose five of seven exercises. For example, one activity, Circus Sequence, consists of a three-ring-circus. This exercise trains the child to identify and reconstruct rapid successions of sounds. Phonic Words presents a series of two pictures and requires the student to match a sound to a picture. This activity is designed to help the child generalize sound processing skills to normal speech recognition. Old McDonald's Flying Farm shows animals flying through the sky while teaching the student to pay close attention to brief phonemes emitted by the farm animals. Phoneme Identification features lively animals and helps the student learn to identify consonant-vowel sequences. Additional activities are Block Commander, Phonic Match, and Language Comprehension Builder. All

of the exercises awarded points showed progress on the screen, and used sounds and lights for feedback to the students.

Experimental Design

The reinforcement system was implemented using an ABABAB reversal design. The reversal design allowed the investigator to collect baseline data, provide the intervention, and then return to baseline. Although the intervention occurred on a bi-weekly basis, data were collected continuously throughout the all phases of the study.

Procedure

The Institutional Review Board at the University of South Florida approved all procedures prior to implementing any procedures. The parents of the participants were also given informed consent forms prior to data collection along with the contact information of the principal investigator for the opportunity to ask any questions before and during the study. In addition, each participating student gave their assent prior to data collection.

The study took place in a regular classroom/computer lab at the participating elementary school. Sessions were held in the morning during the class language arts instruction. The classroom/computer lab consisted of two large tables, desk for the room coach, whiteboard, windows along one long wall, posters and classroom projects displayed on the walls, and several bookshelves. During the computer sessions

the students were seated at individual classroom desks and chairs with approximately 14 laptop computers and headphones.

The staff participating in the supervision of the Fast ForWord program were previously trained by the Scientific Learning Company. The training consisted of a one-day session where staff completed the exact Fast Forword games/activities that the students completed. The staff received detailed instruction prior to beginning the specified activity. The staff were instructed to not provide students with any correct responses during their Fast ForWord computer session. The room coach was on-hand to supervise the children, load software, troubleshoot any technical difficulties, facilitate students' orientation, ensure proper use of programs, and to maintain consistency in program intervention.

Baseline phase. Each day, the students participating in Fast ForWord chose five of seven 20-minute activities each. They were engaged in the computer activities for 100 minutes per day, five days per week, for approximately 6 weeks. As each student demonstrated success on each task, they moved up to the next level in each activity. Students received trial-by-trial computer feedback on each exercise. After an incorrect response, the correct response was shown before the next trial is presented. Correct responses were rewarded by lights, sounds, on-screen animations, long with a pictorial increase in points.

Each child had a point sheet on which the room coach recorded their daily scores, as calculated by the Fast ForWord Program, after completing their 100 minutes. Once they completed this process, the students were sent back to their regular classroom.

Intervention phase. During the Intervention phase, the students continued to receive trial-by-trial computer feedback on each exercise. After an incorrect response, the correct response was shown before the next trial was presented. Correct responses were rewarded by lights, sounds, on-screen animations, and a pictorial increase in points. Each child had the same point sheet on which the room coach recorded their daily scores as calculated by the Fast ForWord Program after they completed their 100 minutes. However, each day during the intervention, prior to starting the Fast ForWord program, the students were informed that they would receive a pick from the prize box for scoring high points for that particular day. In addition, a large prize box was stationed at the front of the room which was labeled "Picks for Points." The box was visible to the students during their entire 100 minutes on the computer serving as visual prompt for increased scores. Prior to beginning the session each day during the intervention, the room coach read the following script aloud:

"Focus on each activity"

"Make sure you choose correct answer"

"Score lots of points"

"Good Luck"

Potential reinforcers that were used for this study were edible treats (e.g., candy, snacks, etc.), tangible items (e.g., sticker, pencils, etc.), and positive statements (e.g., "Great Job!"). These particular items were chosen because they were reported, by the school, to be potential reinforcers when used in the classroom. Once the students completed the required 100 minutes on the computer, their daily points were totaled. The students then had the opportunity to receive a pick from a prize box. This process was conducted privately and individually for each student. Once they received their picks from the box, the student was then sent back to their regular classroom.

During the study, the participants were completely unaware that the investigator would be returning on a bi-weekly basis to administer reinforcement for the points earned. The first phase of the study began with the initial baseline of students participating in the Fast ForWord program. The phases of this study were as follows: During the Initial Baseline, participants began the FFW program as already occurring in the school for the first week. The reinforcement system was not used during this time. During the second week, Intervention Phase 1 began. This was the beginning of the reinforcement system, which was implemented on a daily basis for the

entire week. On week three, there was a return to baseline and this process continued in an ABABAB reversal design for a total of 6 weeks. During the intervention phase, the investigator left at the end of the week (Friday) setting the expectation that the "picks for points" were no longer available. During the return to baseline, the investigator did not have any contact with the participants.

Data Analysis

Visual inspection of the data was used to assess the level of performance of participants throughout the entire study. The primary element examined during visual inspection was the change in level of the participant's scores from one phase to the next. Specifically, the overall level of performance, during each condition was examined, to ensure there is no overlap of the data points. In addition, the investigator examined the variability in the data points within each phase. By using visual inspection the investigator was able to visibly see the change in performance for each participant. The investigator reviewed the data on a daily basis. Additionally, the student scores were downloaded via the computer and totaled each day. The Investigator had 24-hour access to student scores via the Scientific Learning Corporation's computer progress tracker.

Chapter Three

Results

This particular study was designed to assess whether the use of the reinforcement system had an effect on student scores for the Fast ForWord Language Program. The investigator examined whether or not the Fast ForWord computer intervention was enhanced by combining it with a reinforcement system for students identified as having reading difficulties. Data were collected for each participant throughout the six weeks during the ABABAB reversal design. The students had the opportunity to choose five of seven Fast ForWord activities each day. Student scores could either increase or decrease each day depending student performance. However, the average high scores that could be earned in each activity are as follows: Circus Sequence, 790; Phoneme Identification, 800; Old McDonald's Flying Farm, 500; Phonic Words, 675; Phonic Match, 495; Block Commander, 550; and Language Comprehension Builder, 1000. The results are reported for each participant for each individual activity.

Language Comprehension Builder

The mean Language Comprehension Builder scores for each participant for each phase are shown in Table 1. These data are represented graphically in Figures 1 through 3.

Table 1

Mean Value of Weekly Scores for Students Participating in Language Comprehension Builder

Week/Phase	Kiley	Mikey	Matty	Missy	Sandy	Wally
1	141.2	121.6	101.6	104	114.4	72.4
2	477.2	596.8	293.6	411.6	344	274.8
3	704.8	692	325.6	568.8	426.8	332
4	655.6	720	354	793.6	505.2	537.2
5	428.8	683.6	391.6	723.2	367.2	397.2
6	72.4	274.8	332	537.2	397.2	340.4

Figure 1 shows a graphic display of the scores for both Kiley and Mikey during baseline and intervention phases for the Language Comprehension Builder activity. During the first intervention phase, there was a immediate drop in the first data point for Kiley, however after that first day, there was an increase in the level of performance with the remaining three data points at a level consistent with the first baseline. When returning to the second baseline, Kiley's data points began a slightly variable upward trend. This trend maintained when

returning to the second intervention phase with the exception of the last data point in this second intervention phase. Upon the return to third and final baseline, Kiley's scores show a decreasing trend to a level below the first baseline. The last intervention phase clearly shows an increase in score for the first data point however, there is a steady downward trend after that point. The scores across the phases show high variability with overlap in the data across the first intervention phase through the final baseline phase. Several of the data points indicate slightly higher scores during the intervention phases. However, with the significant overlap across phases, maintained higher-level of scores, and the downward trend at the end of each intervention phase, it is difficult to conclude that the intervention was effective for Kiley.

Figure 1 also illustrates the data for Mikey. The first intervention phase shows an increase in Mikey's scores from the initial baseline. There is overlap of the scores once returning to the second baseline with moderate variability and showing no real trend. When returning to the second intervention phase the scores indicate a stable rate however, there is an upward trend for the last three scores. There is slight variability in the data during the third baseline phase with no trend. The last intervention phase shows an increase in Mikey's scores above the third baseline with a general upward trend. Mikey's data

show some increase in scores during the intervention phases and a decrease in scores once there is a return to baseline. However, due to the overlap of data points across the baseline and intervention phases and the rapid increase in the score at the end of second baseline, it is unclear if the intervention was indeed effective.

