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Three Studies Evaluating a Computer-Based Sight-Word Reading Intervention System across Special-Needs Students

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To the Graduate Council:

I am submitting herewith a dissertation written by Jared Scott Yaw entitled "Three Studies Evaluating a Computer-Based Sight-Word Reading Intervention System across Special-Needs Students." I have examined the final electronic copy of this dissertation for form and content and recommend that it be accepted in partial fulfillment of the requirements for the degree of Doctor of Philosophy, with a major in School Psychology.

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Three Studies Evaluating a Computer-Based Sight-Word Reading Intervention System across Special-Needs Students

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Degree

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Dedication

For my beautiful and loving wife Codee.

Acknowledgment

I want to again thank my lovely wife Codee. Without her constant encouragement and support, this hardly would have been possible. As I grow with you more and more each day, you continue to teach me what it means to be a man, and a husband. I also want to thank my parents, Jeff & Nita Yaw. To my father; your words of wisdom in times of need have always found their mark. Truly as you have said, "W*hen the student is ready, the master will appear*." Your words continue to prove themselves, not only in my academic path, but in my life as a whole. To my mother; I thank you for always being there for me, and above all else, thank you for instilling in me a love for the Lord and a passion for His word. Your life has been a lasting testament to me; to always seek Christ and His grace, to walk in His statutes and His laws, and to *in everything be prayer and supplication, with thanksgiving before the Lord our God.* And to my friends; they say when a man enters the straights of life, he is fortunate if he has a few friends upon whom he can count to the uttermost. If that is so, then I am truly blessed to have so many of you in my life.

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Abstract

This dissertation includes three studies extending research on a computer-based sight word reading intervention across special needs students. In Study I, a multiple-baseline across behaviors design was used to evaluate automatic sight-word reading in a fourth-grade student with intellectual disabilities. Immediately after the intervention was applied to each of three lists of sight words, the student made rapid gains in her ability to read those words within 2 s.

In Study II, an adapted alternating treatment design was used to evaluate the effects of two computer-based flashcard interventions among four elementary students with disabilities. The two interventions were similar; with either 1-s response intervals (i.e., students had 1 s to read the word before they heard it) or 5-s response intervals applied. Instructional time was held constant (3 min per session) across both the 1-s and 5-s procedures; consequently, students completed six learning trials during each 1-s session but only two during each 5-s session. Results showed similar gains in sight-word mastery rates across both the 1-s and 5-s response interval interventions.

In Study III, a multi-phase adapted alternating treatment design was used to evaluate the effects of two computer-based flashcard reading interventions among three elementary students with disabilities. Each intervention provided students with either 1-s or 5-s response intervals. Instructional trials were held constant (three trials per word, per session) across both the 1-s and 5-s procedures and results were analyzed using both crude (i.e., sessions) and precise (i.e., seconds) measures of instructional time. Across all three students, analysis of learning per session showed no differences across the 1-s and 5-s words which suggest that learning trials were equally effective. However, when instructional time was measured more precisely all three students showed higher learning rates under the 1-s intervention.

These studies extend the research on a computer-based sight-word reading intervention system and provide an extensive framework on how researchers should evaluate interventions in light of learning rates. Discussion focuses on the contextual validity (e.g., sustainability, efficiency) of this computer-based intervention. Additionally, implications related to measuring learning rates, evaluating learning trial quality, re-learning, and assessing maintenance are discussed.

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Chapter I

Introduction

Importance of Reading

The acquisition of reading skills is a priority for students with and without disabilities. Bean, Zigmond, and Hartman (1994) note that by the time students enter the middle school grades, textbooks become the major instructional resource in classrooms. In order to learn from written text, students must develop the ability to rapidly read and comprehend what they read (Mastropieri, Scruggs, & Graetz, 2003; Skinner, 2008; Therrien, 2004).

Because it is difficult to imagine teaching every word to every child (Alessi, 1987), educators and researchers often recommend applying a phonemic approach to teach reading (National Institute of Child Health and Human Development, 2000; Skinner & Daly, 2010). The results of the National Reading Panel's (2000) meta-analysis suggested that phonemic approaches (e.g., teaching children to manipulate phonemes in words) to reading skill development were effective across instructional procedures, learners, and grade levels. While teaching letter-sound relationships, segmentation, and blending strategies (i.e., phonemic approach) is often effective, phonemic based approaches to reading skill development have had mixed results when working with students with disabilities (National Institute of Child Health and Human Development, 2000). For many students with specific learning disabilities (SLD), mild and moderate intellectual disabilities (ID), and emotional and/or behavioral disabilities (EBD), the acquisition of basic reading skills (i.e., phonemic awareness) continues to be a serious concern. For instance, Gersten, Fuchs, Williams, and Baker (2001), found that up to 80% of students with SLD have some sort of reading problem.

Goodman (1990) noted that the amount of instructional time allotted for reading in many general and special education classrooms averaged around 1.5 hours per day. Some schools adopting “Reading First” curricula may allot 2.5 hours per day toward the development of reading skills. For a student receiving response-to-intervention services in one of these “Reading First” schools, 3 – 3.5 hours per day may be allotted to reading. Despite the amount of time allotted for pre-reading and early-literacy development, some students continue to struggle to develop phonemic skills (Gersten et al., 2001; National Institute of Child Health and Human Development, 2000). In such cases, and particularly when students have specific learning disabilities, intellectual disabilities, and emotional and/or behavioral disabilities, some researchers have advocated using whole-word or sight-word instructional approaches (Bliss, Skinner, & Adams, 2006; Browder & Lalli, 1991; Burns & Sterling-Turner, 2010).

Sight Word Instruction

A common and effective sight-word procedure used among students with disabilities involves the application of flashcard learning trials (Browder & Lalli, 1991; Browder & Xin, 1998; Orelove, 1982; Skinner, Logan, Robinson, & Robinson, 1997). During typical flashcard instruction a learning trial consists of a) the student being shown a word and being prompted to read the word, b) the student then given an interval to respond, followed by c) response-contingent feedback (e.g., including praise following accurate responses and additional prompts or corrective feedback when the student fails to respond or responds incorrectly). Flashcard learning trial procedures have been shown to enhance sight word reading in students with mild and moderate disabilities (Browder & Xin, 1998; Nist & Joseph, 2008).

Computer-Based Flashcards

Technology and computer-based instruction (CBI) has been used to teach skills to students with disabilities including decoding and word identification (Coleman-Martin, Heller, Cihak, & Irvine, 2005); phonological awareness (Tjus, Heimann, & Nelson, 1998); word reading (Heimann, Nelson, Tjus, & Gillberg, 1995); generative spelling (Kinney, Vedora, & Stromer, 2003); sight word reading (Baumgart & Van Walleghem, 1987; Brewer, White, & Brand, 1991; Farmer, Klein, & Bryson, 1992; Mechling, 2004; Mechling & Gast, 2003) and vocabulary (Moore & Calver, 2000). Relative to traditional and one-to-one teacher instruction, CBI may enhance students' motivation, attention, and time on task (Mechling, Gast, & Thompson, 2008; Moore & Calver, 2000; Okolo, Bahr, & Rieth, 1993).

Recently, researchers have used a computer-based sight-word reading system to target sight-word reading across students with Specific Learning Disabilities (SLD), Intellectual Disabilities (ID), Autism, English Language Learner (ELL), and ADHD (Hilton-Monger, Hopkins, Skinner, & McCane-Bowling, 2011; Hopkins, Hilton, & Skinner, 2011; Yaw et al., 2011). There are many advantages to using CBI when training sight words. While a student is working with the computer, the teacher can attend to other students or classroom issues (Kodak, Fisher, Clements, & Bouxsein, 2011). Although therapists, teachers, and caregivers do not always implement interventions with high levels of integrity (Moore & Fisher, 2007; Mueller et al., 2003), computer programs can be used to consistently provide words and prompts (e.g., audio recording of the correct word) as intended (Kodak et al., 2011). When comparing personal to computer-based instruction, researchers have found higher motivation levels (Heimann et al., 1995; Moore & Calvert, 2000) and decreases in behavior problems during the computer-based instruction (Chen & Bernard-Opitz, 1993).

Remediation

Learning rates. When comparing interventions, learning levels are an important part of assessment. These comparisons can be useful, especially if learning problems are accurately characterized as a failure to learn. However, most learning problems are not a “failure to learn” problem, but a learning rate problem. Most referred students are learning, but their learning rate is unacceptable and they are falling behind with respect to meeting skill development and curricular goals (Cates et al., 2003; Skinner, Belfiore, & Watson, 1995/2002; Skinner, Fletcher, & Henington, 1996). Therefore, when evaluating interventions designed to remedy skill development, researchers should precisely measure learning rates (Skinner, 2008, 2010). Learning rates are computed by dividing a measure of behavior change by instructional/learning time (i.e., minutes or seconds allocated to learning). Research on learning trial quality and learning trial quantity may provide a framework for understanding and improving learning rates (Skinner et al., 1995/2002; Skinner et al., 1996; Skinner, Belfiore, Mace, Williams-Wilson, & Johns, 1997).

Researchers concerned with learning trials have made a distinction between learning trial quality and quantity (Skinner et al., 1997; Skinner et al., 1996; Skinner, Ford, & Yunker, 1991). When comparing learning trials, the trials which occasion more learning are higher quality trials (Skinner et al., 1991; Skinner et al., 1995/2002; Skinner et al., 1997). Researchers have investigated different methods for strengthening learning trial quality by manipulating antecedent (i.e., instructional prompt techniques) and consequent events (Sulzer-Azaroff & Mayer, 1986). For example, Dunlap and Kern (1996) modified instructional and curricular antecedent events to occasion higher quality learning trials, while others have focused on enhancing learning trial quality with consequent events such as immediate corrective feedback following errors and reinforcement for accurate responding or rates of accurate responding (Neef, 1980; Skinner et al., 1996). Alternatively, some researchers have focused on enhancing learning trial quality by manipulating the response itself (e.g., response topography, selection versus producing responses, see Greenwood, Delquadri, & Hall, 1984; Skinner et al., 1991).

Rather than focusing on learning trial quality, others have enhanced learning by enhancing the number or quantity of learning trials (Cates et al., 2003; Skinner et al., 1991; Skinner et al., 1997). Albers and Greer (1991) note that increasing the amount of practice or the quantity of learning trials can lead to increased accuracy, fluency, and maintenance. Often educators increase the quantity of learning trials by allocating more time to learning/instruction (Berliner, 1984). Although lengthening school days or years, and re-allocating time from other school activities (i.e., music, physical education, art) can allow for a greater number of learning trials, these strategies may demand resources that schools do not have, particularly time (Skinner et al., 1996). Another way of increasing learning trial quantity, without having to re-allocate time, is to increase learning trial rates, allowing more complete trials to be completed in a fixed period of time (Skinner et al., 1996; Skinner et al., 1997).

While some may be concerned that enhancing learning trial rates may decrease learning trial quality (Riley, 1986; Rowe, 1974), researchers investigating pacing have found evidence that procedures that enhance learning trial rates may also enhance learning trial quality (Carnine, 1976; Darch & Gersten, 1985). This may occur because more rapid pacing enhances students' attention (Hawkins, Skinner, & Oliver, 2005; Robinson & Skinner, 2002). Regardless, these studies suggest that increasing learning trial quantity in a fixed time interval (i.e., increasing learning trial rates) may enhance learning rates because they increase the amount of practice (number of trials) and the amount learned per trial (quality of trials).

Purpose

With an emphasis on accountability and student learning, teachers consistently report pressure to cover more instructional objectives in less time (Barnett, Daly, Jones, & Lentz, 2004; Braden, 2002). CBI may help address this concern. Previous researchers who have used computer-paced learning trials to teach sight words have generally applied fixed response intervals ranging from 3-5 s (Hilton-Monger et al., 2011; Hopkins et al., 2011; Kodak et al., 2011; Yaw et al., 2011).

Hilton-Monger et al. (2011) implemented a computer-based sight-word intervention across three students; one receiving remedial reading instruction, one English Language Learner, and one student with ADHD. Following guidelines by Hopkins et al. (2011), Yaw et al. (2011) used the CBSWR intervention to increase sight-word reading in a student with autism. With Study I we extended this research by evaluating the effects of a computer-based sight-word reading (CBSWR) intervention in a student with intellectual disabilities.

We designed Study II to evaluate and compare two CBSWR interventions (one with 5-s response intervals, and the other with 1-s response intervals) on sight-word learning rates across four students, a student with autism, two students with SLD, and one student with functional delay. To precisely measure learning rates we held learning time constant (3 min for each CBSWR intervention). Holding learning time constant under each intervention (3 min of each intervention per day) required us to allow learning trial quantity and learning trial rates to vary (i.e., two trials of 5-s response interval words, but six trials of 1-s words).

With Study III we compared two CBSWR interventions, one with 5-s response intervals and the other with 1-s intervals. However, because we were evaluating learning trial quality we held learning trials constant across the interventions (i.e., three trials across both the 5 s and 1 s interventions), and allowed instructional time to vary. These studies help create a framework that may allow researchers to develop and compare interventions so that they can identify the most effective and time efficient interventions (i.e., the intervention that maximize learning rates). Such research may enhance the probability of educators reading experimental research, because such research may allow educators to identify the strategies, procedures, and specific interventions that will remedy skill deficits most rapidly (Skinner, 2010).

Research Questions

The following questions are addressed:

1) Is the CBSWR intervention a valid intervention tool to use with students with mild to moderate intellectual disabilities?
2) Will holding time constant and allowing trials to vary (i.e., Study II) result in different patterns of learning rates across both conditions (1-s vs. 5-s response intervals)?
3) Is the quality of the 1-s response interval condition better/worse than the 5-s response interval condition?

Chapter II

Study I: Evaluating a Computer-Based Sight-Word Reading Intervention in a Student with Intellectual Disabilities[1]

Footnote

[1] This study was completed with support from the Korn Learning, Assessments, and Social Skills (KLASS) Center at The University of Tennessee.