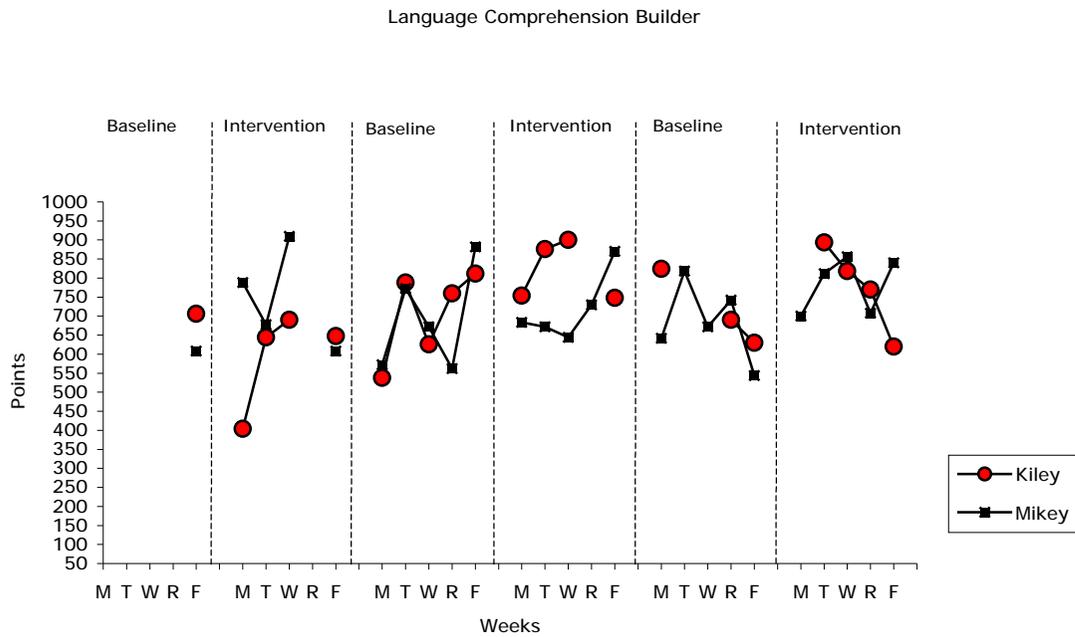


Figure 1. Language Comprehension Builder Scores for Kiley and Mikey

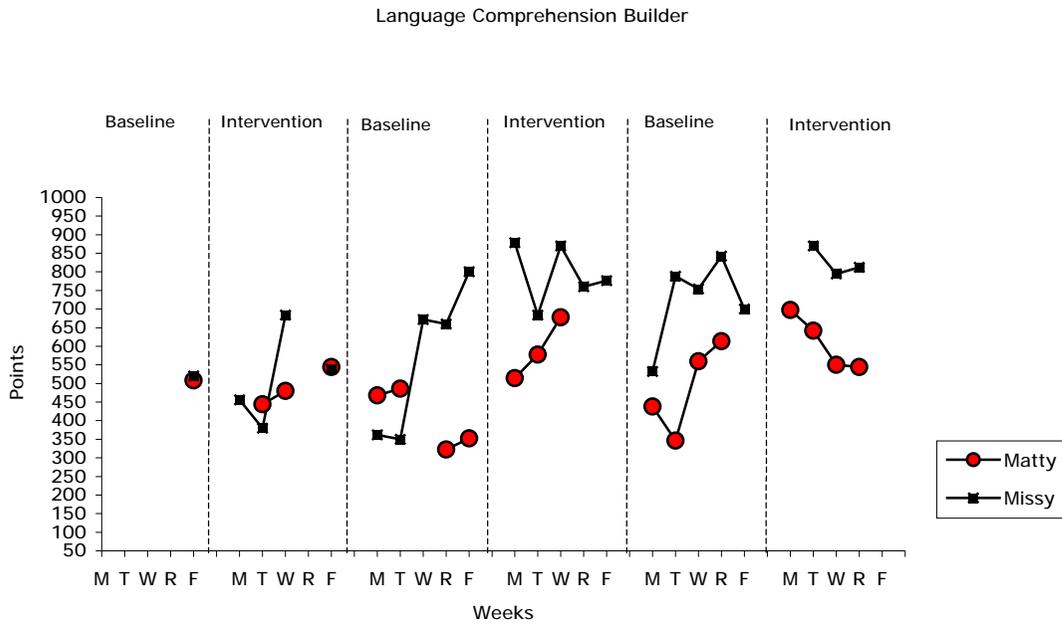


Figure 2. Language Comprehension Builder Scores for Matty and Missy.

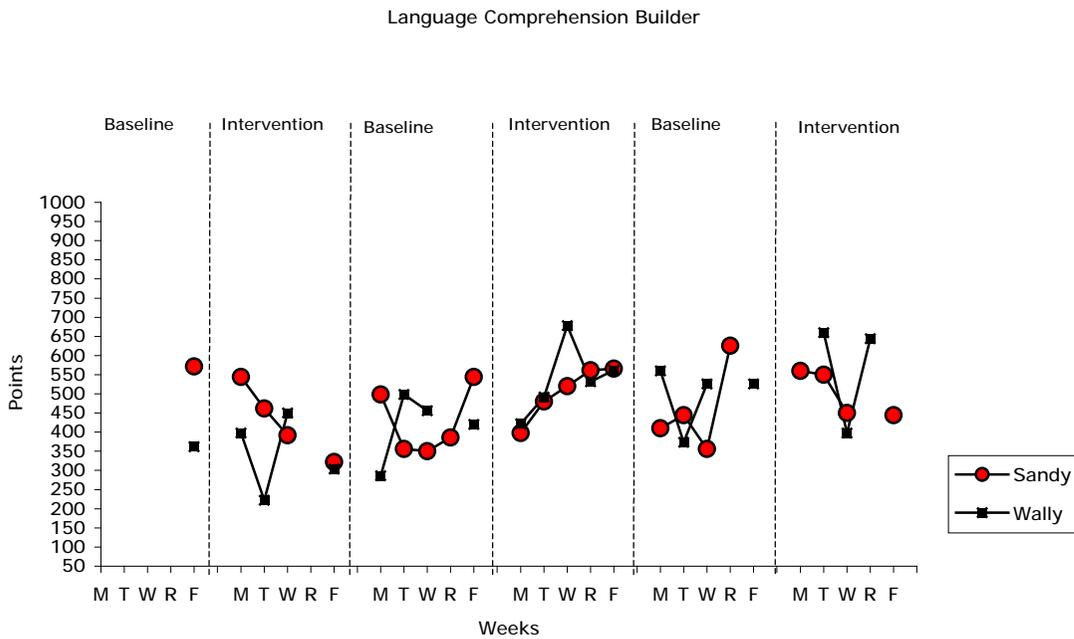


Figure 3. Language Comprehension Builder Scores for Sandy and Wally.

Figure 2 illustrates the data for both Matty and Missy on the Language Comprehension Builder. Missy's data points overlap from

the first baseline phase into the first intervention phase. During the first intervention phase, there is high variability with a rapid increase in the third data point followed by a drop back to baseline level with the fourth data point in this first intervention phase. The second baseline shows high variability with an initial decrease in scores from the intervention phase. However, after the second day, there is a rapid increase in scores maintaining an upward trend with scores higher than those in the first intervention. The data points overlap from the second baseline into the second intervention phase with slight variability in scores. The data are more stable and the level of scores is the highest during the second intervention. When returning to the third and final baseline, there is high variability with an increasing trend. The scores are lowest during the first and last day of this baseline phase. When returning to the final intervention phase, there is a significant increase in Missy's scores with a high stable rate. Overall, there appears to be a noticeable change in the level of scores for Missy over time but not necessarily associated with the intervention.

Similarly, for Matty, there appears to be an overlap in data points from the first baseline into the first intervention phase with a stable, slightly increasing trend in the scores during the first intervention phase. Again, there is an overlap in data points from the first

intervention phase into the second baseline phase. During the second baseline phase, although there was a day that Matty was absent, the four data points show a decrease in scores. Once returning to the second intervention phase, there is a rapid increase in scores with a stable trend. The third baseline displays an initial decrease in scores followed by an upward trend approaching the level of the previous intervention phase. When returning to the third and final intervention phase, the data show an increase in scores initially followed by a decreasing trend. The data are variable across all phases with overlapping data points across most phases. Overall, the intervention appears to be a success resulting in the highest during the intervention phases.

Figure 3 shows the data for both Sandy and Wally. During the first intervention phase, Sandy's data show a steady decrease in scores compared to the initial baseline. During the second baseline, there is an initial increase in score followed by a decrease for three data points and then increasing on the last day of this baseline. The data show an increase in scores with an upward trend during the second intervention phase. Once there is a return to the third and final baseline, Sandy's scores show a decreasing trend consistent with the initial baseline however, the last data point shows an increase. In the final intervention phase, there is a stable rate consistent with the scores in

the final baseline phase. Overall, there does not appear to be a significant change in the data from the baseline to the intervention phases.

Wally's initial intervention phase, in figure 3, shows high variability and three of the four data points have scores which do not differ much from the initial baseline data points. There is high variability across the phases. During the second intervention phase, there is an increasing trend. In the third in final baseline phase, most of the data are at the same level and are consistent with the data in the second intervention phase. Once there is a return to the third and final intervention phase, initially there is an increase in scores, followed by a drop, and then another increase. The results show that there is some overlap in the data for all phases. Therefore, it is not clear if the changes in scores were actually due to the intervention.

Old McDonald's Flying Farm

The mean Old McDonald's Flying Farm scores for each participant for each phase are shown in Table 2. These data are represented graphically in Figures 4 through 6.

Table 2

Mean Value of Weekly Scores for Students Participating in Old McDonald's Flying Farm

Week/Phase	Kiley	Mikey	Matty	Missy	Sandy	Wally
1	--	--	--	--	--	--
2	326.2	285.6	24	152	133.2	123.2
3	187.2	171.2	115.6	153	147.2	54
4	174.3	185.6	127.2	184.8	141.2	198.8
5	330.4	191.2	70.8	232.4	225.6	162
6	447.8	274.8	177.2	147.2	144.8	--

Note. Dashes represent weeks when activity was not selected

Figure 4 displays the results during Old McDonald's Flying Farm activity for Kiley and Mikey. There were no scores during the first baseline phase for Kiley and Mikey. Kiley's scores, in the first intervention phase, show an upward trend. During the second baseline phase, the scores decreased some. In the second intervention phase, the scores remained at a low stable rate similar to the second baseline phase. During the third and final baseline phase, the scores slightly increased. During the third and final intervention phase, the scores show a clear increase in the first two data points but a decreasing trend in the second half of this phase. Due to the high

amount of overlapping data across all phases, it is difficult to determine if the intervention was effective for Kiley.

Mikey's data were stable during the first intervention phase and then slightly decreased during the second baseline phase. When returning to the second intervention phase, there was slight increase in the two data points compared to the second baseline but lower than the first intervention phase. His data remained stable at this level into the third and final baseline phase. Once returning to the third intervention phase, there was a drop in the first data point with an upward trend in the last two data points. A lot of overlap is shown in the data across the six phases for Mikey. The results indicate the change in scores cannot be attributed to the intervention.

In Figure 5, there are no data points in the first baseline phase for Matty and Missy due to the selection of another activity for the week. Matty's lowest score is displayed during the first intervention phase. There is a slight increase in scores during the second baseline phase. During the second intervention phase, Matty's scores again increase. When returning to the third and final baseline phase, the one data point remains stable and consistent with the scores in the previous intervention phase. In the final intervention phase, Matty's scores show a decreasing trend. Although there is variability in the data across the phases, there is also overlap in the data points for each

phase. The results indicate that there is not a significant change in performance during the intervention phases for Matty.