Abstract

A multiple-baseline across behaviors (i.e., word lists) design was used to evaluate a computer-based flashcard intervention on automatic sight-word reading in a fourth-grade student with moderate to severe intellectual disabilities. Immediately after the intervention was applied to each of three lists of sight words, the student made rapid gains in her ability to read those words within 2 s. Approximately eight weeks after the final intervention session, evidence for maintenance and generalization were collected when the student read words learned during the computer-based flashcard procedure that were hand written on index cards, as opposed to displayed on the computer screen. Discussion focuses on the contextual validity (e.g., sustainability, efficiency) of this computer-based intervention.

Evaluating a Computer-Based Sight-Word Reading Intervention in a Student with Intellectual Disabilities

Individual Education Plans contain more reading objectives than any other academic-skill objectives (Bos & Vaughn, 2008). Although remedying early-literacy deficits (e.g., phonemic awareness) may prevent more severe problems from developing, (Ehri & Nunes, 2002; National Institute of Child Health and Human Development, 2000; Watson, Fore, & Boon, 2009), some students continue to struggle with reading skill development even when they receive additional targeted instruction (e.g., response-to-intervention) or individualized services (e.g., special education). In such instances, supplementing early literacy-skill instruction with sight-word reading instruction designed to teach students to read commonly used words (e.g., Dolch words, see Dolch, 1948) may enhance students' confidence in their reading abilities, improve their daily living skills, and reduce frustration associated with learning to read and/or reading instruction (Bliss, Skinner, & Adams, 2006; Browder & Lalli, 1991).

One of the most common procedures used to enhance sight-word reading in people with intellectual disabilities involves the application of flashcard learning trials (Browder & Lalli, 1991; Browder & Xin, 1998; Burns, 2007; Skinner, Logan, Robinson, & Robinson, 1997). A typical flashcard learning trial consists of a) the student being shown a word and being prompted to read the word, b) an interval for the student to respond, and c) response-contingent feedback (e.g., praise following accurate responses, additional prompts or corrective feedback when the student fails to respond or responds incorrectly). Although flashcard instruction has been shown to enhance sight-word reading accuracy, maintenance, and generalization (Browder & Xin, 1998; Burns, 2007; Joseph & Nist, 2006; Nist & Joseph, 2008), these procedures have limited contextual validity (e.g., cannot be easily applied and sustained across context) because they often require a one-to-one, teacher-to-student ratio (Hanely-Maxwell, Wilcox, & Heal, 1982; Skinner, 2008).

Researchers have used several strategies to address this limitation. Researchers investigating incidental learning have had classmates observe peers receiving flashcard instruction and found that some observers learned words that were taught to their classmates (Hanely-Maxwell et al., 1982; McCurdy, Cundari, & Lentz, 1990; Orelove, 1982). These results suggest that small-group instruction may mitigate some contextual validity limitations associated with flashcard instruction. Unfortunately, in these studies some observers did not learn any words taught to classmates and all students learned more words that were taught to them directly, relative to words that were learned via observing others being taught (Hanely-Maxwell et al., 1982; McCurdy et al., 1990; Orelove, 1982).

Others have recommended using technology to provide efficient and sustainable sight-word instruction (e.g., Carbo, 1978; National Institute of Child Health and Human Development, 2000). The taped-words (TW) intervention has been used to enhance sight-word reading in students with learning disabilities (e.g., Freeman & McLaughlin, 1984), emotional/behavioral disorders (e.g., Skinner, Belfiore, & Watson, 1995/2002), and moderate to severe intellectual disabilities (Sterling, Robinson, & Skinner, 1997). During TW students are instructed to read a printed list of words along with a recording of the words being read.

Initially during TW, words were played very rapidly so modeling and/or neurological impress processes would enhance reading accuracy and reading speed or fluency (Carbo, 1978; Cunningham, 1979; Freeman & McLaughlin, 1984; Heckelman, 1969; Hoskisson & Krohm, 1974; Smith, 1979). Subsequent studies suggested that modeling or neurological impress processes do not enhance reading speed; rather, the repeated practice occasioned by the TW intervention caused the increases in automatic responding (Skinner et al., 1993; Skinner, Cooper, & Cole, 1997; Skinner, Johnson, Larkin, Lessley, & Glowacki, 1995; Skinner & Shapiro, 1989; Sterling et al., 1997). Consequently, Bliss et al., (2006) altered TW procedures by enhancing the delays between words being read on the tape and encouraging students to attempt to read the word before it was played on the tape (e.g., to attempt to *beat the tape*). Similar procedures had been used with tape-paced instruction to enhance math-fact automaticity (see Carroll, Skinner, Turner, McCallum, & Masters, 2006; McCallum, Skinner, & Hutchins, 2004; McCallum, Skinner, Turner, & Saecker, 2006; Poncy, Skinner, & Jaspers, 2007). Adding these delays may have enhanced learning, as the additional time to respond and challenging students to try to beat the tape may have increased active responding (Greenwood, Delquadri, & Hall, 1984; McCallum et al., 2006). Also, the recording may provide immediate feedback that reinforces accurate responding and provides corrective feedback for inaccurate responding (McCallum et al., 2004; Skinner et al., 1997; Skinner & Smith, 1992).

Although tape-based instruction has many advantages, it may be challenging for some students to maintain their place as they attempt to read words from a printed list of words along with (e.g., Freeman & McLaughlin, 1984) or just before (e.g., Bliss et al., 2006) the tape (Krohn, Skinner, Fuller, & Greear, in press). Recently, Hilton-Monger, Hopkins, Skinner, and McCane-Bowling (2011) developed and evaluated a computer-based sight-word reading (CBSWR) system that addressed this problem by using technology (e.g., Microsoft© PowerPoint© software electronic flashcards) to pace students sight-word learning trials by presenting only one word at a time. Specifically, a sight-word appeared on the computer screen and the student had 2 s to read the word before a recording of the word being read was played. The initial multiple-baseline evaluation showed post-intervention gains in sight-word reading across three students; one with ADHD, one receiving remedial reading instruction, and an English Language Learner (Hilton-Monger et al., 2011). Yaw et al. (2011) replicated and extended this research and found that following the application of the CBSWR intervention, a sixth-grade student with autism made even more immediate and rapid gains than the participants in the Hilton-Monger et al. (2011) study. Although these two studies support the efficacy of the CBSWR intervention, external validity was limited because no maintenance data were collected and all sight-word reading was done on the computer screen. Consequently, researchers could not determine if improvements would generalize to printed (as opposed to electronic) material.

Summary and Purpose

Computer-based instruction has been used in special education classrooms to enhance a variety of academic skills, including pre-reading and reading skills (Baumgart & VanWalleghem, 1987; Boone, Higgins, Notari, & Stump, 1996; Heimann, Nelson, Tjus, & Gillberg, 1995; Okolo, Bahr, & Rieth, 1993). The current study was designed to replicate and extend previous research on the CBSWR intervention (Hilton-Monger et al., 2011; Yaw et al., 2011). Specifically, we attempted to determine if this procedure could enhance sight-word reading in a student with intellectual disabilities and if these improvements would be maintained over eight weeks and generalize to printed flashcards.

Methods

Participant and Setting

This study was conducted at a rural elementary school in the Southeastern United States. The school served 750 – 800 students. Approximately 88% were Caucasian, 7% African-American, 2% Asian American, and 1% Hispanic/Latino. About 60% of the students qualified for free or reduced lunch. The participant was a 10 year old female fourth-grade Caucasian student who will be referred to as Leah. Leah had a diagnosis of moderate to severe intellectual disabilities and received all her academic instruction in a self-contained special-education classroom that included 10 students, one special education teacher, and two teacher's aides. A Ph.D. student in a school psychology program served as the primary experimenter.

Procedures were run in Leah's classroom. There were four round tables in the room and students spent most of the day working at their assigned grade-level tables. Experimental procedures were run at the computer learning area which had five computers or at one of the four round tables using the graduate student's personal laptop.

Materials

Following guidelines provided by Hopkins, Hilton, and Skinner (2011), the primary researcher used Microsoft© PowerPoint© to construct a computer-based sight-word reading (CBSWR) system that included two separate programs, one for assessment and one for intervention. Both programs presented primer and first-grade Dolch words in 88 point Arial style font. Words were presented one at a time, centered on the screen. During assessment phases, students were recorded using Apple © GarageBand© software. These recordings were used to calculate interobserver agreement.

Design and Dependent Variables

A multiple-baseline across behaviors (i.e., word lists) design was used to evaluate the effectiveness of the intervention on sight-word reading (Kazdin, 2011). The intervention was applied in a staggered fashion across three lists (A, B, and C) of 10 Dolch words. Target words were selected by Leah's teacher who volunteered to select 30 words from the primer and first-grade Dolch word lists that Leah could probably not read (see Appendix B). These words were randomly assigned to three lists of 10 words each.

The dependent variable was the number of words read correctly within 2 s during assessment. Baseline lasted 3, 8, and 13 sessions for lists A, B, and C respectively. Decisions on when to apply the intervention to lists were based on visual analysis of time-series data (e.g., trends and variability). During baseline- and intervention-phase assessments, Leah read words from the computer screen that presented one word at a time for 2 s. Only words read correctly within 2 s were scored as correct. Approximately eight weeks following the last intervention-phase assessment, another assessment was conducted. Leah was given 2 s to read each of the 30 target words. During this assessment the words were handwritten (printed) on index cards. Only words read correct within 2 s were scored as correct.

Procedures

General procedures. A special-education teacher requested assistance with Leah's reading. The teacher indicated that Leah enjoyed working on computers and was motivated to improve her reading; however, she had shown little early literacy skill development. Over three consecutive school days, Leah was assessed on each of the three lists of words. After these initial assessment-only sessions, CBSWR intervention procedures were run two-four school days per week. During this phase, the intervention was applied in a staggered fashion to one list at a time. Assessment of all three lists of words was conducted immediately after Leah completed the intervention. Following the first session and throughout the experiment Leah was given stickers following each session. These stickers were not given contingent upon her reading performance, but were delivered with labeled praise and for following directions and trying her best.

Assessment procedures. With the exception of the eight-week maintenance assessment, the same assessment procedures were used throughout the study. All assessments were administered by the primary experimenter. During each session, all three lists of targeted primer and first-grade Dolch words were assessed. Specifically, the primary experimenter placed the student in front of a computer. The assessment program was opened and the student was prompted by the word START displayed on the computer screen. The student was instructed to click START and try to read each word aloud before it disappeared from the screen. After one list was assessed, identical procedures were used with the other two sets. During each assessment, each word from the list was presented in random order. Also, the order in which each list (A, B, and C) was assessed was counterbalanced across sessions.

During assessments, each word was displayed for 2 s. If the student responded accurately within 2 s, the experimenter recorded the word as correct. After 2 s, the word disappeared from the screen and the next word was displayed 2 s later. After each session, the number of accurate responses (within 2 s) was totaled and plotted as time-series graphs. Visual analysis of these graphs was used to make judgments regarding variability, trend, level, and immediacy of change. These judgments were used to make phase-change decisions (Kazdin, 2011). During the maintenance and generalization assessment that occurred eight weeks following the last intervention, the primary experimenter printed all 30 sight-words on index cards. He then met with Leah in her class, sat across from her at a table and presented one word at a time, in random order. Words read accurately within 2 s were scored as correct.

Intervention procedures. The intervention began at sessions 4, 9, and 14 for lists A, B, and C respectfully. A digital folder containing Leah's name was loaded onto a classroom computer. The folder contained five separate programs of the CBSWR intervention, one for each day of the week. Five separate programs were needed so that for each list, words could be presented in a different (random) order across days. Such procedures were used to prevent the student from responding accurately based on word sequence (e.g., learning the first word is cat). Each intervention session was supervised by the primary experimenter.

After the primary experimenter opened the correct computer program, the student was instructed to sit before the computer with the headphone set on. Each CBSWR intervention included 40 learning trials as the targeted 10-word list was repeated four times. Leah initiated the intervention by clicking on the word START displayed on the screen. Once started, sight-words appeared on the screen for 2 s, followed by the primary experimenter's voice recording of the sight-word, and another 2 s delay before the word was replaced on the screen with the next word. Leah was instructed to 1) try to read each word before she heard the recording of the word (i.e., instructed to "try to beat the computer"), and to 2) repeat the word after she heard the recording. The computer program lasted about 3 min and 20 s.

Maintenance and Generalization Assessment

After the intervention was withdrawn from a list (i.e., List A and B), we continued to assess the student's performance on those words. These data provided us with some short-term maintenance data for words in Lists A and B, but not for list C. However, we did collect long term maintenance data across all words, including list C words. Approximately eight weeks (i.e., 56 days) following the last intervention session, the primary experimenter returned to collect maintenance (i.e., eight weeks of no intervention) and generalization (i.e., from computer screen to hand-printed index card) data. The primary experimenter sat across from Leah at one of the round classroom tables and presented, in random order, all words included across each of the three target word lists. Using a stopwatch, the experimenter presented words to Leah and recorded those words correctly read within 2 s.

Procedural Integrity and Interobserver Agreement

The primary experimenter ran all procedures. Using a procedural integrity checklist, the primary experimenter self-monitored his behavior during intervention and assessment procedures. Every other day, during intervention and assessment sessions, the special education teacher or one of the teacher's aides observed the experimenter and completed a similar checklist. A comparison of these checklists displays that the experimenter completed all procedures correctly and in prescribed sequence. Each of the assessment sessions was recorded, and an independent observer listened to 60% of the assessment sessions and scored words read correctly/incorrectly. For each assessment interobserver agreement was 100%.

Results

Figure 1.1 displays the number of Dolch words Leah read correctly within 2 s across word lists and phases. On the fifth assessment session Leah read 2 words correct on list B, otherwise across all three lists, Leah read zero or one word correct within 2 s during baseline. Visual analysis of baseline data (see Figure 1.1) shows that prior to applying the intervention

Leah's reading performance on each word list was either stable (List A and C) or decreasing (List B). Across all three lists, immediately after the intervention was applied Leah showed an increase in automatic sight-word reading of targeted words and no concomitant increase on untargeted words. Figure 1.1 shows no overlapping data across baseline and intervention phases for any word list. Across all baseline assessments Leah only read three words correctly within 2 s. Following the last intervention session Leah read 28/30 words correct within 2 s.