The first intervention phase for Missy shows two data points at a stable level of performance. During the second baseline phase, Missy's data stay at a consistent level similar to the first intervention phase. However, during the second intervention phase, there is an increase in the data showing the highest scores across all phases. When returning to the third baseline, there is a clear decrease in the scores but an upward trend. In the final intervention phase, the scores show a decreasing trend and overlap completely with the previous baseline. The data overlap across all six phases with very slight variability. It is not clear if any increase during the intervention phase was due to the intervention.

There were no data points in the first phase of the study for Sandy and Wally as shown in Figure 6. Sandy's data in Figure 6 show that the scores in the first intervention phase indicate an upward trend in the data immediately followed by a decrease during the second baseline phase. When returning to the second intervention phase, there is a small initial increase in scores but a downward trend. The third baseline shows a stable trend with scores consistent with those during the second intervention phase. The final intervention phase

shows an increasing trend. However, due to the overlap with baseline it is difficult to determine if the increase was due to the intervention.

There are only a few data points in each phase for Wally displayed in Figure 6. His data is fairly stable across all phases except for the slight downward trend in the third baseline. In addition, there are no data points for Wally in the final intervention phase. There is overlap in the data points across all baseline and intervention phases and thus intervention effects are difficult to determine with any confidence.

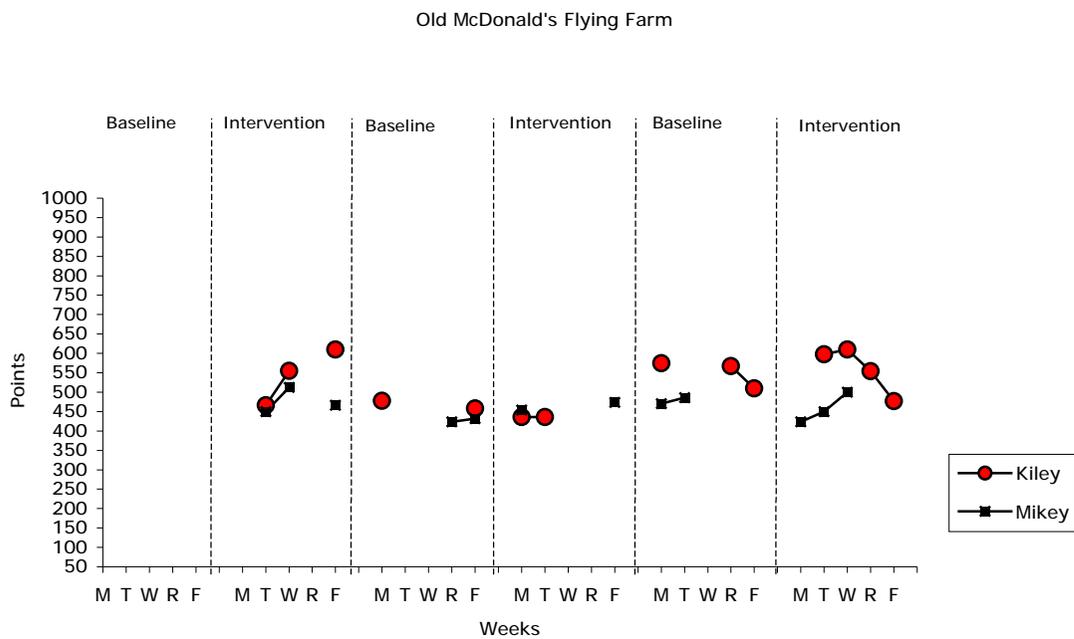


Figure 4. Old McDonald's Flying Farm Scores for Kiley and Mikey.

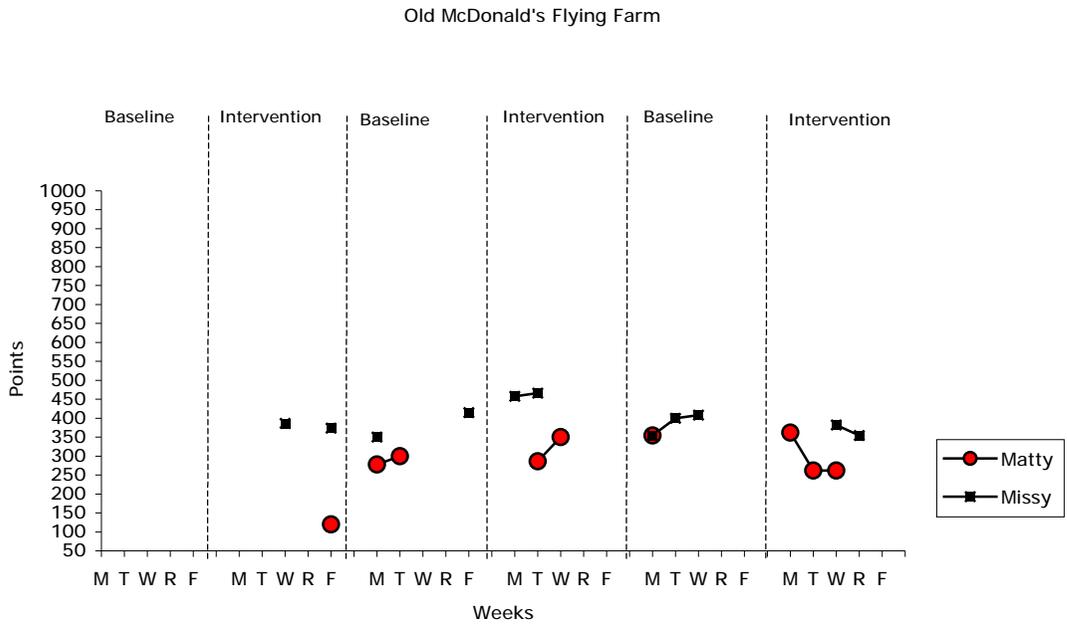


Figure 5. Old McDonald's Flying Farm Scores for Matty and Missy.

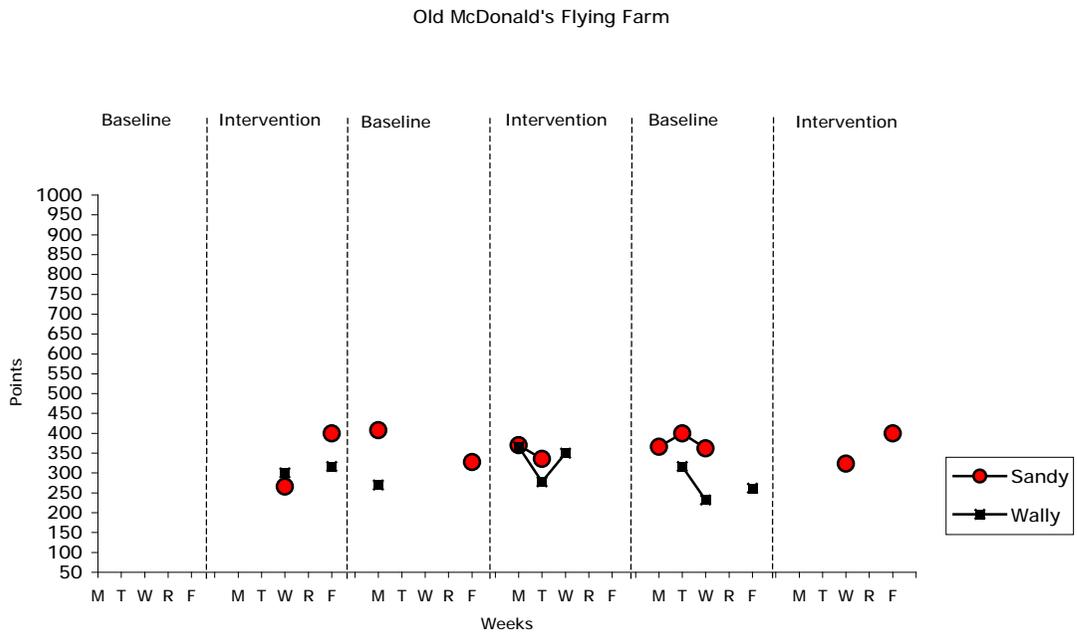


Figure 6. Old McDonald's Flying Farm Scores for Sandy and Wally.

Phonic Words

The mean Phonic Words scores for each participant for each phase are shown in Table 3. These data are represented graphically in Figures 7 through 9.

Table 3

Mean Value of Weekly Scores for Students Participating in Phonic Words

Week/Phase	Kiley	Mikey	Matty	Missy	Sandy	Wally
1	--	--	--	--	--	--
2	180	201	171	178	176	102
3	180	299	170	183	162	123
4	209	307	91	277	227.2	187
5	201	227	148	238	107	195
6	208	241	127	95	155	--

Note. Dashes represent weeks when activity was not selected

Figure 7 shows the data for both Kiley and Mikey during the Phonic Words activity. There were no scores during the first baseline phase for Kiley and Mikey. Kiley's data shows very little variability. In addition, the scores do not change significantly from baseline to intervention phases. All intervention phases, along with the second baseline phase show an upward trend in the data. Mikey's data points in Figure 7 are also stable with what appears to be a flat trendline, with little change occurring across phases. The results for both Kiley

and Mikey may indicate a slight increase in performance over time for the Phonic Words activity, but that change does not appear to be related to the reinforcement intervention.

Figure 8 illustrates the Phonic Words scores for Matty and Missy. There were no scores during the first baseline phase. Matty's data show a downward trend in the first intervention, second baseline phase, and final intervention phase. There is a large increase in score from the first data point to the second data point in the third baseline phase. There appears to be some variability in Matty's data as well as an overlap of data points across the second intervention phase into the third baseline phase.

Missy's scores show a slight increase in scores in the first and, initially, the second intervention phase. However, this does not seem to maintain during the last three days in the second intervention phase. Missy's data is stable with overlap across the second intervention phase, third baseline phase, and final intervention phase. These data do not indicate that the intervention had an effect on scores for neither Matty nor Missy.

Sandy's data are displayed in Figure 9. The trend in Sandy's data indicate a decrease during the first intervention and then an increase when returning to the second baseline. Upon return to the final intervention phase, there is an initial increase in performance which

then drops again at the last data point. This pattern of performance, along with the overlap of data points across each phase of the study suggest that the intervention did not have much impact on Sandy's performance.

Wally's scores were the lowest during the first intervention phase, however, there is change in both the level and the trend throughout each phase (see Figure 9). The trend in Wally's scores increased in both the second and third intervention phases with a decreasing trend observed when returning to baseline. In addition, there appears to be overlap in Wally's data points across several phases.

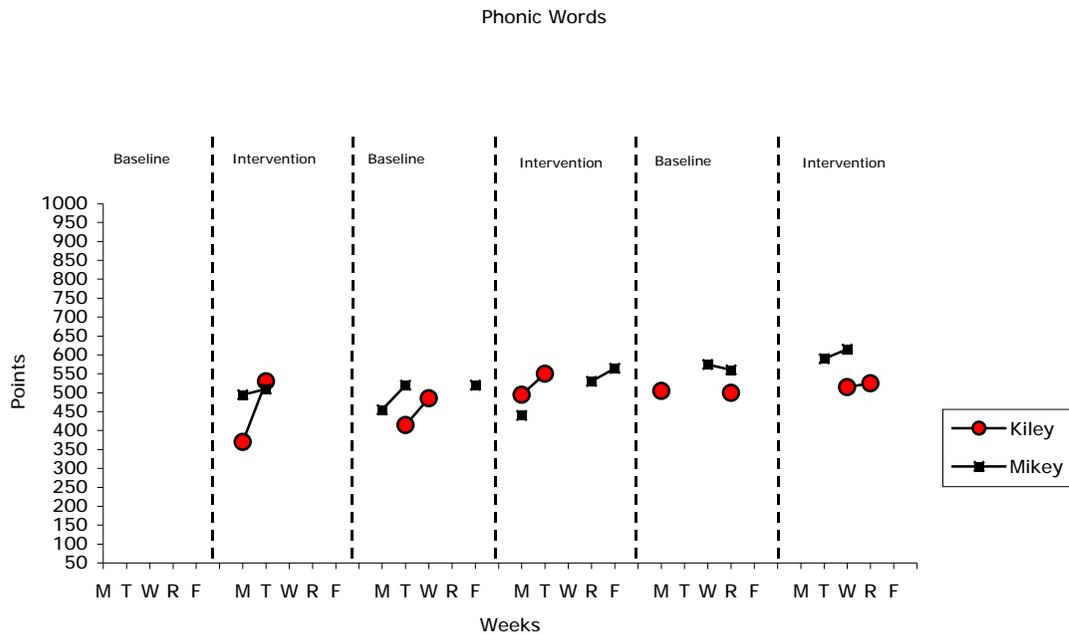


Figure 7. Phonic Words Scores for Kiley and Mikey

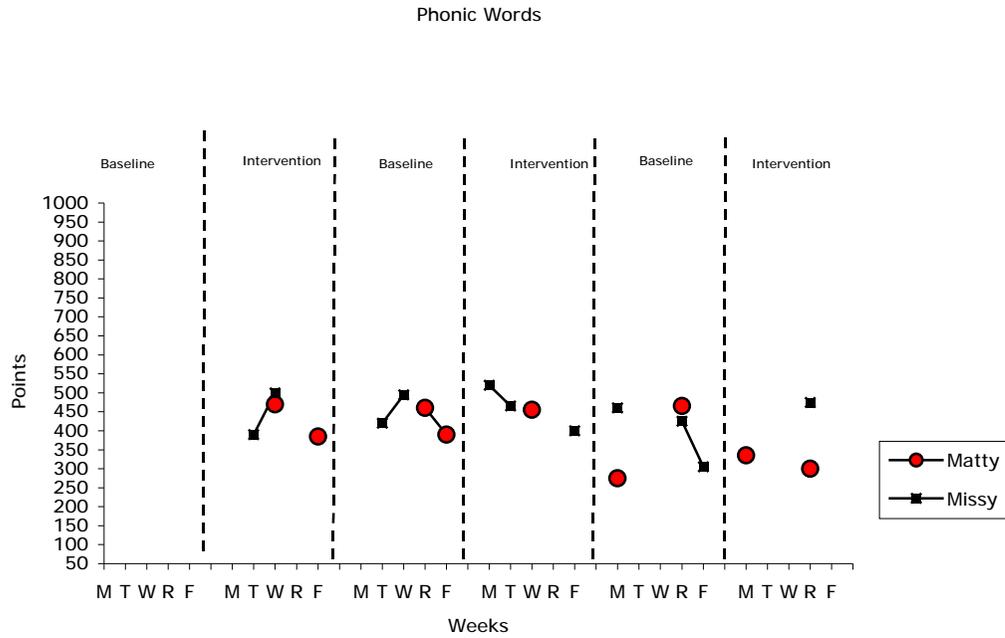


Figure 8. Phonic Words Scores for Matty and Missy.

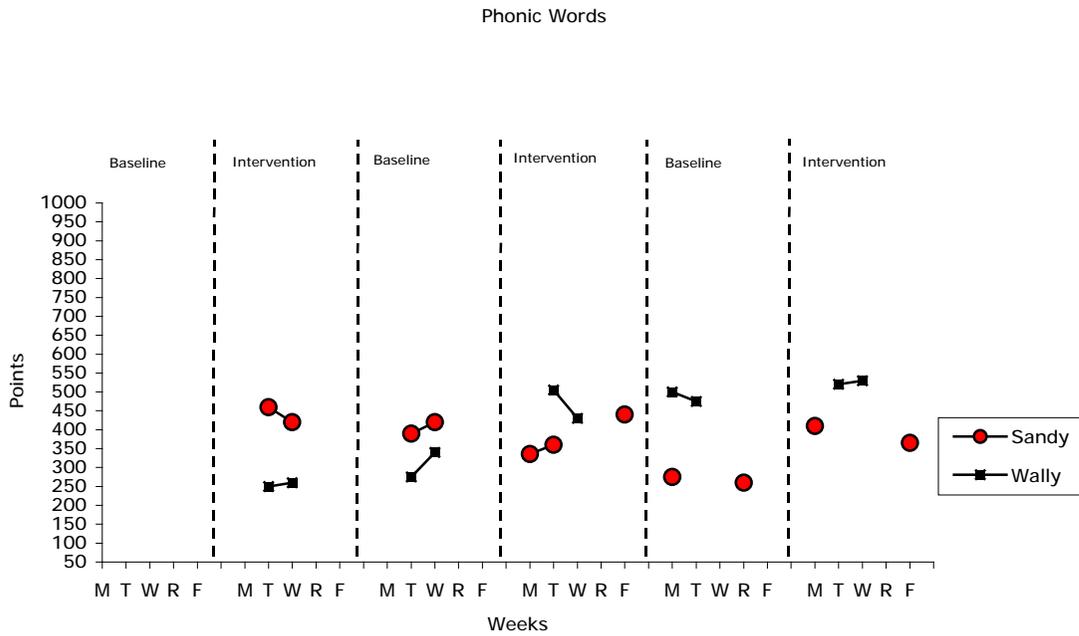


Figure 9. Phonic Words Scores for Sandy and Wally.

Circus Sequence

The mean Circus Sequence scores for each participant and each phase are shown in Table 4. These data are represented graphically in Figures 10 through 12.

Table 4

Mean Value of Weekly Scores for Students Participating in Circus Sequence

Week/Phase	Kiley	Mikey	Matty	Missy	Sandy	Wally
1	104.8	103.2	69.2	78	72	61.6
2	413	466	238	320.4	316.8	278
3	491.6	525.6	322.4	428.8	275.2	220.4
4	448	470.8	308.8	558.4	242.8	308.4
5	309.2	604.4	403.6	541.6	355.8	366.4
6	408.8	706	366.4	348.4	540.4	332.8

Note. Dashes represent weeks when activity was not selected

During Circus Sequence, Kiley's data show some variability across each phase with the exception of the second baseline phase which appears to be stable (See Figure 10). There is a decrease in scores during the first intervention phase with the exception of the very last data point. The data points for the first intervention phase overlap into the second baseline phase. The second intervention phase shows an upward trend followed by a decreasing trend in the

final baseline phase. The final intervention phase overlaps almost entirely with the previous baseline phase.

Mikey's data has slight variability across each phase and an overall pattern of increasing scores. The data points show an immediate increase during the first intervention phase, followed by a drop in this phase that continues into the next baseline phase. When returning the second intervention phase, the scores initially increase but then decrease at the end of the phase. The third baseline phase shows an upward trend. The final intervention phase shows the highest scores with the continued upward trend. It is unclear if the increases in scores for both Kiley and Mikey were related to the intervention.

Figure 11 displays the data for Matty and Missy during the Circus Sequence activity. Initially, Matty's scores decrease during the first intervention phase and then show an initial increase in the first data point in the second baseline phase. The next four data points in the second baseline phase show a steady upward trend. Matty's scores continue the steady upward trend during the second intervention phase. Initially, there is a downward trend in the final baseline phase, however, there is a large score increase in the last data point. The final intervention phase indicates a decreasing trend. Missy's data show a lot of variability in each phase. The data show that several of the scores were higher for Missy during the intervention phases and

were low during the baseline phases of Circus Sequence. However, due to the variability in the data and the overlap in the data across phases, it is not clear that such changes were attributed to the intervention.

Figure 12 displays the data for Sandy and Wally. Sandy's scores increase from the initial baseline into the first intervention phase, however there is a downward trend in the first intervention phase. Once returning to baseline, there is a steady slow decrease in scores. This trend is followed by an upward trend in the second intervention phase but the data overlap almost completely with the previous baseline. The third baseline phase shows an increase in scores with an upward trend which continues into the final intervention phase.