Short term maintenance-phase data collected after the intervention was removed from Lists A and B suggest that Leah not only maintained, but actually enhanced her accurate responding after the CBSWR intervention was withdrawn and applied to other word list(s). Approximately eight weeks after the final treatment session targeting List C, Leah was given the opportunity to read the same 30 words that were hand printed on index cards. Again, Leah read 28 of the 30 words correctly within 2 s.

Discussion

Previous researchers found evidence that the CBSWR intervention enhanced Dolch word reading in four students; one ELL, one with ADHD, one receiving remedial reading instruction, and one with autism (Hilton-Monger et al., 2011; Yaw et al., 2011). Our current findings, which show immediate increases in sight-word reading accuracy after the intervention was applied to each list and the failure to find concomitant increases on untargeted lists support these earlier studies. Together, these studies provide clear evidence that the CBSWR intervention can enhance sight-word reading.

Our current finding extended previous research on the CBSWR procedure by providing evidence of generalization across subjects, time, and stimuli. The current results show that the intervention was effective in a student with moderate to severe intellectual disabilities (generalization across subjects). Also, we found that words learned via the CBSWR intervention were maintained eight weeks after the final treatment session (generalization over time). Finally, we found that Leah's improved reading of words on the computer generalized to hand-written (printed) words on index cards (generalization across stimuli).

Although the current results enhance the data-base supporting the CBSWR intervention, several external validity limitations associated with CBSWR research need to be addressed. To gain a better understanding of how effective the procedure is across students, studies are needed with much larger groups of students. Also future researchers should determine if the sight-word learning occasioned by CBSWR interventions would allow students to read and comprehend these words when presented in isolation and in embedded text (see Nist & Joseph, 2008). Rapid and accurate word reading may require fewer cognitive resources (e.g., attention, working memory) than slower reading. Therefore, those who read commonly used words automatically may have more resources available to apply to other activities including comprehending broader text (National Institute of Child Health and Human Development, 2000; Samuels, 2007; Skinner, 1998). This suggests that researchers should determine if using the CBSWR intervention to enhance students ability to read commonly used words automatically results in improved comprehension across a broad array of written connected texts.

One reason for conducting the current study was to provide a graduate student with supervised intervention experience. Consequently, the graduate student initiated and supervised all procedures. Although Leah appeared to quickly acquire the ability to complete the intervention, because the primary experimenter supervised each session, we did not take full advantage of computer-based instruction. Additional studies where students self-administer the CBSWR intervention would enhance the contextual validity research base supporting the efficiency and sustainability of this intervention.

Evidence of internal, external, and contextual validity is critical (Fudge et al., 2008). After validity is established many educators want to know if a procedure is superior to other validated procedures (Skinner, 2008). When procedures target skill development (learning), comparative effectiveness studies must indicate the procedure that *most rapidly* enhanced skills (Skinner, 2010). Therefore, future researchers should compare the CBSWR intervention with other empirically validated procedures (e.g., taped-words) to determine which procedure results in the greatest increase in learning rates (see Cates et al., 2003; Joseph & Nist, 2006; Nist & Joseph, 2008; Skinner, Belfiore, Mace, Williams, & Johns, 1997; Skinner et al., 1995/2002).

Chapter III

Study II: A Comparison of Two Computer-Based Sight-Word Intervention Effectiveness Study: Holding Learning Time Constant to Precisely Measure Learning Rates[2]

Footnote

[2] This study was completed with support from the Korn Learning, Assessments, and Social Skills (KLASS) Center at The University of Tennessee.

Abstract

An adapted alternating treatment design was used to evaluate the effects of two computer-based flashcard sight-word reading interventions among four elementary students with disabilities. The two interventions were similar; with either 1-s response intervals (i.e., students had 1 s to read the word before they heard it) or 5-s response intervals applied. Instructional time was held constant (3 min per session) across both the 1-s and 5-s procedures; consequently, students completed six learning trials during each 1-s session but only two during each 5-s session. Despite this difference in learning trials, results showed similar gains in sight-word mastery rates across both the 1-s and 5-s response interval interventions. Subsequent phases showed students were able to read most mastered words 95 days later when they were presented on index cards and provided some evidence that some students maintained more 1-s words. However, in two of the three students, these small differences were easily and rapidly erased as students appeared to re-learn previously mastered words during maintenance assessments and brief post-maintenance re-learning treatments. Discussion focuses on measuring learning rates, learning trial quality, re-learning, and the pitfalls of measuring maintenance in a dichotomous manner.

A Comparison of Two Computer-Based Sight-Word Intervention Effectiveness Study: Holding Learning Time Constant to Precisely Measure Learning Rates

In the early grades, educators focus classroom instruction on developing reading skills (i.e., phonemic awareness, word attack skills). However, by the middle elementary grades, a shift occurs where students are responsible for gleaning more and more academic information from textbooks (Bean, Zigmond, & Hartman, 1994). Because reading skills are critical to learning and functioning across so many advanced curricula objectives and life activities, educators and researchers have focused on models, strategies, and procedures designed to prevent early reading skill deficits (Mastropieri, Scruggs, & Graetz, 2003; Watson, Fore, & Boon, 2009).

A phonemic approach to early reading skill development is supported by a vast amount of research (National Center for Education Statistics, 2005). Although such approaches are often applied, a significant number of American school children have early reading skill deficits (Donahue, Voelkl, Campbell, & Mazzeo, 1999). Various assessment systems have been developed that are, in part, designed to identify these early pre-reading skill deficits and evaluate procedures designed to remedy early reading skill deficits as quickly as possible (AIMSweb, 2006; Good, & Kaminski, 2002). Additionally, various remedial models (e.g., summer school, after-school tutoring, response-to-intervention) have been applied that often involve allotting additional instructional/learning time to remedying identified skill deficits. With response-to-intervention models, that time typically comes from the school day.

In some schools that already focus on reading skills (e.g., some "Reading First" elementary schools already allot 2.5 hours per day to reading skill development), students who receive more intensive RtI services may be spending 3.5 hours per school day on activities designed to enhance pre-reading and early-literacy phonemic skills. Despite all of this time allotted for phonemic-based instruction, some students show little skill development. In such cases, it may be helpful to allot some instructional time to sight-word reading instruction (Bliss, Skinner, & Adams, 2006; Browder & Lalli, 1991; Harris & Sipay, 1985).

Researchers have been working with a variety of flashcard drill and practice methods designed to enhance automatic (rapid and accurate) sight-word (commonly used and/or irregular words) reading in students with reading skill deficits (e.g., Hilton-Monger, Hopkins, Skinner, & McCane-Bowling, 2011; Kodak, Fisher, Clements, & Bouxsein, 2011; Windingstad, Skinner, Rowland, Cardin, & Fearrington, 2009; Yaw et al., 2011). Browder and Xin (1998) note a variety of flashcard drill and practice methods that have enhanced automatic sight-word reading. A typical flashcard sight-word learning trial is modeled after a traditional stimulus-response-stimulus learning trial. The first stimulus involves the presentation of a word and prompting the student to read the word, followed by a response interval or amount of time for the student to read the word aloud, and then a second stimulus which typically provides response-contingent feedback (e.g., praise for accurate responses or corrective feedback for failure to respond or responding incorrectly).

Automated Drill and Practice: Response Intervals and Learning Rates

During flashcard sight-word instruction, when working one-on-one with students the teacher can alter each response interval based on the students response to the flashcard. For example, if the students read the word correctly immediately after the word is presented, the teacher could say “correct” and immediately present the next word. If the student says the wrong word immediately, the teacher may want to provide immediate corrective feedback (e.g., “No, the word is house.”). In both instances the response interval was very brief as the student quickly said a word. However, a student may say nothing for 5 s as he/she focuses on the flashcard and then say “I don’t know,” in which case the teacher could read the word aloud for the child, effectively ending the longer response interval (e.g., 5-7 s response intervals).

Research supports the application of different response intervals contingent upon student responding (Riley, 1986; Rowe, 1974); however, when using automated learning systems it may not be possible to adapt response intervals for each trial (McCallum, Skinner, Turner, & Saecker, 2006; Parkhurst, Skinner, Yaw, Poncy, & Luna, 2010). Consequently, those attempting to pace learning trials using audio recorded prompts and/or computers have been challenged to set a priori response intervals that will maximize learning rates (Skinner & Shapiro, 1989; McCallum et al., 2006; Parkhurst et al., 2010). Although idiosyncratic and task differences make it unlikely that researchers will ever identify *the* ideal response interval (because it is not stable), research on active academic responding, learning trial quality, learning trial quantity, and learning trial rates may provide some guidance (Skinner, Belfiore, & Watson, 1995/2002; Skinner, Fletcher, & Henington, 1996).

When examining learning trials, it is often useful to distinguish between learning trial quality and quantity (Skinner, Belfiore, Mace, Williams-Wilson, & Johns, 1997). When comparing two learning trials, the trial that produces the most learning per trial would be considered a higher quality trial (Skinner, Ford, & Yunker, 1991). While researchers have focused on antecedent and consequent variables that may influence learning trial quality (e.g., intrusiveness of prompts, reinforcement quality, and immediacy of feedback), it is also important to focus on the response that is surrounded by these stimuli. In almost all instances, academic skill development requires students to actively respond to academic stimuli (Greenwood, Delquadri & Hall, 1984; Skinner & McCleary, 2010; Skinner, Pappas, & Davis, 2005). Thus, when setting response intervals, one must consider how much time students will need to actively respond. In many instances we may tend to be cautious when developing our automated procedures (e.g., computer-based flashcard sight-word intervention) and set intervals that may be longer than typically needed. This may be especially true when working with students with disabilities (Kodak et al., 2011). For example, although 1-s intervals may be long enough for most students to respond to most words, educators and researchers may set longer response intervals (e.g., 5 s) just to be sure that each student has sufficient time to read each word. While this cautious approach of setting longer than needed response intervals may appear rational, research on wait times and pacing suggest that such procedures may retard learning by decreasing learning trial quality.

During class-wide recitations, a teacher may ask the class a question with the hope that all students will respond covertly (e.g., try to answer the question) and some will raise their hand to answer. Rowe (1974) indicated that the average response interval a teacher gives before calling on a student to answer a question is 1 s. Because skill development often requires student responding, Riley (1986) found that the time required to formulate answers interacts with wait times to influence learning. Specifically, when teachers asked “higher level” questions that required more time to formulate responses, students learned more when wait times were longer. Longer wait times did not enhance learning when students were asked lower level questions of fact that could be answered immediately.

Alternatively, employing response intervals or wait times that are too long may retard learning. Researchers investigating pacing have found that enhancing the pace of student responding, (through feedback, setting specific time limits, reinforcement, explicit timing, more rapid paced instruction, and the additive interspersal procedure) can sometimes enhance response accuracy and perhaps learning trial quality or the amount learned per trial (Carnine, 1976; Darch & Gersten, 1985; Hawkins, Skinner, & Oliver, 2005; Robinson & Skinner, 2002). Although the causal mechanism is far from understood, there is some evidence to suggest that increasing the pace of learning trials or pace of student active academic responding may enhance students sustained attention to academic tasks and the amount of learning per trial, provided that the learning tasks require higher levels of sustained attention (Hawkins et al. 2005; Robinson & Skinner, 2002).

Even when enhancing learning trial pace has not improved the quality of learning trials, enhancing learning trial pace increases the number of learning trials completed in a fixed amount of time, or learning trial rates (Skinner et al., 1996; Skinner et al., 1997). Previous researchers have observed that increasing the amount of practice or the quantity of learning trials enhances learning or skill acquisition, fluency development, and maintenance (Albers & Greer, 1991; Ebbinghaus, 1885; Greenwood et al., 1984; Ivarie, 1986; Malone, 1990; Roediger, 1985; Skinner & Shapiro, 1989). To understand the importance of learning trial rates, consider two different types of sight-word learning trial procedures. The two procedures occasion the same amount of learning per trial (i.e., learning trial quality is equal), but one trial requires 1 min to complete and the other only 6 s. If you allot 10 min per session for remedial sight-word training, with the 6-s trial procedure, students will complete 100 trials in 10 min; however, with the 1-min trial procedure students will only complete 10 trials per sessions. In this instance, a student-focused teacher who wants to remedy problems as quickly as possible will choose to apply the 6-s trials because the additional trials will result in more learning (i.e., more words learned, maintained, and able to be applied) during each 10 minute session (Skinner, 2008; Skinner, 2010). Thus, when learning trial quality is equal, applying the procedure that enhances learning trial rates may also enhance learning or skill development rates (Skinner et al., 1991; Skinner et al., 1996; Skinner et al., 1995/2002). One way to increase learning trial rates is to reduce response intervals.

Purpose

Previous researchers, who were not using learning trials, investigated an intervention known as taped-words where students were instructed to read words from printed lists along with a tape that plays word lists while students read (Freeman & McLaughlin, 1984; Skinner & Shapiro, 1989). Researchers compared learning under taped words interventions where words were presented every 1 s versus every 5 s (Skinner, Johnson, Larkin, Lessley, & Glowacki, 1995; Skinner, Smith, & McLean, 1994). In one study, Skinner et al., (1994) held opportunities for active responding or practice constant as each list of words was repeated three times and found some evidence that the 5-s procedure caused greater learning. However, because the 5-s procedure took more time, when researchers re-analyzed the data using more precise measures of learning rates (e.g., amount of learning per min of taped word intervention), results showed that the 1-s procedure produced a much larger increase in learning (Skinner et al., 1995/2002). These findings demonstrate how applying higher quality learning trials (more learning per trial) can retard learning rates (i.e., remediation, growth) when those higher quality trials take more time than lower quality trials.

Researchers have developed and evaluated computer-based reading systems designed to teach students sight words using flashcard like learning trials. In these studies researchers provided students with fixed response intervals ranging from 2 s to 5 s (Hilton-Monger et al., 2011; Kodak et al., 2011; Yaw et al., 2011). While such intervals may provide sufficient time for students to respond, using briefer response intervals may enhance learning rates by enhancing learning trial quality, (perhaps by enhancing the quality of student's attention to tasks, see Carnine, 1976; Hawkins et al., 2005) and learning trial rates or the number of learning trials that can be completed in a fixed period of time (Skinner et al., 1995/2002; Skinner et al., 1996; Skinner et al., 1997).