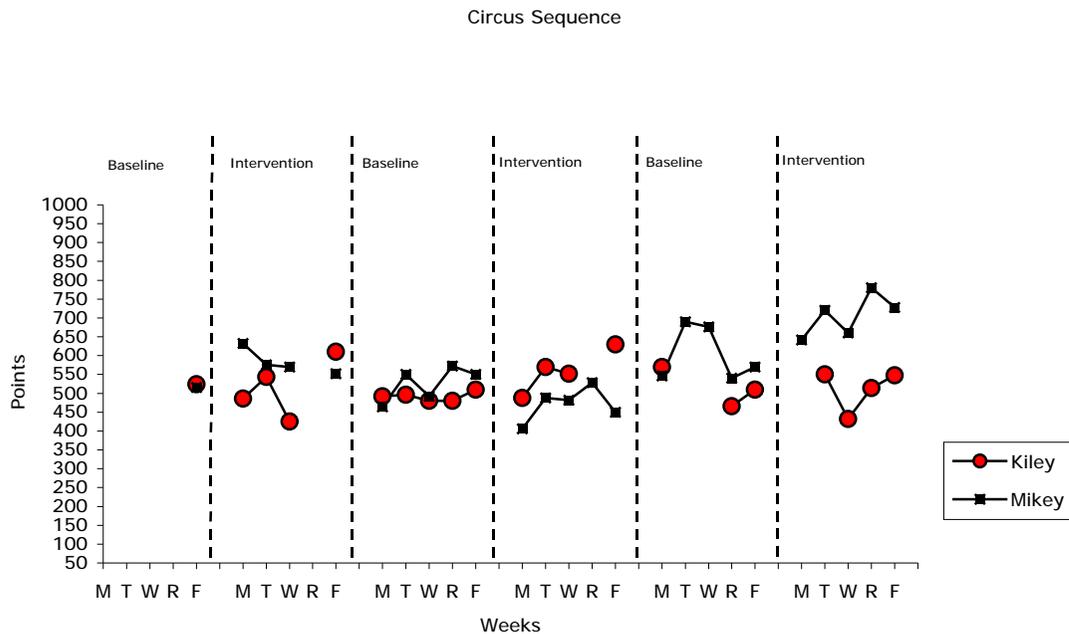


Figure 10. Circus Sequence Scores for Kiley and Mikey.

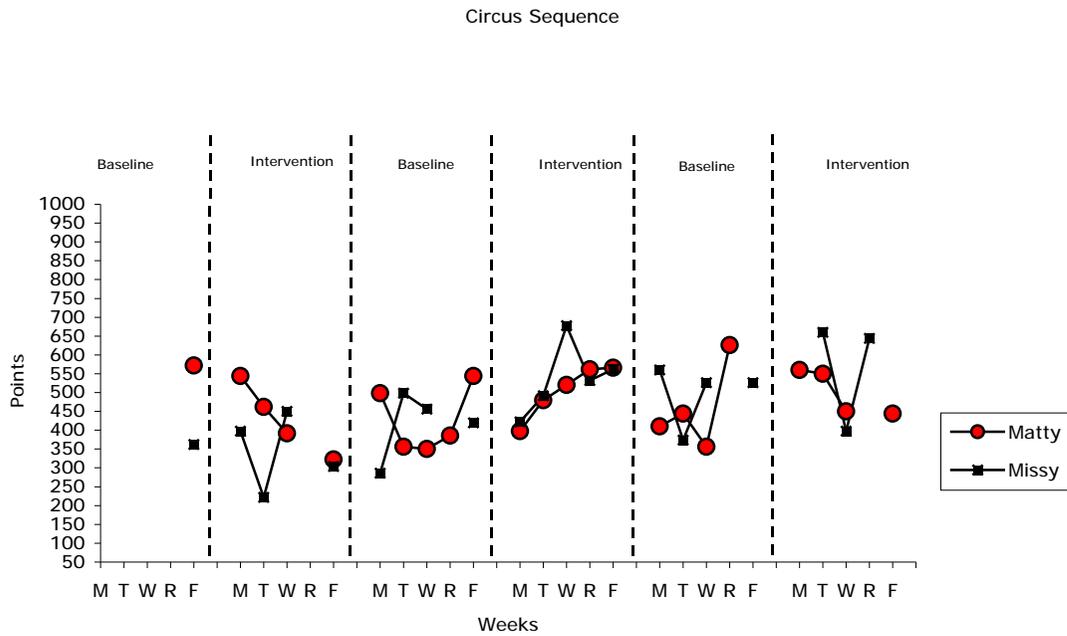


Figure 11. Circus Sequence Scores for Matty and Missy.

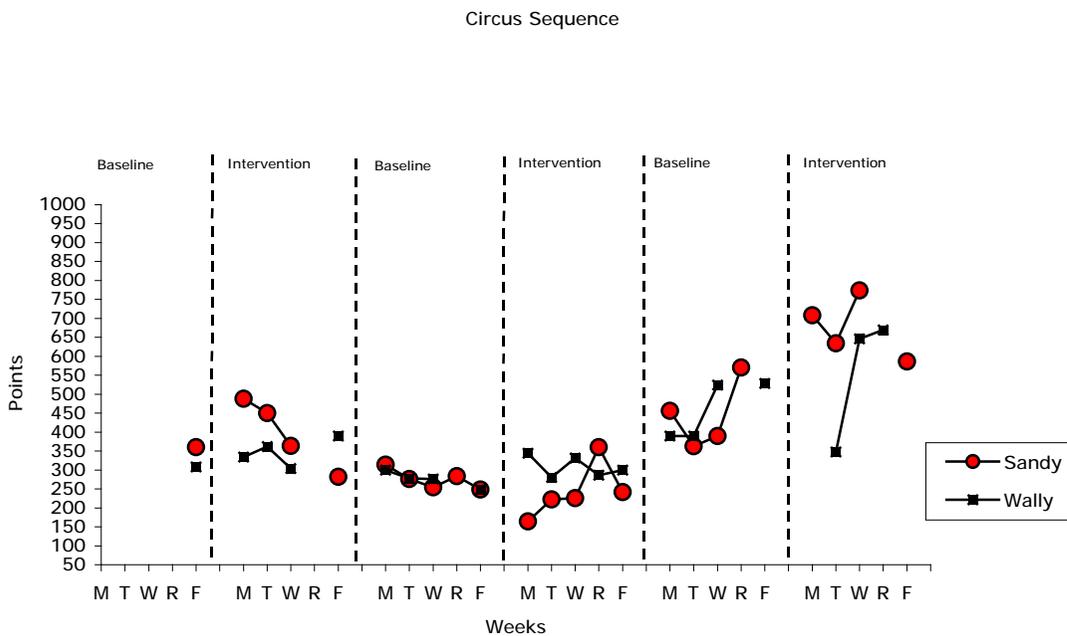


Figure 12. Circus Sequence Scores for Sandy and Wally.

Wally's data points are low with a steady overall increase when taking into account all the data points in all phases. The first three

phases show a generally flat trend. A slight increase in scores is noted from the first baseline into the first intervention phase and a decrease once returning to the second baseline. There appears to be more variability in the final three phases for Wally. Overall there seems to be a slight increase in scores for both Sandy and Wally across all phases. This could be an increase in student performance due to practice on the Circus Sequence activity. Therefore, it is unclear if the reinforcement intervention was effective for Sally and Wally.

Block Commander

The mean Block Commander scores for each participant for each phase are shown in Table 5. These data are represented graphically in Figures 13 through 15.

Table 5

Mean Value of Weekly Scores for Students Participating in Block Commander

Week/Phase	Kiley	Mikey	Matty	Missy	Sandy	Wally
1	50.4	70.8	75.6	69.6	---	67.2
2	62.4	63.6	80.4	104.4	96	97.2
3	195.6	231.6	108	201.6	118.8	123.6
4	141.6	207.6	33.6	172.8	120	99.2
5	76.8	235.2	214.8	141.6	39.6	32.4
6	212.4	177.6	64.8	62.4	---	225.6

Note. Dashes represent weeks when activity was not selected

The scores for Kiley and Mikey are illustrated in Figure 13. The data for Kiley show little change across all phases. Kiley's scores slightly increase from the first baseline phase to the first intervention phase. There is a slight increase in the second baseline phase. This general trend of slight change both within and across phases was observed throughout the study, but given the high degree of overlap, these changes cannot be attributed to the intervention with any confidence.

Mikey's data show that most of the highest scores were earned during the baseline phases. However, there also appears to be more variability during these baseline phases. Overall, Mikey's data do not demonstrate an effect for the reinforcement intervention.

In Figure 14, both Matty and Missy have higher scores in the initial baseline phase than during the first intervention phase. Matty's lowest score was earned during the second intervention phase and increased once there was a return to baseline. Matty's data show variability across phases, with the lowest scores earned during the intervention phases.

Missy also maintained higher scores during the baseline phases and downward trends during the intervention phases. Therefore, it seems clear that the intervention did not increase the scores for neither Matty nor Missy.

Sandy and Wally's data is displayed in Figure 15. Overall, Sandy maintains a low and somewhat stable level of data in each phase. Sandy showed an increasing trend in the second baseline and the subsequent (second) intervention phase. There was only one data point for Sandy in the third baseline phase and no data were collected for her during the final intervention phase. Given these circumstances, it is difficult to fully evaluate the intervention effects for Sandy.

Wally's data show some variability during the phases of the intervention but in general decrease after the first baseline and do not return to the initial baseline phase levels until the final intervention

phase. The last intervention phase shows a change in scores with an upward trend in the data.