The current experiment was designed to compare sight word learning rates across two computer-based flashcard interventions, one with 5-s response intervals and the other with 1-s intervals. Because our interests were primarily applied, (i.e., we were interested in determining the most effective remedial procedure for our participating students), we held time working under each intervention constant (3 min of each intervention per day) and allowed learning trials to vary. To reduce the impact of ceiling effects, under each intervention we used flow list procedures; as one word was mastered (i.e., read accurately within 2 s across two consecutive assessments) it was removed and replaced with a new unknown word (Hubbert, Weber, & McLaughlin, 2000; McLaughlin, Mabee, Reiter, & Byram, 1991). While our primary dependent variable was words mastered, we also included a maintenance and generalization assessment phase (about 12 weeks after the experimental phase), followed by a final brief post-maintenance re-learning treatment phase to evaluate re-learning of mastered, but not maintained words.

Method

Participants and Setting

This study was conducted in a self-contained special education classroom in a rural elementary school in the Southeastern United States. The school served 750-800 students and the student population was approximately 88% Caucasian, 7% African-American, 2% Asian American, and 1% Hispanic/Latino, with 60% of the students qualifying for free or reduced lunch. Participants included four boys, three in third-grade and one in fourth-grade. The participants will be referred to as Alan, Michael, Lucas, and Andrew, the fourth-grade student. Alan (age 9) and Michael (age 9) had been diagnosed with a specific learning disability in reading. Although Alan's reading, writing, and spelling instruction were delivered by a special education teacher in a self-contained classroom, he received all other education in his general education classroom. Because of his behavior problems, Michael received most of his services (math was the primary exception), within the self-contained special education classroom. Lucas (age 10), a third-grade student diagnosed with functional delay,[3] received all educational services in the self-contained classroom, as did Andrew (age 11), a fourth-grade student diagnosed with Autism. Empirical data from each student’s most current evaluation is seen in Table 1.1.

[3]Functional delay means a continuing significant disability in intellectual functioning and achievement which adversely affects the student’s ability to progress in the general school program, but adaptive behavior in the home or community is not significantly impaired and is at or near a level appropriate to the student’s chronological age (Tennessee State Department of Education, 2008).

The special education classroom was staffed with two full time teaching assistants and a special education teacher who had two years of experience in public-school special education and more than 15 years of home school experience. A Ph. D. student in a school psychology program served as the primary experimenter and ran all procedures with the participants. To collect interscorer agreement data, a fellow school psychology graduate student independently scored 60% of the recorded assessment sessions.

The classroom served six students all day and three students who received some, but not all their daily instruction in this room. The classroom contained 10 individual student desks, each with a chair. Also, the classroom had a game area, and six learning areas; an area composed of seven desktop computers to aid in instruction, a reading area, and four round tables designated as separate learning spaces. All procedures were run on one of seven computers in the computer learning area or at one of the round learning tables, sometimes using the graduate student's personal laptop computer.

Materials

Based on previous research (Hilton-Monger et al., 2011; Yaw et al., 2011) and guidelines described by Hopkins, Hilton, and Skinner (2011), the primary researcher used Microsoft© PowerPoint© to construct personalized (i.e., each contained words that the student did not know) computer-based sight-word reading (CBSWR) systems for each of the four participants. Each system included two programs, one for assessment and one for intervention. Both programs presented words in 88 point Arial style font. Words were presented one at a time, centered on the screen. Apple © GarageBand© software was used to record student responses during all assessments.

Design and Dependent Variables

A modified, multi-phase adapted alternating treatment (MAAT) design (Sindelar, Rosenburg, & Wilson, 1985; Skinner & Shapiro, 1989) was used to evaluate and compare the two CBSWR interventions, one with 5-s response intervals (i.e., there was a 5-s delay between the word appearing on the screen and the recording of the word being played) and the other with 1-s response intervals. For each student, a pre-test phase was used to gather a list of unknown target words which were then assigned to one of three lists (1-s list, 5-s list, and control list) using stratified (across reading level) random assignment.

Consistent with alternating treatments designs (Kazdin, 2011), on each school day, each student was exposed to both the 1-s and 5-s CBSWR interventions, with the interventions applied in counterbalanced sequence across days. Each day, each intervention was run for exactly 3 min. Because intervention time was held constant, we compared learning rates across the two CBSWR interventions (Skinner, 2010; Skinner et al., 1995/2002; Skinner et al., 1997). Immediately after each intervention a sight-word reading assessment was conducted. Consistent with alternating treatment design, we included a third list of words (control list) that was merely assessed (Sindelar et al., 1985). This no treatment control list allowed us to assess for history effects or sight-word reading gains that were caused by events outside experimental conditions (e.g., classroom learning). In order to reduce reactive arrangements (e.g., daily assessment of words not being targeted may have caused students to become frustrated and decreased learning across conditions, see Cuvo, 1979), we assessed student performance on no treatment words every other school day (Skinner & Shapiro, 1989). Our primary dependent variable was the number of words mastered. Words were considered mastered when read correctly, within 2 s, across two consecutive assessments. Flow lists were used (see McLaughlin et al., 1991), so that after a word was mastered it was dropped from the CBSWR system (both intervention and assessment programs) and replaced with a new unknown word.

Approximately 12 weeks (i.e., 95 days) after the last session, when summer recess ended, three of the four participants returned to this school and the final two phases of the study were completed. First, three sessions were used to assess and compare maintenance and generalization of 1-s and 5-s words. Sessions were similar to pre-tests sessions as students were given 2 s to correctly read words hand printed on index cards. Next, a three-session brief post-maintenance re-learning phase was implemented. During this phase a modified CBSWR 1-s intervention was used. Rather than targeting only 15 words, the modified CBSWR intervention contained *all* 1- s and 5-s words mastered during the MAAT phase. Additionally, each of the previously mastered words (for some students there were almost 100) was only presented in one learning trial (i.e., 1 trial per mastered word).

Procedures

General procedures. A special education teacher requested assistance with the four students. The teacher indicated that these students were at least two grade levels behind in their reading, enjoyed working on computers, and were motivated to improve their reading. Although the students had been, and were being exposed to phonetic-based reading instruction, the teacher requested that the researcher apply an effective procedure that would not require much time, but would give the students a sense of success. Specifically, the teacher was concerned that the students were currently spending too much time on phonemic instruction and elementary reading skills, and that this time could be frustrating as their progress was often slow. Consequently, the teacher and researcher decided to target sight words using the CBSWR system.

Next, four sequential phases were applied (i.e., pre-testing, MAAT, maintenance and generalization (M&G), and brief post-maintenance re-learning (BPMR)). Sessions were run from 7:45- 9:30 A.M. as the primary experimenter worked individually with each student at a learning area table or at a computer. After each session was completed the primary experimenter provided verbal labeled-praise. This verbal praise was not given contingent upon reading performance; rather, students were praised for trying their best and following directions. After completing the MAAT phase, the experimenter created *Reading Achievement Certificates*, and the special education teacher awarded one to each student for their participation in the intervention. The certificates were not contingent upon performance.

Pre-test phase. Pre-test procedures were used to collect lists of roughly 150-200 unknown words for each third-grade student. During two pre-test sessions, conducted over two consecutive school days, all third-grade students were assessed using primer through third-grade Dolch words (Dolch, 1948). Alan, a third-grade student, and Andrew, a fourth-grade student, were also assessed on a list of over 125 compound words their teacher selected from an online source (Walton, 2003) used by another teacher. Because Alan and Andrew were stronger readers, these additional words were needed so that we could collect a pool of at least 150 unknown words.

During pre-testing, a participant sat with the primary experimenter at one of the learning area tables. The experimenter had a group of index cards with words hand printed on one side. The experimenter told each student that he wanted him to try to read each word after it was presented. The participant was instructed to pay attention because he would only have a couple of seconds to read each word (i.e., 2 s). The experimenter then began to present flashcards, one at a time, for 2 s (using a stop watch). Words read correctly within 2 s were placed in one pile, and words not read correctly within 2 s were placed in another pile. Each time the cards were presented, they were presented in random order. The next school day, similar procedures were followed except words read correctly the first day were not assessed on the second pre-test session.

Modified adapted alternating treatments phase. Next, the alternating treatments phase was run for 12 consecutive school days. For this phase there were three conditions, 1-s response interval CBSWR intervention, 5-s response interval CBSWR intervention, and control list assessment only (every other day). To begin the study, for each participant, each condition was randomly assigned to a set of 15 mutually exclusive unknown sight words. These initial three lists of 15 unknown words were constructed by taking the pool of unknown words for each student and then using stratified random assignment (stratified by grade levels) to assign unknown words (starting at the primer levels) to one of three lists. For example, if Lucas had 9 unknown primer words and 42 unknown first-grade words, each of the three lists of words would contain 3 primer words and 14 first-grade words. For each list, each initial set of 15 words would then contain 3 primer words and 12 words randomly selected from the 14 first-grade words assigned to that list. As Lucas mastered or learned words, those words would be replaced by randomly selecting a word from the lowest grade level of unknown words remaining in that list. In our example, when Lucas learned his first word, one of the two remaining first-grade words would be randomly selected to replace that word mastered. For Alan and Andrew, the additional compound words were treated as fourth-grade words.

The MAAT phase began following the initial two pre-test sessions. Digital folders containing each student's name were loaded onto a classroom computer. Each intervention session was supervised by the primary experimenter. The students were instructed to sit down before the computer and place the headphones set over their ears. Guided by the experimenter, they were then instructed to open up the intervention folder and find their name and correct intervention list.

Each word list (1-s, 5-s, and control list) contained 15 unknown words. Although both CBSWR interventions lasted 3 min, because response intervals were much longer for the 5-s intervention, the number of learning trials per session was 90 (six trials per word) for 1-s words but only 30 (two trials per word) for 5-s words. For both CBSWR interventions, each time the list was repeated, the words were presented in random order.

Once the intervention procedures were started, a sight-word would appear on the screen for either 5 s (i.e., 5-s response interval condition) or 1 s (i.e., 1-s condition), at which point an audio recording of the experimenter reading the word was automatically played. The word would then disappear from the screen and 1 s later the next word appeared on the screen. Each student was instructed to try to read each word before they heard the recording of the word (i.e., instructed to "try to beat the computer") and to repeat the word after they heard the recording. The 1-s and 5-s CBSWR interventions were applied each day in counterbalanced order.

Assessments of 5-s and 1-s words were conducted immediately following completion of each intervention. Every other session the control words were also assessed. During these sessions, control word assessments were randomly sequenced around the two (i.e., 1 s and 5 s) intervention-assessment activities. During assessments, the computer displayed the 15 un-mastered words in random order. Each word was displayed for 2 s. If the student responded accurately within 2 s, the experimenter recorded the word as correct. After 2 s, the word disappeared from the screen and the next word was displayed. After each session, the number of accurate responses (i.e., within 2 s) was totaled and plotted as time-series graphs. Across all three lists, words were considered mastered when they were read correctly within 2 s across two consecutive assessments. When a word was mastered, the primary experimenter removed it from the intervention and assessment programs and replaced it with the next (for each list they were ordered by grade level) unknown word from the appropriate word list. In order to collect interobserver agreement data, each assessment session was recorded using Apple© GarageBand© software.

Maintenance and Generalization Assessment

Approximately 12 weeks (i.e., 95 days) following the last MAAT session, three of the four students returned from summer break, and maintenance (i.e., 12 weeks of no intervention and no formal education) and generalization (i.e., from computer screen to hand printed index card) data was collected. Three sessions were run on consecutive Mondays and Wednesdays. These sessions were identical to the pre-test sessions except, for each student, only 1-s and 5-s words that were mastered during the MAAT phase were assessed. Again, working individually with each student at a learning area table, the primary experimenter presented index cards of mastered words and the student had 2 s to read each word.

Brief Post-Maintenance Re-learning Intervention Procedures

Following the final maintenance and generalization (M&G) assessment, we applied a modified CBSWR intervention (e.g., booster shot) on three consecutive Wednesdays and Mondays. Using only 1-s and 5-s words mastered during the MAAT phase, the researcher constructed one CBSWR intervention program that included all words. To keep this procedure efficient, the research employed 1-s response intervals. This modified CBSWR intervention only presented each mastered word one time and required between 104 s (Michael who mastered the least amount of words) and 212 s (Andrew who mastered the most words). Once each student completed the brief post-maintenance re-learning intervention (BPMR), the researcher used the hand-printed index cards and procedures used during the M&G phase to assess words read accurately within 2 s.

Procedural Integrity and Interobserver Agreement

The primary experimenter ran all procedures. On each intervention and assessment session, the primary experimenter self-monitored his behavior using a procedural integrity checklist. On 50% of sessions (i.e., every other day), the special education teacher observed the intervention and assessment procedures and completed a similar procedural integrity checklist. These integrity checklists showed that the experimenter completed all procedures correctly and in the prescribed sequence. Additionally, the teachers' integrity data indicated that the students appeared to follow directions in all cases, repeating words after they heard them. The teachers' procedural integrity notes also indicated that the students appeared to try to read each word before the recording.

Another school psychology graduate student randomly selected and independently listened to 60% of the recorded assessment sessions while scoring words read correctly within 2 s. For each session, interscorer agreement was calculated by dividing the number of agreements on words read correctly within 2 s by the number of agreements plus disagreements and multiplying by 100. The interscorer agreement score for each session was 100%.

Results

Table 1.2 displays the number of 1-s, 5-s, and control words mastered by each student during the MAAT phase and the phase-average number of these words read correctly within 2 s during the maintenance and generalization phase and the brief post-maintenance re-learning intervention phase. MAAT phase data show nearly identical gains in words mastered across all students, with Alan and Andrew showing the most rapid learning rates. Average M&G phase data (i.e., regression), which could only be collected for three students (i.e., after summer recess Alan began attending a different school) revealed that all three students read more 1-s words correctly than 5-s words. However, average BPMR phase data (i.e., recuperation) show a reduction in this discrepancy of 60% for Michael (from five words to two words), and 50% for Lucas (from six words to three words). For Andrew, average words read correctly during the BPMR phase were identical across the 1-s and 5-s words.

Figures 2.1-2.4 display the word reading accuracy data for each phase for Alan, Michael, Lucas, and Andrew, respectively. For the MAAT phase of the study, the figures depict words mastered. Word mastery required students to read the word accurately, within 2 s, across two consecutive assessments. Consequently, no words could be mastered during the first session (i.e., session three). However, pre-test, M&G phase, and BPMR phase data displayed in Figures 2.1-

2.4 are words read correctly within 2 s for each session, with no requirement for accuracy across consecutive sessions.

Figure 2.1 shows no consistent differences on 1-s and 5-s word mastery rates for Alan during the MAAT phase. Control list reading performance showed steady but much more gradual increases with a total of 5 words mastered. These small increases suggest that learning outside experimental conditions (history effects) and spill-over effect (e.g., one treatment causing increase in performance on words assigned to the other condition) had little impact on 1-s and 5-s word learning (Skinner & Shapiro, 1989). Consequently, the MAAT phase data suggest that both interventions were similarly effective in increasing Alan's sight-word mastery learning rates. Overall, Alan mastered 51 words in 36 min under the 1-s CBSWR intervention (1.42 words mastered for each min spent learning) and 50 words in 36 min under the 5-s CBSWR intervention (1.38 words mastered for each min spent learning).

Although Figure 2.2 shows that Michael made more immediate gains on 1-s words relative to 5-s words, as the MAAT phase continued no discernible differences in word mastery rates were evident across the two CBSWR interventions. Control word reading performance showed three words mastered by the sixth session with no additional gains. Again, the small gains on control words suggests that the equivalent large gains on 1-s and 5-s words could not be accounted for by history or spillover effects. Over the course of the MAAT phase, Michael mastered 27 5-s words and 25 1-s words. As Michael participated in 11 intervention sessions, words mastered per min of CBSWR intervention were 0.82 for 5-s words and 0.76 for 1-s words.

Exactly 95 days following the last MAAT phase session (summer break), M&G phase data were collected. On the first assessment Michael showed a larger decrease in maintenance of

5-s words read correctly (from 27 to 15 or a 44% decrease) relative to 1-s words read correctly (from 25 to 20 or a 20% decrease). However, a sharp increase on 5-s words read correctly on the third maintenance and generalization assessment session suggest that merely repeated testing may have allowed Michael to re-learn many 5-s words (Skinner & Shapiro, 1989). In the final phase, when the 1-s CBSWR intervention was reapplied to all mastered 1-s and 5-s words, Michael showed an immediate increase in 1-s word reading accuracy. Furthermore, and after only three brief (about 104 s) post-maintenance re-learning (BPMR) sessions, Michael's performance on both lists was identical, 24 words read correctly within 2 s, and near MAAT intervention phase maximum levels of 25 and 27. These data suggest that although maintenance was stronger for the 1-s words, this advantage was short lived and appeared to be corrected by merely providing the opportunity to read the words again during assessment and/or a brief re-exposure to the treatment.

Figure 2.3 displays Lucas' data, which are similar to Michael's. During the MAAT phase, more immediate increases occurred on the 1-s words, but after three sessions learning rates were higher on the 5-s words and then tended to even out as the study progressed. By the end of the MAAT phase Lucas had mastered 34 5-s words and 33 1-s words or 0.94 5-s words per min and 0.92 1-s words per min. Again, small gains (three words) on the control words suggest that history and spillover effect did not cause these equivalent gains across the two CBSWR interventions.

As with Michael, Lucas showed a larger decrease in word reading accuracy on the first M&G phase for mastered 5-s words (from 34 to 15 or a 56% decrease) relative to mastered 1-s words (from 33 to 20 or a 39% decrease). Across both lists, Lucas showed an increase in word reading accuracy over the next two M&G assessments. Following the first BPMR (about 136 s) session, Lucas' performance on both lists was almost identical, but a sharp increase on 1-s words read correctly following the second BPMR session resulted in greater word accuracy levels on the 1-s words (32) relative to the 5-s words (29) on the last BPMR assessment.

Figure 2.4 displays Andrew's data which reveal no consistent differences in word mastery rates across 1-s and 5-s words. By the end of the MAAT phase Andrew mastered 53 5-s words and 52 1-s words. Total words mastered per minute of learning were 1.47 and 1.44 for the 5-s and 1-s words, respectively. Andrew mastered eight control words over the course of the intervention. Although this increase on control words is larger than we found with other participants, these are small gains compared to intervention phase and do not support the conclusions that the majority of the gains on 5-s and 1-s words were caused by history or spillover effects. Andrew's first M&G assessment showed a sharper decrease in 5-s words read accurately (i.e., from 53 to 38 or a 28% decrease) than 1-s words read accurately (from 52 to 42 or a 19% decrease). However, Figure 2.4 shows that as this phase continued, difference across the 1-s and 5-s words decreased. After the modified BPMR (about 212 s) CBSWR intervention was applied, reading accuracy levels were almost identical across the 1-s and 5-s words and were almost equal to the highest levels obtained during the MAAT phase.

Discussion

During the MAAT phase, we applied each CBSWR intervention for 3 min. The intervention procedures were similar except for two related variables. First, one intervention included 1-s response intervals and the other used 5-s response intervals. Second, because intervention time was held constant, response interval differences allowed for many more learning trials to occur during the 1-s CBSWR intervention (total of 90 or six trials per word) than the 5-s CBSWR intervention (total of 30 trials or two per word). The results of this study were fairly consistent across the four participants. During the MAAT phase, students showed little differences in word mastery rates across the two interventions. About 12 weeks later, initially most students showed higher accuracy on 1-s words relative to 5-s words; however, these differences tended to wane as the M&G phase progressed and/or as the modified BPMR CBSWR intervention was applied.

Implication, Limitations, and Future Research

Previous findings related to both learning trial quantity and quality suggest that we should have seen greater gains in word mastery under the 1-s CBSWR intervention. Since Ebbinghaus' (1885) research on the Method of Savings, numerous researchers investigating reading skill development have shown that the amount of practice enhances learning, maintenance, and speed of responding (Dowhower, 1987; Ferkis, Belfiore, & Skinner, 1997; Greenwood et al., 1984; Skinner & Shapiro, 1989). Because this long history of research on practice suggests that the 1-s trials should have produced greater increases in sight-word mastery and maintenance, researchers should investigate why we found no differences in learning across the 5-s and 1-s trials.

One explanation for our findings may be that the 5-s trials were higher quality than the 1-s trials. Some researchers have found evidence that increasing learning trial rates, rates of active responding, or pacing can enhance learning trial quality (amount learned per trial), perhaps by improving students' attention to task and response accuracy (Carnine, 1976; Darch & Gersten, 1985; Hawkins et al., 2005; Robinson & Skinner, 2002). One exception is when response intervals are so short that students do not have time to actively respond (Riley, 1986; Rowe, 1974). As we did not measure student responding during the intervention phase, it is possible that our 1-s intervals were too brief for students to respond. However, our casual observations of the students during intervention and the teacher's observations did not support this hypothesis, as the students frequently responded prior to the recordings and appeared to consistently try to read each word before the recording. In other words, no students were observed to consistently apply the strategy of merely waiting for the recording of the word and then repeating it. Also, the participants appeared to learn words rapidly across both conditions, which suggest that suppression of learning during the 1-s trials did not cause equivalent mastery rates.

A second explanation is that history or spillover effects accounted for these equivalent findings. However, if learning outside experimental conditions caused equivalent learning across both the 1-s and 5-s words, then we should have observed similar improvements on the control list. Similarly, if one CBSWR intervention enhanced performance on the other list of words (spillover effect), then it should have also spilled over to the control words, causing an increase in learning on these words (see Skinner & Shapiro, 1989). As students showed much smaller increases on control words, relative to 1-s and 5-s words, these explanations are not supported by our data.

A third plausible explanation is ceiling effects prevented us from finding differences across the 1-s and 5-s interventions. Perhaps the basic CBSWR intervention was so effective it masked any differences in sight word mastery rates caused by different response intervals. Because there are several variables associated with the CBSWR intervention that may have optimized learning, this may be a more appropriate direction for future research. Previous researchers have found that working on the computer can enhance motivation and learning (Okolo, Bahr, & Reith, 1993). As the participants' teacher indicated all participants liked working on the computer, the CBSWR intervention may have enhanced student cooperation and task focus; thereby, amplifying learning under both conditions. Although the computer program was designed for independent learning, the primary experimenter was with the students throughout all intervention and assessment procedures. This one-to-one attention may have enhanced learning under both conditions (Wasik & Slavin, 1993). Even with the 5-s response intervals, the CBSWR intervention was structured to provide more immediate feedback and higher rates of active responding than often occur in the classroom; both of which can enhance learning (Greenwood et al., 1984; Skinner & Smith, 1992).

Prior to beginning the study we were concerned that six learning trials per day may occasion ceiling effects (1-s response intervals), but we did not think that two trials per day (5-s response intervals) would also occasion ceiling effects, especially in students with disabilities (Albers & Greer, 1991; Belfiore, Skinner, & Ferkis, 1995; Ferkis et al., 1997). However, previous researchers have shown that occasioning active academic responding, without enhancing complete S-R-S learning trials, can enhance learning in general, and more specifically reading skills (Greenwood et al., 1984; Skinner & Shapiro, 1989). During each 5-s CBSWR session, students completed only two trials per word, but they had five opportunities to read each word; one opportunity with each of two S-R-S trials (during the 5-s response interval), one opportunity to read each word after each trial (they were instructed to repeat the word after the recording), and one opportunity to read each word during the assessment that followed each 5-s intervention session. Thus, we suggest that future researchers interested in investigating our equivalent findings from a theoretical perspective consider attempting to control for ceiling effects, perhaps by reducing active responding (e.g., do not instruct students to repeat words after they hear the recording).

During our initial maintenance and generalization assessments (i.e., regression) we found support for Ebbinghaus' (1885) Method of Savings which suggested that practice enhances maintenance. Also, increases in word reading accuracy that occurred over the course of our repeated M&G assessments support Ebbinghaus' work related to re-learning. Specifically, these increases showed that once learned, re-learning (i.e., recuperation) often requires less time, effort, and practice (see Skinner & Shapiro, 1989). Finally, our increases in word reading accuracy following BPMR sessions, which provided only 1 trial per word, add further support to the theory that once learned, re-learning can occur quicker and with fewer trials.

Our results supported previous research related to maintenance and re-learning and suggest some directions for future researchers. For example, researchers investigating flash-card reading programs have found that incremental rehearsal (including 70% known flashcards and 30% unknown) reduces students sight-word learning rates when compared to programs that target 100% unknown words (Burns & Sterling-Turner, 2010; Joseph & Nist, 2006; Nist & Joseph, 2008); however, results on maintenance are mixed. Burns and Sterling found that although students learned fewer words under incremental rehearsal, they maintained more words. However, Skinner's (2008) re-analysis of Nist and Joseph's data showed that students both learned and maintained more words under the condition with 100% words unknown. Skinner (2010) suggested these inconsistent findings may have been related to target words (Burns and

Sterling-Turner taught students with learning disability Esperanto words while Nist and Joseph taught students commonly used words). Regardless, the current study suggests that one-shot dichotomous scoring procedures used to assess maintenance (i.e., maintained or not maintained) may be misleading. Specifically, because students appeared to re-learn previously mastered words rapidly, scoring them as un-maintained and suggesting that it will require students as many trials to re-learn those words as it would to learn new words (see Burns & Sterling-Turner, 2010) is another example of imprecise measurement that can mislead practitioners. Based on our results we strongly recommend that researchers use multiple assessments to measure maintenance, as merely being given the opportunity to read the word during assessment may be enough to cause re-learning (see Skinner & Shapiro, 1989). In addition, researchers focused on maintenance should also determine how quickly previously mastered words can be re-learned.

If our current results were not affected by ceiling effects, then our results suggest that the two 5-s CBSWR intervention trials resulted in the same learning as six 1-s trials, which suggest that our 5-s trials were higher quality (more learning per trial) than our 1-s trials. As these results appear to conflict with earlier research on pacing (Carnine, 1976; Darch & Gersten, 1985; Hawkins et al., 2005; Robinson & Skinner, 2002), future researchers should investigate this hypothesis. Specifically, by running a similar study where trials, as opposed to instructional time are held constant, researchers may find that three 1-s trials results in as much learning as three 5-s trials. This type of finding would have clear applied value in that it would suggest that we could occasion the same amount of learning we found in our current study under both CBSWR interventions, in less than half the time, effectively doubling the learning rates. These types of studies that emerge from precisely measuring learning rates may not only enhance our ability to produce a data base that allows educators to identify procedures that most rapidly remedy deficits (Skinner, 2008), they may lead to advances in our basic understanding of variables that influence learning (Skinner, 2010).

Chapter IV

Study III: A Comparison of Sight-Word Learning Rates Across Two Computer-Based Interventions:

Holding Learning Trials Constant to Evaluate Learning Trial Quality[4]

Footnote

[4] This study was completed with support from the Korn Learning, Assessments, and Social Skills (KLASS) Center at The University of Tennessee.

Abstract

A modified, multi-phase adapted alternating treatment design was used to evaluate the effects of two computer-based flashcard sight-word reading interventions among three elementary students with disabilities. Each intervention provided students with either 1-s or 5-s response intervals (i.e., students had either 1 s or 5 s to attempt to read the word before they heard a recording of the word). Instructional trials were held constant (three trials per word, per session) across both the 1-s and 5-s procedures and results were analyzed using both crude (i.e., sessions) and precise (i.e., seconds) measures of instructional time. Across all three students, analysis of learning per session showed no differences across the 1-s and 5-s words which suggest that learning trials were equally effective. However, when instructional time was measured more precisely all three students showed much higher learning rates under the 1-s intervention. Maintenance and generalization assessment phase data (four weeks after cessation of the intervention) and brief post-maintenance re-learning intervention phase data also showed that the 1-s procedure resulted in superior learning. Discussion focuses on educators' selection of interventions based on learning rates, learning trial quality, and student acceptability.