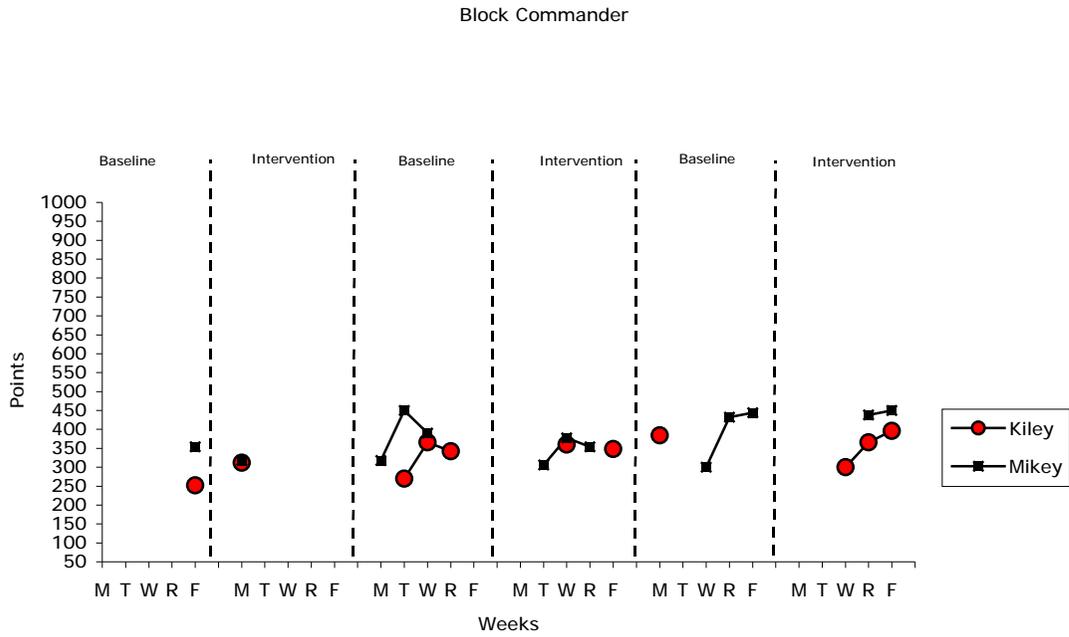


Figure 13. Block Commander Scores for Kiley and Mikey.

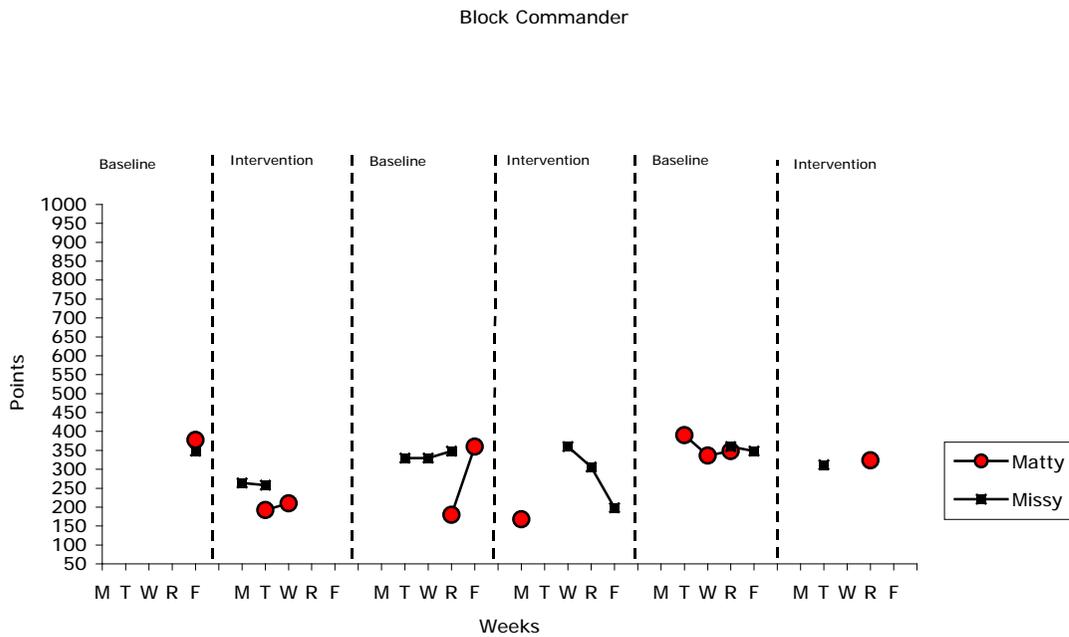


Figure 14. Block Commander Scores for Matty and Missy.

Block Commander

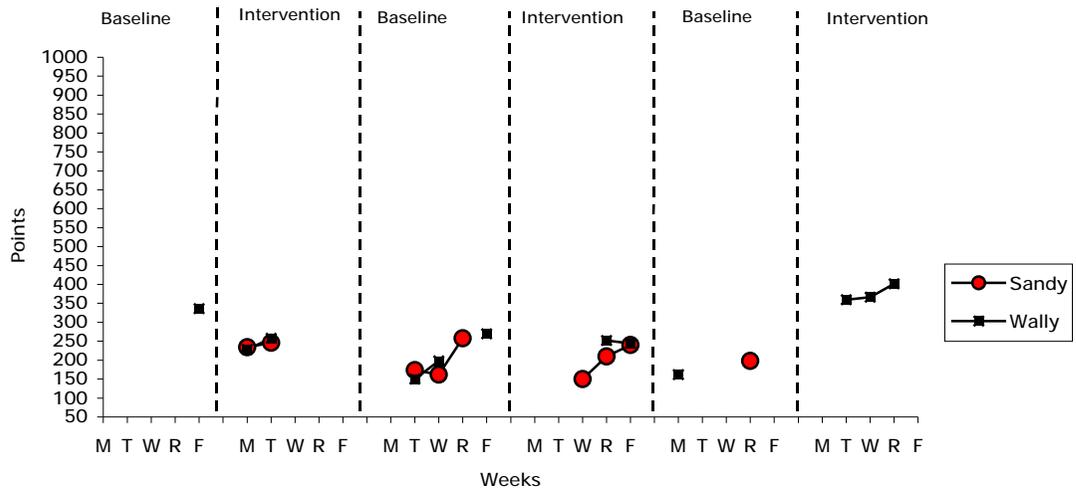


Figure 15. Block Commander Scores for Sandy and Wally.

Phoneme Identification

The mean Phoneme Identification scores for each participant for each phase are shown in Table 6. These data are represented graphically in Figures 16 through 18.

Table 6

Mean Value of Weekly Scores for Students Participating in Phoneme Identification

Week/Phase	Kiley	Mikey	Matty	Missy	Sandy	Wally
1	---	---	---	---	---	---
2	120.2	96.8	94.8	127.4	85.8	70.2
3	483.6	438.6	298.2	334.6	309	254.2
4	547.4	521.4	382.8	636.2	336.6	337
5	452.8	547.4	292.6	615.4	360	493
6	336.4	595.2	412.8	557.4	321.2	314.2

Note. Dashes represent weeks when activity was not selected

Kiley and Mikey’s data during the Phoneme Identification activity are displayed in Figure 16. Kiley’s data appears to maintain a generally stable level with overlap of data points across the phases. There is an increase in scores during the beginning of the first intervention phase but then a decrease in the second half of this intervention phase that continues into the second baseline. This is followed by a generally flat trend through the rest of the second baseline. There is an initial increase in scores in the second intervention phase, but overall these data almost completely overlap with the second baseline. When returning to the third baseline phase, there appears to be a downward trend in the data. This trend

continues through the final intervention phase. Given this pattern in the data, it is unclear whether the intervention was effective.

Mikey's data vary throughout both baseline and intervention phases making intervention effects difficult to detect. When returning to baseline, there is a slight decrease followed by an increase in the last data point. The final intervention phase indicates the largest steady increase in scores of any of the phases. Due to the overlap in data points between phases and variability within phases, it is not clear if the scores were increased by the reinforcement intervention.

In Figure 17, Matty's data show some variability across all six phases. Matty's data overlaps across the first baseline phase and the first intervention phase. There is an upward trend in scores during the second baseline phase. There is an initial drop in score in the second intervention phase followed by an increase and then an abrupt decrease. Once returning to the final baseline phase, there is a steady upward trend. The scores decrease in the final intervention phase with a continued downward trend similar to the previous intervention phase. In examining the data, it appears that the intervention did not have an effect on Matty's scores.

Missy's scores show a generally flat trend during the initial intervention phase and decreases in scores with a downward trend in both the second and third intervention phases. The second and third

baseline phases have generally upward trends. These results suggest a lack of effectiveness of the intervention and suggest that for this student, the reinforcement may have had an unintended negative effect on performance.

Figure 18 displays the data for Sandy and Wally during Phoneme Identification. Sandy's data show a lot of overlap across all phases and some variability. There is an initial increase in scores during the first intervention phase. After the first day there is an immediate decrease with a downward trend. However, there is an increasing trend during the second intervention phase. Two of the three data points in the final intervention phase overlap with the previous baseline phase indicating little change. Although, there are slightly higher scores during intervention, due to the overlap in data points across the phases, the effectiveness of the intervention is unclear.

Wally's data also show a high degree of overlap across the phases. Other than the last data point of the first intervention phase and the last data point of the second baseline, his data show a flat trend. However, the second intervention phase displays an upward trend in the data and then an initial drop in performance once returning to baseline. The last intervention phase shows a rapid upward trend. This pattern in Wally's data makes it difficult to determine the effectiveness of the reinforcement intervention.

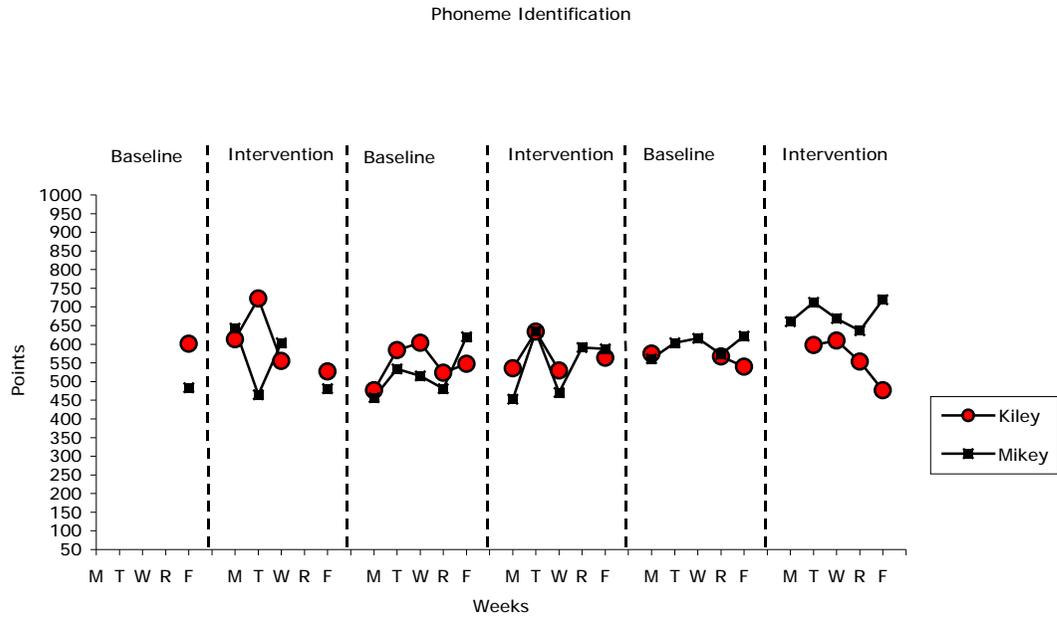


Figure 16. Phoneme Identification Scores for Kiley and Mikey.

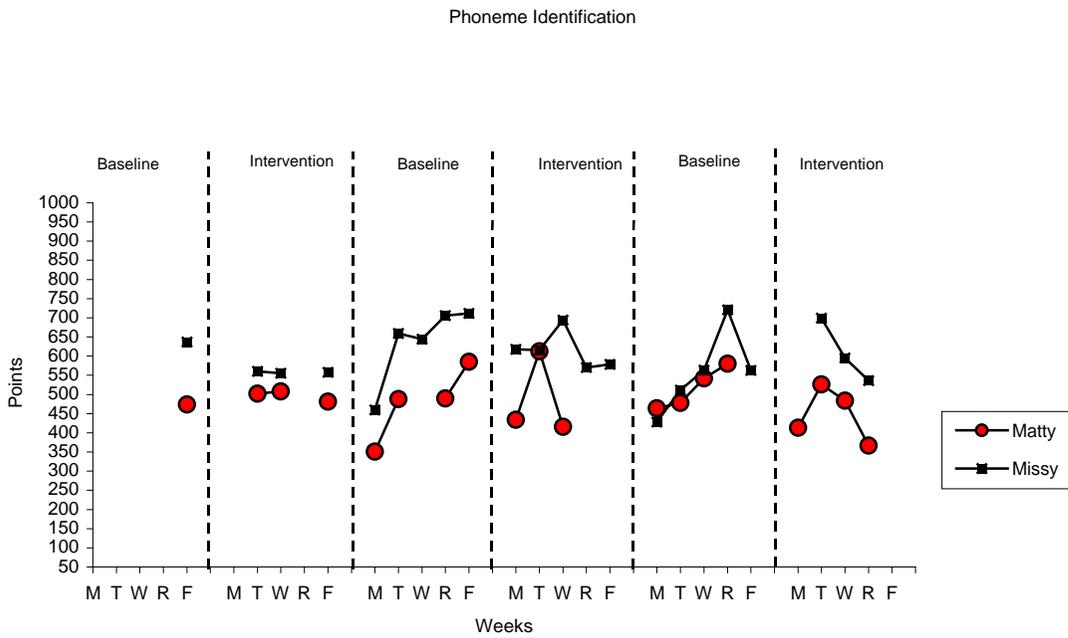


Figure 17. Phoneme Identification Scores for Matty and Missy.

Phoneme Identification

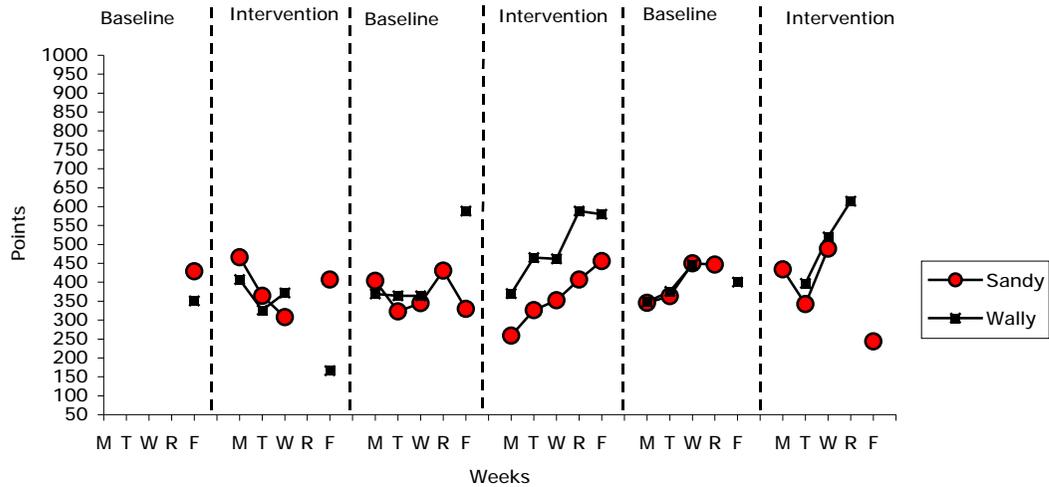


Figure 18. Phoneme Identification Scores for Sandy and Wally.

Phonic Match

The mean Phonic Match scores for each participant for each phase are shown in Table 7. These data are represented graphically in Figures 19 through 21.

Table 7

Mean Value of Weekly Scores for Students Participating in Phonic Match

Week/Phase	Kiley	Mikey	Matty	Missy	Sandy	Wally
1	54.8	59.2	44.4	69.4	29	38.8
2	107.6	88.4	76.2	77	84.8	98
3	210.6	120.2	112	203.4	156	68.8
4	160.4	192	88.8	127.4	113.4	150.6
5	69.4	259.4	99.2	135.8	114.2	95
6	161.4	275.6	128	132	95.2	22.6

Note. Dashes represent weeks when activity was not selected

Figure 19 illustrates the data for Kiley and Mikey during the Phonic Match activity. There are very few data points in each phase for Kiley, however the data maintain a low stable rate with few differences between the phases. Although the data points indicate an upward trend in both the first and second intervention phases, there is overlap in the data points across each phase. The scores for Kiley decrease upon implementation of the first intervention and then increase for the second data point. The scores drop initial upon implementing the second baseline but then increase for the last two data points. In the second intervention phase, there is a slight upward trend. The only data point in the final baseline phase is lower than the previous phase. There is an initial increase in score then a significant

drop in score during the final intervention phase. Given these data, it cannot be determined if the intervention was effective for Kiley.

Although Mikey's data points look similar to Kiley, there is an increase in scores during the second intervention phase, a decrease when returning to baseline and then another increase in the third intervention phase. The data shows a slight upward trend across all six phases. Both Mikey and Kiley could have increased their performance due to practice over time on the Phonic Match game. Therefore, one cannot discern if the observed increase during the intervention phases was due to the intervention itself.

Matty and Missy's data are displayed in Figure 20. There are two data points for Matty during each phase with a low, slightly variable level. There does not appear to be a significant change in scores from baseline to intervention across any of the phases. The low level of responding, overlap of data points, combined with very few data points in each phase, suggest that the intervention did not produce a reliable change. Likewise, there are only two data points for each phase for Missy. There is little difference in the scores from baseline to intervention. There is overlap across the phases and an upward trend in the data during the last baseline phase. Therefore, it appears that the intervention was not effective for Missy.

Figure 21 shows the data for Sandy and Wally. Sandy's data indicates a low stable level of responding with no discernable trend across all phases. There is overlap in the data points across each phase. There is a slight increase in scores during the second intervention phase. The final intervention phase shows an overlap of data with the previous baseline but a slight upward trend. However, the low levels combined with lack of trend make it difficult to conclude if the intervention was effective for Sandy. Similarly, Wally's data points maintain a low level with no reliable change from one phase to the next. Notably, the last baseline phase shows a rapid increase in one data point. Due to the overlap in data points across each phase and the lack of trend in the data, it cannot be determined if the intervention was effective.

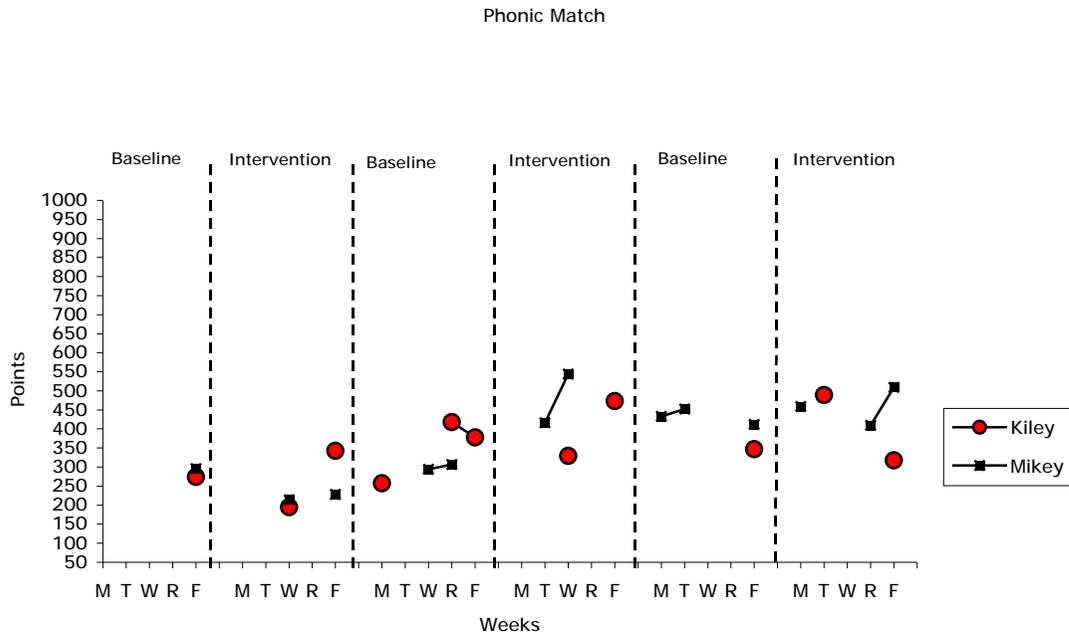


Figure 19. Phonic Match Scores for Kiley and Mikey.