A Comparison of Sight-Word Learning Rates Across Two Computer-Based Interventions: Holding Learning Trials Constant to Evaluate Learning Trial Quality

Improving reading achievement has been a priority in the American public education system. Students with disabilities often display deficits in phonological processes and decoding skills that can hinder their ability to read unfamiliar words (Conners, Atwell, Rosenquist, & Sligh, 2001; Ehri & McCormack, 1998). Although attempting to remedy early-literacy skill deficits (e.g., phonemic awareness) may prevent more serious problems (Ehri & Nunes, 2002; National Institute of Child Health and Human Development, 2000; Torgesen, 2001; Watson, Fore, & Boon, 2009), some students continue to struggle to develop phonemic-based reading skills despite additional services (e.g., response-to-intervention, special education). When early-literacy problems persist, some researchers have suggested that educators consider allotting at least some time to sight-word reading (Bliss, Skinner, & Adams, 2006; Browder & Lalli, 1991; Harris & Sipay, 1985). Flashcard instructional strategies have been used to enhance sight-word reading in people with disabilities (Browder & Lalli, 1991; Browder & Xin, 1998; Yaw et al., 2011).

Typical flashcard sight-word interventions involve learning trials that include a) presenting a sight-word and prompting the student to read the word, b) time allotted for the student to attempt to read the word, (i.e., response interval) and c) response-contingent feedback (Browder & Xin, 1998; Hilton-Monger, Hopkins, Skinner, & McCane-Bowling, 2011). Many studies have been conducted examining the effectiveness of various flashcard instructional models (Browder & Xin, 1998; Hilton-Monger et al., 2011; Joseph & Nist, 2006; Nist & Joseph, 2008; Skinner, 2008; Skinner, Belfiore, & Watson, 1995/2002). Although identifying effective sight-word instructional procedures is important, it is not sufficient. In order to prevent and remedy problems, researchers need to conduct relative effectiveness studies that identify the interventions that result in the most rapid learning (Skinner, 2010). To do this, researchers must include more precise measures of instructional time (Cates et al., 2003; Skinner et al., 1995/2002).

Although researchers evaluating sight-word instructional procedures have frequently used precise measures of the amount of behavior change (e.g., number of words learned), because they often used very rough measures of time spent learning (e.g., instructional sessions), their measures of learning rates were less precise (Bramlett, Cates, Savina, & Lauinger, 2010; Joseph & Nist, 2006; Nist & Joseph, 2008; Skinner et al., 1995/2002). Such crude measures of learning rates may produce misleading results that support erroneous theoretical conclusions (Skinner, 2010). Also, imprecise measures of learning rates have and can cause researchers to recommend interventions that produce more behavior change than others (e.g., more words learned), but take so much additional time that they actually retard learning relative to alternative interventions that produce less behavior change, but require much less time (Cates et al., 2003; Skinner et al., 1995/2002; Skinner, Belfiore, Mace, Williams-Wilson, & Johns, 1997; Skinner, 2008; Skinner, 2010).

One way of increasing learning rates is increasing the quantity of learning trials within a fixed period of time (see Skinner, Ford, & Yunker, 1991; Skinner, Fletcher, & Henington, 1996; Skinner et al., 1997). During flashcard instruction, reducing response intervals can increase learning trial rates (Skinner et al., 1996). Additionally, reducing response intervals will increase the pace of the flashcard activities, which may increase the amount of learning per trial (Carnine, 1976; Darch & Gersten, 1985; Hawkins, Skinner, & Oliver, 2005; Robinson & Skinner, 2002). Recently, Yaw (see chapter 3) conducted a study to determine whether increasing flashcard learning trial quantity in a fixed period of time would occasion higher learning rates. The researchers compared sight-word learning rates across two computer-based flashcard interventions, one with 5-s response intervals and the other with 1-s intervals. Holding time constant at 3 min for each intervention session allowed for two trials of 15 5-s words, but allowed for six trials of 15 1-s words. Although the 1-s condition allowed for 3 times as many learning trials as the 5-s condition, learning rates were equal. Yaw provided several explanations for his findings. One explanation was that the 5-s response interval trials were higher quality (i.e., they produced more learning per trial) than the 1-s trials. However, because this finding is inconsistent with previous research, (e.g., Carnine, 1976; Darch & Gersten, 1985; Hawkins et al., 2005; Robinson & Skinner, 2002), Yaw suggested that his no difference findings may have been caused by ceiling effects. Specifically, Yaw suggests that the computer-based learning trials may have been very high quality, which reduced the impact of the extra trials (quantity of learning trials) during the 1-s intervention.

Purpose

The current study was designed to extend the Yaw (see Chapter III) study where researchers held learning/instructional time constant in order to compare two computer-based sight-word reading (CBSWR) interventions (one with 5-s response intervals, the other with 1-s response intervals) on sight-word learning rates in elementary students with disabilities. To obtain a more valid comparison of learning trial quality we held learning trials constant across the 1-s and 5-s interventions (Skinner et al., 1997) and allowed instructional time to vary (see

Skinner, 2008). Because educators need remediation procedures that remedy skill deficits rapidly, the current study also extends the Yaw study from an applied perspective (Skinner, 2008). Specifically, we evaluated a briefer (relative to both procedures used by Yaw) CBSWR intervention which included 1-s response intervals, but only three trials per word.

Methods

Participants and Setting

This study was conducted in a self-contained special education classroom in a Southeastern United States rural elementary school that served 750-800 students, with about 60% qualifying for free and reduced lunch, and the student population being about 88% Caucasian, 7% African American, 2% Asian American, and 1% Hispanic. This classroom was staffed with two full-time teaching assistants and a special education teacher, who provided services to six students throughout the school day and three other students for specific activities. A Ph. D. student in a school psychology program ran all intervention and assessment sessions with the participants. The room had 10 individual student desks that typically faced the front of the room, six additional learning areas spread throughout the classroom, a computer area that included seven desktop computers, a reading/learning center, and four large round tables designated as separate learning areas. Procedures were run on one of the seven available computers or at one of the round tables, occasionally using the graduate student's personal laptop.

Participants were three boys, two in fourth grade and one in fifth grade. The students will be referred to as Michael (fourth grade, age 10), Lucas (fourth grade, age 11), and Andrew (fifth grade, age 12). Michael's primary diagnosis fell under a specific learning disability in reading, but due to his behavioral problems he received all services (except for mathematics instruction) in the self-contained classroom. Lucas had been diagnosed with functional delay and Andrew with autism; both received all services within the special education classroom. Table 2.1 provides empirical data on students related to academic and cognitive areas.

Materials

Using published guidelines (see Hopkins, Hilton, & Skinner, 2011), the experimenter constructed personalized computer-based sight-word reading (CBSWR) systems for each of the three participants (Hilton-Monger et al., 2011, Yaw et al., 2011). Two programs were included in each student's CBSWR system, one for intervention and one for assessment. Both programs presented words taken from the Dolch word list (Dolch, 1948) and the *Reading Street Tennessee* curriculum (Blachowicz, Cheyney, & Allerbach, 2008) in 88 point Arial style font, one at a time and centered on the computer screen. During all assessments, participants were recorded using Apple© GarageBand© software.

Design and Dependent Variables

Following guidelines delineated by Sindelar, Rosenburg, and Wilson (1985), as well as Skinner and Shapiro (1989), we used a modified, multi-phase adapted alternating treatment (MAAT) design to evaluate and compare the CBSWR interventions. The CBSWR interventions differed in that one presented words with 5-s response intervals (i.e., there was a 5-s delay between the word appearing on the screen and the recording of the word being played) and the other with 1-s response intervals. Following each treatment, an assessment was conducted where students had 2 s to read each of the 15 target words. Words were presented on the computer screen, one at a time, in random order. To assess for history (e.g., learning that occurred in the classroom but outside experimental conditions) and spillover effects (e.g., improvement under one treatment caused improvement on the other), a control list of words was assessed every other session. This assessment was randomly sequenced to occur before either treatment (5 s or 1 s) or after either post-treatment assessment.

During the MAAT phase, words were considered mastered when read correctly across two consecutive assessment sessions. The researcher used flow list procedures; as one word was mastered (i.e., read correctly across two consecutive days of assessment) it was removed and replaced with a new unknown word (Hubert, Weber, & McLaughlin, 2000; McLaughlin, Mabee, Reiter, & Byram, 1991). We also assessed students' word reading accuracy during a maintenance and generalization phase and during a brief post-maintenance re-learning intervention phase when students were given 2 s to read mastered words hand printed on index cards.

Pre-test assessments were used to identify unknown sight-words for each participant and assigned to one of three word lists (1-s list, 5-s list, and control list) using stratified (across reading level) random assignment. This was followed by a MAAT phase that lasted 10 treatment sessions. The researcher modified the AAT design by assessing a control list of words less frequently (i.e., every other day of assessment). We applied this modification to reduce the number of times we asked students to read words that they were not taught. Previous researchers used similar intermittent assessment procedures to assess for history and spillover effects, while reducing the possibility of students becoming frustrated with being repeatedly asked to read words they did not know and were not being taught (Skinner & Shapiro, 1989). Approximately four weeks later, a maintenance and generalization phase was applied for three sessions followed by a brief post-maintenance re-learning intervention phase (again three sessions).

During the MAAT phase our dependent variable was words mastered, which was operationally defined as words read correctly within 2 s across consecutive assessments. For these assessments students read words presented on the computer screen. During the other three phases (pre-test, maintenance and generalization, and brief post-maintenance re-learning) our primary measure was number of words read correctly per session; thus, there was no requirement to read words correctly within 2 s across consecutive sessions. During these phases, words were scored as correct when the student correctly read words hand printed on flashcards within 2 s (using a stop watch).

Procedures

General procedures. A special education teacher contacted the researcher and requested continuing assistance with three students that the experimenter had worked with the year before. The teacher saw improvement in sight-word reading skills following the previous intervention and wanted the researcher to continue to implement similar procedures. In addition to the original Dolch words that were still to be targeted, the teacher provided the experimenter with supplementary curricular words taken from a popular reading curriculum, *Reading Street Tennessee* (Blachowicz et al., 2008), according to each student's reading level. The teacher indicated that although she would continue with phonetic-based reading instruction, she felt the targeting of sight-words was important. As all three students had participated in an earlier study where similar procedures were used, no words targeted during that study were included in this study.

The researcher then conducted four sequential phases across the next 10 weeks; a pre-testing phase, MAAT, maintenance and generalization (M&G), and brief post-maintenance re-learning intervention (BPMR). According to the teacher's wishes, sessions were run from 7:45-9:30 A.M. on Mondays and Thursdays. During all sessions, the primary researcher worked with each student individually at a learning area table or at one of the seven available desktop computers. Verbal labeled-praise was given to each student for following directions and doing their best. At the end of four phases, the researcher created and awarded each student with a *Reading Achievement Certificate*. These certificates were not awarded based on performance, but simply for participating in the study (see Appendix C).

Pre-test phase. The experimenter ran pre-test procedures to collect lists of roughly 100-150 unknown words for each student. For Michael and Lucas, pre-testing was done with second- and third-grade Dolch (Dolch, 1948) words and third- and fourth-grade words from the *Reading Street Tennessee* curriculum (Blachowicz et al., 2008). Andrew was pre-tested on fifth- and sixth-grade words from the *Reading Street Tennessee* curriculum (Blachowicz et al, 2008). *Reading Street Tennessee* curricular words were chosen from words that would not be targeted for classroom instruction for at least 8-10 weeks after the intervention was scheduled to start.

During pre-testing, the primary experimenter sat with participants at one of the four learning area tables with index cards containing hand-printed pre-test words. Words were presented one at a time for 2 s, and each student was instructed to attempt to read each word as it was presented. When a word was correctly read within 2 s, it was placed in one pile, while words not read correctly within 2 s were placed in another pile. Cards were presented in random order to each participant. Only words not correctly read within 2 s on the first day of pre-testing were assessed on the following day.

Modified adapted alternating treatment phase. The experimenter implemented the MAAT phase for roughly six weeks with sessions run in the morning on Mondays and Thursdays. Each session included both the 1-s and 5-s response interval CBSWR interventions and assessment, presented in counterbalanced order. Also, control words were assessed every other day. These assessment only sessions were randomly sequenced around the two intervention-assessment activities (i.e., 1-s and 5-s).

For each student, each condition was assigned a set of mutually exclusive words. Using stratified (across reading grade level) random assignment the experimenter initially developed three sets of 50 unknown sight words (i.e., read incorrectly twice during pre-testing) for each student. Each list of 50 words was assigned to one of three conditions (i.e., 1-s CBSWR intervention, 5-s CBSWR intervention, control). For each set, words were then randomly sequenced by grade level (e.g., first all third-grade words were randomly sequenced, followed by all fourth-grade level words presented in random order). Finally, for each set the first 15 words were chosen. As words were mastered, the researcher chose the next available word to replace the mastered word. The primary experimenter used these three sets of words to assemble each participant's customized CBSWR system.

During each MAAT-phase session the experimenter worked with each student at a computer. Digital folders containing both intervention and assessment programs were loaded onto a classroom computer, labeled with each student's name. The experimenter instructed students to sit down before the computer and place the designated headphone set over their ears. Students were then instructed to adjust the volume accordingly to a desirable level. Each student was then instructed to find and open the folder with his name, and proceed to the appropriate intervention or assessment. If a student had problems finding his correct folder and/or program, he was assisted by the instructor.

Each word list (1-s, 5-s, and control list) contained 15 unknown words. Both CBSWR interventions repeated each set of 15 words three times (i.e., trials were held constant at three). However, because response intervals were much longer for the 5-s intervention, the total instructional time for each 5-s intervention session was 270 s or 4 min 30 s, but only 90 s for each 1-s intervention session. Each time the words were presented, they were presented in random order.

Students were instructed to open the correct intervention (i.e., 1-s or 5-s). Upon opening the file, a screen with the word START was presented. When ready, students were instructed to click the word START to begin the intervention. They were told once they clicked START, words would be displayed and they were to try to read each word before they heard a recording of the word (i.e., "try to beat the computer"). They were also instructed, upon hearing the recording of the instructor's voice, to repeat the word. Sight words would then appear on the screen for either 5 s or 1 s, at which time the computer automatically triggered a recording of the experimenter reading the word. The target word remained on the screen for 1 s after the recording, allowing the student to repeat the target word while it was displayed. The target word was then replaced on the screen with the next word.

Upon completion of each intervention, assessment data were collected for the targeted 15 words. The same procedures were used to assess performance on the 15 control words. For each assessment the program presented the 15 un-mastered words in random order. Each word was displayed for 2 s. When a word was read correctly within 2 s across two consecutive assessments it was considered mastered. When a word was mastered the experimenter removed it from both the intervention and assessment programs and replaced it with the next unknown word assigned to that condition.

Maintenance and Generalization Assessment

Maintenance and generalization (M&G) sessions (i.e., regression) were conducted approximately 4 weeks (i.e., 30 days) following the last MAAT session. Generalization was assessed as students read hand-printed index cards, as opposed to words off the computer screen. During each assessment the student was assessed on all words mastered (presented in random order) during the MAAT phase (i.e., mastered 1-s, 5-s and control words). Three sessions were run on consecutive Mondays and Thursdays, and assessment procedures were identical to those used during pre-testing as students were given 2 s to read each word.

Brief Post-Maintenance Re-learning Intervention Procedures

A modified CBSWR intervention was applied following the final maintenance and generalization assessment session across three sessions applied on consecutive Mondays and Thursdays (i.e., to assess for recuperation). A single CBSWR intervention was applied each session. During this intervention each word mastered during the MAAT phase was targeted in a single 1-s response interval learning trial. Intervention times ranged from 76 s (i.e., Lucas mastered the least amount of words) to 136 (Andrew mastering the most words). After participants completed each brief post-maintenance re-learning intervention (BPMR), the researcher used the hand-printed index cards to assess words read correctly within 2 s.

Procedural Integrity and Interobserver Agreement

All intervention and assessment procedures were run by the primary experimenter. The experimenter used a self-monitoring behavior checklist to assist in procedural integrity during intervention and assessment sessions. During every other session (i.e., 50% of sessions), a similar procedural integrity checklist was completed by the special education teacher. Both the experimenter's and teacher's integrity protocol checklists indicated that all intervention and assessment procedures were applied correctly and in the proper sequence (see Appendix D). These forms also indicated that students appeared to follow directions, appeared to try and read each word before the recording, and repeated words after they heard the recording.

A fellow school psychology graduate student was asked to randomly select and independently score 60% of the recorded assessment sessions. Percent of interscorer agreement was calculated for each session by dividing the number of agreements on words read correctly within 2 s by the number of agreements plus disagreements and multiplying by 100. The interscorer agreement score for each session was 100%.

Results

Table 2.2 displays the aggregate data for each student across phases for each condition (5-s, 1-s, and control) and measure of instructional time (i.e., session and seconds). The third column in Table 2.2 displays each student's maximum number of 1-s, 5-s, and control words mastered (i.e., accurate within 2 s across two consecutive assessments) for each student. The adjacent data displays the number of words mastered per minute for each student in each intervention condition. Words mastered per minute of instruction were calculated by multiplying the maximum number of mastered words by 60 s and dividing by the total number of instructional seconds (across the entire MAAT phase) spent engaged in the CBSWR intervention.

In Table 2.2, the fourth column displays the average number of words read correctly across each maintenance and generalization (M&G) phase session for each student. Again, the adjacent data depicts the maintenance rates which were calculated based on instructional seconds, as opposed to sessions. Words maintained per minute of instruction were calculated by multiplying the average number of words across each of the three maintenance sessions by 60 s and dividing by the total seconds spend engaged in the CBSWR intervention. The fifth column in Table 2.2 displays each student's brief post-maintenance re-learning phase (BPMR) data. Again, the data displays the average number of words read correctly and the second column presents this data as a rate measure with instructional seconds totaled across the MAAT phase and BPMR phases. Thus, this measure was calculated by multiplying the average number of words read correctly during the BPMR phase by 60 s and dividing by total instructional seconds spent engaged in the CBSWR intervention during the MAAT phase and BPMR phase.

Across subject comparisons show that for all phases, Andrew mastered and maintained the most words assigned to the CBSWR interventions, followed by Michael, and then Lucas. Similar data were obtained when more precise measures of learning rates were calculated as across subject comparisons show that for all phases Andrew mastered and maintained the highest number of words per minute of instruction, followed by Michael, and then Lucas.

MAAT phase data displayed in Table 2.2 show that when within-subject comparisons are made across CBSWR interventions, Michael and Lucas mastered a similar number of words (difference less than 3) under the 1-s and 5-s interventions, while Andrew mastered 38 words under the 1-s intervention and 30 words under the 5-s condition. However, the adjacent rate data show that all three students had learning rates that were more than 100% higher under the 1-s intervention relative to the 5-s intervention. Aggregate M&G and BPMR phase data displayed in Table 2.2 show a similar pattern to MAAT phase data. Specifically, while Michael and Lucas showed little differences across interventions in words read correctly, Andrew read 6 and 8 more 1-s words correctly during the M&G and BPMR phase than 5-s words, respectively. The rate data show that all three students read more 1-s words correct per minute of instruction than 5-s words correct across the M&G and BPMR phases. Again, across all students and measures, learning rates were over 100% higher for the 1-s words.

Figures 3.1, 3.3, and 3.5 display the word reading accuracy data for each phase for Michael, Lucas, and Andrew, respectively. In these figures learning time is measured and plotted on the horizontal axis using sessions. MAAT phase data show words mastered (i.e., words read accurately within 2 s, across two consecutive assessments). Therefore, no words were able to be mastered during the first session (i.e., session three). During the pre-test, M&G, and BPMR phases, the data display words read correctly within 2 s for each session with no requirement for accuracy across consecutive assessments. Figures 3.2, 3.4, and 3.6 display the same word reading accuracy data as Figures 3.1, 3.3, and 3.5, only instructional time is measured and plotted on the horizontal axis using a more precise measure of instructional time (i.e., seconds of time spent in CBSWR interventions rather than CBSWR intervention sessions).

Michael

Figure 3.1 displays Michael's data with instructional time measured and plotted as intervention sessions (i.e., days of intervention), and Figure 3.2 shows the same data using a more precise measure of instructional time, instructional seconds. Visual analysis of Figure 3.1 shows steady increases in words assigned to both interventions (i.e., 1 s and 5 s) with little to no increases in the control list words. The small increases in control words (only 2 words mastered) suggest history and spillover had little to no impact on 5-s and 1-s word learning. Thus, visual analysis of Figure 3.1 suggests that both interventions were similarly effective.

M&G phase data displayed in Figure 3.1 demonstrates that after four weeks (i.e., 25 days following MAAT phase), Michael showed similar decreases in words read correctly across both interventions. The initial M&G assessment showed a decrease from 24 to 19 5-s words (i.e., 21% decrease) and 23 to 17 1-s words (i.e., 26% decrease). Further repeated assessments showed a slightly increasing trend across both lists during the assessment-only M&G phase. During the subsequent BPMR phase, Michael showed similar increases in re-learning across the two phases. Following three 94-s BPMR intervention sessions (total of 282 s for all three sessions), Michael's word reading accuracy across both conditions was 46 words read correctly within 2 s, just one shy of his total words mastered during the MAAT phase (i.e., 24 for 5-s words and 22 for 1-s words).

When slopes are compared across 1-s and 5-s words, Figure 3.1 suggests no difference in Michael's learning rates across the two CBSWR interventions. However, visual analysis of Figure 3.2 shows that the 1-s intervention resulted in much greater rates of learning. As indicated in Table 2.2, when instructional time is taken into consideration, Michael mastered 24 5-s words in 2700 s (i.e., 0.53 words mastered for each minute spent learning) and 23 1-s words in 900 s under (1.53 words mastered for each minute spent learning). As with the MAAT phase data, Michael's data show far greater learning rates across M&G and BPMR phases on 1-s words relative to 5-s words (see Table 2.2 for aggregate data).

Lucas

Figures 3.3 and 3.4 display Lucas' data, with Figure 3.3 showing learning levels by sessions and Figure 3.4 displaying that same data using instructional seconds on the horizontal axis. When making comparisons across conditions and measures of instructional time, Lucas' data is remarkably similar to Michael's. Specifically, Figure 3.3 shows that during the MAAT, M&G, and BPMR phases, sight-word learning levels were similar across both interventions and during the MAAT phase Lucas learned no control words. These across conditions comparisons suggest that both interventions were equally effective, and history and spillover effects did not confound the experiment.

After four weeks without CBSWR interventions, Lucas showed a decrease in correctly read 5-s words (from 20 to 12, a 40% decrease) and a similar decrease on correctly read 1-s words (from 18 to 12, a 44% decrease). As with Michael, similar increases were seen simply by repeated exposure to previously mastered words during the second and third assessment-only M&G phase sessions (Skinner & Shapiro, 1989). Following the BPMR phase, where three brief 76-s (total of 228 s) interventions were applied, steady increases in performance across both 1-s and 5-s words were seen, with a 100% return to previously mastered levels under the MAAT treatment phase following the third BPMR intervention.

While Figure 3.3 suggested that the two interventions resulted in equivalent learning rates (i.e., similar learning per session), when time spent learning was measured in instructional seconds (see Figure 3.4), that data shows that Lucas' learning rates were superior under the 1-s

CBSWR intervention. Lucas learned 20 words in 2700 s of instructional time during the 5-s intervention (i.e., 0.44 words learned per minute of instruction), compared with 18 words learned in 900 s during the 1-s intervention (1.2 words per minute). Data depicted in Figure 3.4 also shows that when learning rates were measured more precisely, the 1-s intervention resulted in stronger learning rates across M&G and BPMR phases.

Andrew

Figure 3.5 shows Andrew's intervention data collected and plotted by sessions, and Figure 3.6 displays the same data using a more precise measure of instructional time (i.e., instructional seconds as opposed to sessions). Although the MAAT phase in Figure 3.5 shows that Andrew consistently read more 1-s words per session than 5-s words, the slopes for the 1-s and 5-s words were nearly identical. Thus, although aggregate data displayed in Table 2.2 suggested that the 1-s condition may have resulted in greater learning rates per session, the similar slopes for the 1-s and 5-s intervention data series displayed in Figure 3.5 suggest that the number of words learned from one session to the next was similar across intervention conditions. As Andrew showed steady learning of 1-s and 5-s words, while learning only 1 control word, data displayed in Figure 3.5 suggest that both interventions were similarly effective, and that the experiment was not confounded by history or spillover effects.

During the first M&G phase, Andrew showed a 34% decrease in 1-s words and a 40% decrease in 5-s words. As with Michael and Lucas, Andrew's data display steady increases in 1-s and 5-s words read correct across the three M&G phase assessment-only sessions. By the third M&G session, the percentage of words lost from the final MAAT phase session decreased from 34% to 13% for the 1-s words, and from 40% to 17% for the 5-s words. During the BPMR phase, which required three 136 s CBSWR interventions (total of 408 s), Andrew's reading accuracy levels returned to near maximum MAAT phase levels (37/38 words correct and 29/30 words correct).

Whereas Figure 3.5 showed similar slopes across 1-s and 5-s data series during the MAAT phase, Figure 3.6 shows a steady increasing separation in words learned across each condition. Specifically, Figure 3.6 shows a much steeper slope for 1-s word learning relative to 5-s word learning, indicating higher learning rates. During the MAAT phase, Andrew learned 30 words in 2700 s under the 5-s intervention (i.e., 0.66 words learned per min of instructional time), and 38 words in 900 s during the 1-s intervention (2.53 words per min of instruction). Additionally, Andrew's M&G and BPMR phase data show learning rates for 1-s words that are much greater than 5-s words. As with Michael and Lucas, different conclusions are supported when learning rate data were measured more precisely and instructional seconds, as opposed to instructional sessions, were plotted on the horizontal axis.

Student Acceptability

Following the last BPMR phase session, the primary experimenter created and administered a six item Student Acceptability measure (see Appendix E) to each student. The first three items were designed to evaluate the overall computer program and the last three were designed to determine which specific intervention (1-s or 5-s) the students preferred. Before starting, the experimenter informed each student that there were no right or wrong answers. Working individually with each student, the experimenter presented each student with the form, read each item to the student in sequence, and clarified items as needed. Students then circled their responses before the experimenter moved on to the next item.

The three students provided nearly identical answers (see Appendix E, which contains the number of students who selected each response option for each item), suggesting that all enjoyed using the computer program to learn sight words, and all preferred the 1-s intervention (depicted as the rabbit on the acceptability form) to the 5-s intervention (depicted as the snail). This preference was also evident, though not empirically measured, throughout the study as student's verbally acknowledged many times they did not care for the 5-s (or slower) intervention. For example, students would say things like, "I don't like this one!" or "The words are *too* slow," and "Let's do the fast one."

Summary

Within-subject comparisons are remarkably similar across subjects. Figures 3.1, 3.3, and 3.5, show similar slopes across both the 1-s and 5-s data series for each student, suggesting equal learning under each condition when instructional time is measured in sessions. However, when more precise measures of instructional time are used (i.e., instructional seconds) visual analysis of Figures 3.2, 3.4, and 3.6, shows that the 1-s intervention results in superior learning rates. Together, these results show that the 1-s intervention was superior, not because the trials were higher quality, but because the trials took less time.

Discussion

During the MAAT phase, for both the 1-s response interval condition and the 5-s response interval condition the number of trials per session was held constant at three while instructional time was allowed to vary across the two conditions. Consequently, 1-s response interval sessions took about 90 s, whereas 5-s intervention sessions took about 270 s. Learning rates where then compared across the two conditions using crude (sessions) and more precise (seconds) measures of learning time. To compare maintenance and re-learning across conditions similar comparisons were made across the two measures of instructional time.

With respect to relative treatment effectiveness, consistent results were obtained across all three participants. For each participant, when instructional time was measured in sessions, there were small and inconsistent differences in words learned per session. However, when instructional time was measured in seconds, across all three students, data suggest that learning rates were consistently greater on words assigned to the 1-s condition. These results support previous researchers who have shown how decisions regarding intervention effectiveness on student learning rates will change depending upon how instructional time is measured, and in this case, graphed, on the horizontal axis (Skinner et al., 1995/2002).

Implications, Limitations, and Future Research

Skinner et al. (1995/2002) suggested that learning problems are most accurately characterized as learning rates problems, as opposed to failure to learn. Thus, in order to prevent and remedy learning problems educators need to identify strategies, procedures, and interventions that result in the most rapid learning (Skinner, 2008). Although most researchers and educators would agree that if two interventions are equally effective at increasing student learning, educators should choose the intervention that takes less time (Skinner et al., 1995/2002), few researchers measure instructional/learning time with much precision (Bramlett et al., 2010). Our current study demonstrates the problem with using such crude measures, as we consistently found no differences in learning across conditions when using sessions as our measure of instructional time; however, when we altered our temporal measure from sessions to instructional seconds, we found clear differences in learning rates in favor of the 1-s response interval condition. Thus, the current study serves as another example of how using more precise measures of instructional time can influence our evaluation of treatments and our conclusions regarding relative treatment effectiveness.