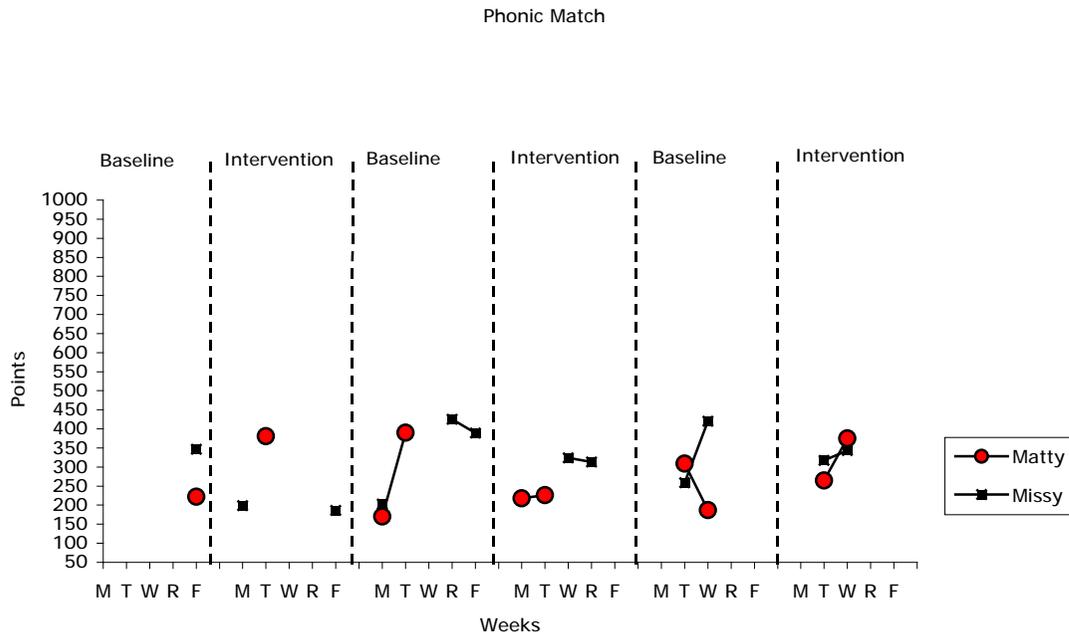


Figure 20. Phonic Match Scores for Matty and Missy.

Phonic Match

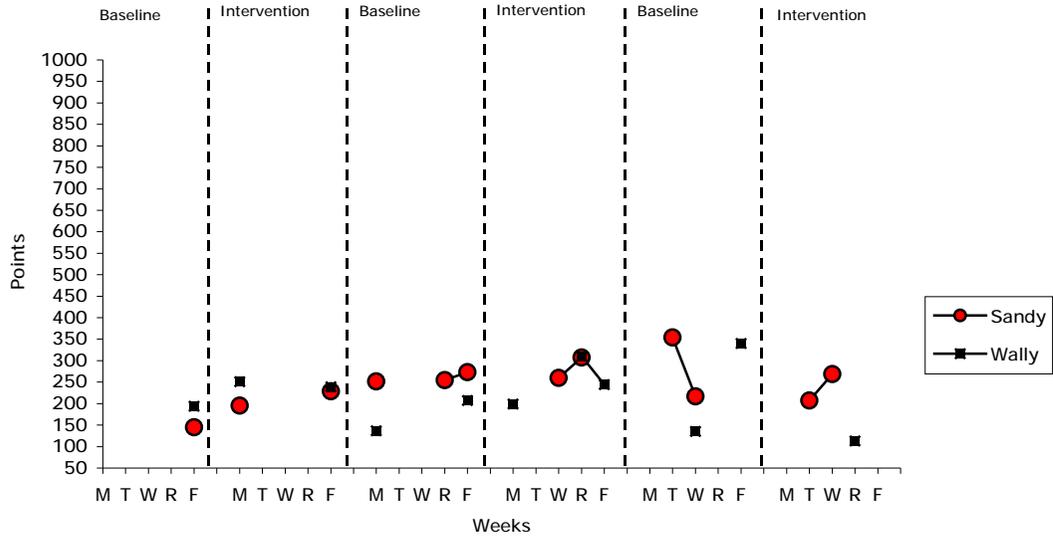


Figure 21. Phonic Match Scores for Sandy and Wally.

Chapter Four

Discussion

The purpose of this study was to evaluate the effects of reinforcement system on the scores of the students participating in the Fast ForWord Language Computer Program. The research question examined whether the use of a reinforcement system had an effect on student scores in the Fast ForWord Language Program. The results show that there were few significant differences in the student scores throughout the seven Fast ForWord activities evaluated over the various phases of the study. In general, the fewer the number of overlapping data points between baseline and treatment phases, the more likely there will be a treatment effect. The relatively small effects observed in this study in combination with the frequent overlapping data points makes it unclear whether the changes in participant performances are due to the intervention. Therefore, it is difficult to conclude if the reinforcement system had a meaningful impact on the scores of the any of the participants. Although the data show a slight increase in scores for several of the participants during the intervention phases of the Fast ForWord activities, it cannot be

determined conclusively if the increase was due to the reinforcement system due to several challenges to internal validity.

The Scientific Learning Corporation incorporated reinforcement directly into their software. However, no studies evaluating the effectiveness of the use of reinforcement in conjunction with the Fast Forward computer program were found. Specifically, research is lacking on the use of social rewards, tangible rewards, and activity rewards incorporated directly into the Fast ForWord program. Despite the lack of research on the effectiveness of adding reinforcement to the Fast ForWord program, research does exist to support the role of reinforcement for improving academic performance, including reading.

Billingsley (1977), conducted a study to show that providing reinforcement for accurate responses improves the reading performance of students in both general and special education classrooms. Furthermore, Magg (1999), a proponent for the use of positive reinforcement in the classroom setting, writes, "Reinforcement is one of the most misunderstood concepts of behavior modification, yet it represents the single most effective technique for changing students behavior." Planned consequences for increased performance may enhance the effectiveness of reading interventions, including an intervention like Fast ForWord.

Limitations

Interpreting the results from this study should be done with caution due to some possible threats to the validity of this study. Several limitations were inherent in the design of the study. One limitation that may have impacted the internal validity for the study is the inability within the school setting to control for the use of instructional techniques in the classroom that may have had an effect on the student scores during the Fast ForWord training. It is not possible to discern whether language and performance gains (i.e., increase in scores) resulted from the Fast ForWord training or other interventions within the context of instruction that may have occurred at the same time.

Additionally, another potential threat to internal validity was multiple treatment interference. It is possible that the students received some form of reading instruction in their classrooms. In addition, it is possible that the students may also have received some form of instruction from parents in their homes (Martella et al., 1999).

Another possible threat to internal validity is the manner in which the students were selected for participation. Although the independent variable was manipulated, the students were not assigned randomly but rather were pre-selected for participation by their school to receive Fast ForWord.

In addition, social interaction could have posed a threat to internal validity. It is possible that the participant performance was due to social pressures to perform. Variation in the dependent variable produced by one or more of the validity threats could easily be mistaken for variation due to the independent variable.

Possible threats to external validity (i.e., the extent to which the findings of the study could generalize to other populations or settings) also exist. This particular study evaluated the performance of six participants, which is a small sample size. Thus, the degree to which these results would generalize to other student populations should not be assumed.

Directions for Future Research

Future research on the effectiveness of a reinforcement system incorporated into the Fast ForWord programs should be explored. One question brought up during this study is whether students need to spend 100 minutes per day five days a week on the Fast ForWord activities to show a significant gain in their reading skills. The amount of time that a student is currently required to spend on the Fast ForWord activities is 100 minutes per day. However, this may become an issue for younger children with potential for problems of fatigue due to being engaged for long periods of time. For this reason, it seems important to examine varying amounts of time in order to determine

what the optimal amount of time is needed to see an increase in performance.

In addition, current research shows that students are “pulled-out” from their regular language arts instruction to participate in the Fast ForWord program. To date, no studies have been conducted to evaluate the effectiveness of the Fast ForWord program as a supplemental reading intervention rather than a replacement for the general education classroom’s core reading instruction. Most academic interventions are administered as a supplement to the instruction that students receive in their general education classroom, therefore, it this appears to be a significant area in need of further study.

Although this study examined the scores of the students participating in the Fast ForWord program, it appears to be important to also look at the speed, accuracy, and percent of correct response for students during each activity when evaluating a reinforcement system. Collecting these data would help to determine what specific behavioral dimension (i.e., accuracy, speed, etc.) is being reinforced. The Fast ForWord program tracks the number of mouse clicks during the activities and the percent of correct responses. The program takes into account the number of clicks of the mouse before the correct response is achieved. The sooner the participant clicks the correct answer, the higher the score.

This particular study assessed the use of reinforcement in order to determine a change from baseline to intervention. However, it is possible that the students may click the mouse repeatedly until they received the correct response in an attempt to increase their scores or complete the activity quicker. Fortunately, if this were to occur, the student scores would not increase as much as they would by determining the most appropriate response first.

This study evaluated a reinforcement system by using a reversal design. However, during the study the investigator had limited control over each phase due to the constraints of the participating elementary school. Therefore, for future studies, it is suggested the researcher examine the data in order to obtain a stable baseline prior to implementing any intervention.

Conclusions

There were many attractive aspects of utilizing the reinforcement system designed for this study. It was easy to implement, required minimal time, and there was virtually no cost. These intervention characteristics are typically appealing to most educators. General education teachers who have little time to spend implementing time consuming and complicated interventions to motivate their students find efficient strategies especially desirable. However, efficient and low cost interventions must still be effective.

This study was conducted to determine if the use of a reinforcement system could have an effect on the scores of students participating in the Fast ForWord Language Program. The results show that there was not a meaningful increase in student scores with the use of a reinforcement system throughout each of the Fast ForWord activities. It could be said that more questions than answers were raised in the course of this study as it remains unclear what variables relative to this intervention ultimately lead to any changes in the scores of the students participating in Fast ForWord.

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