One of the advantages of self-managed or technology delivered interventions is that educators may not have to be involved in their delivery. However, when students are not monitored by others (e.g., teachers) they may be more likely to quit working on academic tasks because adults are not supporting, supervising, prompting, or reinforcing their efforts (Skinner, 2002). Therefore, developing and evaluating interventions that students find acceptable or prefer is critical (Skinner & Smith, 1992). In the current study, all three students indicated that they preferred the rapid paced 1-s response interval intervention. Thus, not only did the 1-s response intervals result in the more rapid learning rates, students also preferred the CBSWR intervention with these intervals. Future researchers should consider investigating the relationships between pacing, student learning, and student preference. For example, researchers may find that students tend to prefer interventions that result in the most rapid learning or that rapid paced intervention may enhance learning because they sustain student attention (Darch & Gersent, 1985; Hawkins et al., 2005; Robinson & Skinner, 2002).

Researchers investigating learning rates have addressed questions regarding learning trial quantity (number of trials) and learning trial quality or amount learned per trial (Skinner et al., 1997). Yaw (see Chapter III) conducted a similar study but held instructional time, as opposed to learning trials, constant and found that the larger number of trials under the 1-s condition (6 as opposed to 2) did not enhance learning rates. Yaw offered two explanations for his results. One was that ceiling effects may have resulted in the extra trials under the 1-s response interval condition having little impact on learning rates. Alternatively, Yaw suggested that the 5-s response intervals were higher quality trials, which resulted in similar learning from two 5-s trials and six 1-s trials. However, because previous research suggests that more trials enhances sight-word learning (e.g., Skinner & Shapiro, 1989) and that, rapid pacing either enhances or has no effect on learning trail quality (e.g., Robinson & Skinner, 2002), Yaw suggested that learning trial quality was an unlikely explanation for his findings.

In the current study, by holding trials constant (i.e., three trials for 1-s and 5-s intervention), we were better able to assess learning trial quality under the two conditions (Skinner et al., 1997). Our findings indicate that learning trials under both the 1-s and 5-s response interval conditions produced similar improvement in sight word reading, which suggests that in the Yaw (Chapter III) study, unequal learning trial quality did not account for the no-difference findings. Because ceiling effect may have influenced the Yaw (Chapter III) findings, future researchers conducting similar studies may want to control for ceiling effects by limiting learning trials under both conditions, targeting more words at once, or targeting more difficult words.

When data were analyzed with sessions being the measure of instructional time, all students showed decrements during the maintenance sessions, but the decrements were similar across conditions. During maintenance and generalization (M&G) and the brief post-maintenance re-learning (BPMR) sessions, all students showed similar increases in accurate word reading across the two conditions. The rapid gains made during these two conditions support the Yaw (see Chapter III) findings. Based on these findings, future researchers should exercise caution when interpreting one-shot maintenance data. The current and previous findings

(Yaw, Chapter III) suggest that these single assessments probably underestimate maintenance as merely giving the students the opportunity to read each word three times (once during each assessment) allowed them to re-learn words. Furthermore, three flashcard trials per word (one during each brief post-maintenance re-learning intervention) resulted in students approaching their highest levels of performance during the MAAT phase. We also compared maintenance and re-learning across the 1-s and 5-s conditions with seconds serving as a measure of instructional time. Our results were identical to those for sight-word learning rates. Specifically, we found that the 1-s condition resulted in more words maintained and re-learned per instructional minute.

One limitation of the current study was the small sample of participants ($n = 3$). Another limitation is that maintenance and generalization phase data did not include assessment of comprehension or generalization across context. Thus, the current study should be replicated with a larger sample of more diverse participants (e.g., disability categories, sex, ethnicity, age). Additionally, researchers should collect data designed to indicate if the observed increase in sight-word reading translates to improved functional skills (e.g., improved comprehension).

One of the primary advantages to computer-based instruction is that it may free teacher time. However, in the current study the primary experimenter implemented all sessions with students. Future researchers should address this concern by allowing students to implement the procedures independently. Although we asked students which intervention they preferred, researchers should conduct more direct assessment of preference by using simultaneous treatment designs that allow students multiple opportunities to choose their intervention and perhaps choose alternative interventions to either of the CBSWR procedures. Also, future researchers should compare the effectiveness and efficiency of the CBSWR intervention computer program with other sight-word interventions to identify the procedure that results in the greatest learning rates.

In the current study, we used 5-s response intervals and 1-s response intervals. Although idiosyncratic differences make it unlikely that there is any particular *ideal* response interval, future researchers should consider conducting similar studies with more than two response intervals. For example, if there were three different response intervals, 1-s, 3-s, and 5-s, researchers would have evidence that allows them to evaluate whether there is a linear relationship between response intervals and learning rates.

Teacher/researcher time required to prepare the CBSWR interventions, student time to transition to and from the intervention, and time spent during assessments was not included in our more precise measure of instructional time (i.e., instructional seconds). From an applied perspective, these additional requirements are likely to influence evaluations of an interventions usefulness or contextual validity. Additionally, in the current study such temporal variables are likely to be equivalent across conditions. Consequently, in the current study, if we included teacher time preparing materials and student time transitioning in our measures of instructional seconds, we likely would have found decreases in the relative differences between the two conditions with respect to learning, maintenance, and re-learning rates. Therefore future applied researchers may want to consider including all temporal variables associated with instructional procedures when using more precise measures of learning rates.

Chapter V

General Discussion

This dissertation was initiated by a special education teacher who asked a Ph.D. school psychology student to help her students learn to read commonly used sight words. Previous researchers developed a computer-based sight-word reading system and evaluated it across four students; one ELL student, one with ADHD, one receiving remedial reading instruction, and one with autism (Hilton-Monger, Hopkins, Skinner, & McCane-Bowling, 2011; Yaw et al., 2011). With the current series of studies, we extended the research on the CBSWR intervention by focusing on learning rates, generalization, and maintenance.

The results from Study I showed that the CBSWR intervention system was effective at enhancing sight-word reading accuracy in a student with moderate to severe intellectual disabilities. This extended the research on the CBSWR intervention system to a different disability category. We also extended the research of the CBSWR system by assessing for maintenance and generalization eight weeks following the final treatment session (generalization over time), and found that the students were able to read most words learned on the computer program when they were hand printed on index cards (generalization across stimuli). The results from this study led the teacher to contact the primary researcher to request similar services the following year.

Initially, the teacher indicated that she wanted the researcher to apply a time effective (many students were discouraged) and efficient (students were already spending over 2 hours per day in reading) procedure that would enhance her students' sight-word reading. Study I showed that the CBSWR intervention was effective. Therefore, in subsequent studies we used precise measures of instructional time to determine if we could enhance learning rates by modifying the

CBSWR interventions. In Study II and Study III, we compared learning rates when the CBSWR interventions were applied with 1-s and 5-s response intervals.

Study II was designed to measure the relative effectiveness across two CBSWR interventions, one with 5-s response intervals and the other with 1-s intervals. The researchers held session time constant at 3 min, allowing for two trials of 15 5-s words per session and six trials of 15 1-s words per session. The results of this study were largely consistent and showed little differences in word mastery rates across both the 5-s and 1-s interventions in the four participants. Although no differences were found in sight-word mastery rates, maintenance and generalization (M&G) assessments conducted 12 weeks (summer break) after the final treatment session initially showed that students displayed higher word-reading accuracy on 1-s words relative to 5-s words. This finding supports numerous researchers who have shown that practice enhances learning, maintenance, and speed of responding (Dowhower, 1987, Ebbinhaus, 1885; Ferkis, Belfiore, & Skinner, 1997; Greenwood, Delquadri, & Hall, 1984; Skinner & Shapiro, 1989). However, we also found these initial differences across 1-s and 5-s words were reduced simply by repeated exposure to words previously learned during assessment-only M&G sessions. These M&G sessions, coupled with three brief post-maintenance re-learning (BPMR) sessions showed that students quickly re-learned previously mastered words, which led researchers to conclude that one-shot dichotomous (either correct or incorrect) assessments can underestimate students' maintenance.

During Study II, even though there were three times as many instructional trials under the 1-s condition relative to the 5-s condition, learning rates were similar across the two CBSWR interventions. One explanation for these findings was that the 5-s trials were higher quality (i.e., more learning per trial). However, this hypothesis is not supported by previous researchers who found evidence that increasing the pace of learning trials enhances learning trial quality (see Carnine, 1976; Darch & Gersten, 1985; Hawkins, Skinner, & Oliver, 2005; Robinson & Skinner, 2002). An alternative explanation for the no-difference finding was that ceiling effects may have reduced the impact of the additional trials. Thus, with Study III we conducted a similar study; however, in order to obtain a better comparison of learning trial quality we held the number of trials per session constant while allowing session time to vary.

During Study III, students completed three trials per word under both the 1-s and 5-s response interval CBSWR interventions. Thus, the 1-s intervention sessions required approximately 90 s to implement and the 5-s intervention required 2700 s. The results from Study III displayed consistent findings across the three participants. Specifically, when learning rates were analyzed across instructional sessions, there was no difference in the 1-s and 5-s interventions. However, when a more precise measure of instructional time (i.e., seconds instead of sessions) was used, all participants showed learning rates (i.e., words mastered, words maintained, and words generalized) that were at least 100% higher during the 1-s intervention. These results confirmed previous researcher's analysis which demonstrated how relative comparative effectiveness studies can lead to markedly different conclusions depending upon how precisely researchers measure instructional time and learning rates (see Skinner, Belfiore, & Watson, 1995/2002).

Recently researchers have focused on the difference between learning levels and learning rates. Skinner (2008) noted that in many intervention studies, behavior change or learning often serves as the dependent variable. However, researchers often fail to take into consideration the instructional time needed to occasion such changes in behavior (i.e., learning). For example, Nist and Joseph (2008) held learning trials constant across three different flashcard procedures involving incremental rehearsal (IR). Their results confirmed previous research showing that the IR procedures resulted in higher learning per session. However, IR sessions also took so much more instruction time that the IR procedures resulted in lower rates of learning than a standard flashcard procedure. Based on the Nist and Joseph (2008) study, educators who want to remedy deficits as rapidly as possible should not choose the procedure that occasioned the greatest learning or behavior change, but the procedure that produced the greatest learning rates (Cates et al., 2003; Skinner, 2008). With Study III, similar conclusions may be drawn regarding the 1-s and 5-s interventions. Specifically, although both the 1-s and 5-s interventions resulted in similar learning per session, the 1-s response interval session occasioned much higher learning rates.

The implications of this research are important to educators whose job is to help remedy learning problems. Skinner et al. (1995/2002) notes that most learning problems are not a failure to learn, but rather a failure to learn at an appropriate and desired rate. Although the conversion of learning levels to learning rates (e.g., words learned per minute) may be lost on some, others see it as a vital distinction. The current educational climate has emphasized evidence-based and empirically driven interventions to remedy student learning deficits. This demand should drive educators and researchers to evaluate interventions using more precise measures of learning rates so that educators can determine the procedures that will remedy deficits most rapidly (e.g., Cates et al., 2003; Skinner, 2008; Skinner, 2010; Skinner et al., 1995/2002; Yaw, in progress).

Future Research

The results and implications of this series of studies provide numerous directions for future researchers. The hypothesis that ceiling effects may have contaminated treatment comparisons in Study II has both applied and theoretical implications. To further analyze ceiling effects, a similar study could be conducted where learning trials across both 5-s and 1-s words are held constant at two trials, instead of three trials. We may find that two 1-s trials results in similar learning levels in a third less time as three 1-s trials.

Students need time to transition to and from the CBSWR activities. This time can be substantial relative to the time spent engaged in the CBSWR activities. For example, a 1-s CBSWR intervention session may take 60 s, but the time required to stop doing something else and transition to the CBSWR intervention may require 2 min. Also, the time required to stop the CBSWR intervention and transition back to another activity may take another 2 min. Thus, a 60-s session may actually require 5 min of school time. When attempting to maximize learning rates, researchers may want to consider these and other temporal variables, which suggest another direction for future researchers. For example, researchers could increase the time allotted to the CBSWR intervention by targeting more words (e.g., 60 instead of 15), thereby increasing the time spent engaged in learning time relative to the time spent transitioning.

In the current series of studies, students were first presented with a word and asked to attempt to “beat the recording,” followed by an audible recording of the word, and then asked to repeat the word. Researchers could investigate whether repeating words enhances learning rates. Applying procedures similar to Study II and Study III (i.e., modified adapted alternating treatments design), where one treatment requires students to repeat the word and the other does not, may allow researchers to enhance our understanding of the sight-word learning process. Similarly, researchers could test whether multiple repetitions (e.g., repeat the word three times) increases learning levels/rates.

Although we set our response intervals a priori (i.e., 5-s or 1-s), future CBSWR researchers may want to focus on varying student control over prompting of the word and/or audio recording. Also, researchers may want to alter response intervals depending upon the educational objective and target word. For example, with a classroom curricula focused on phonemic awareness, longer response intervals may allow students to practice the phonemic skills (e.g., segmenting and blending). Alternatively, researchers could modify to CBSWR intervention to allow the student to press a button (e.g., the space bar or mouse) and hear the word, giving each student as much time as they need to attempt to apply their phonemic skills to read the words. However, with irregular words, educators may want to prevent students from applying phonemic skills by using brief response intervals. Additionally, researchers should determine if allowing students to select when the recording is played enhances students' learning and perceptions of the CBSWR intervention, particularly with students who have been shown to prefer interventions where they have a greater sense of control (e.g., students with ADHD, see Bennett, Zentall, & French, 2006; Dunlap et al., 1994; Powell & Nelson, 1997).

In this series of studies, the CBSWR intervention extended the previous research to include students with intellectual disabilities, functional delay, and specific learning disabilities (generalization across subjects). Also, we assessed maintenance or generalization over time and across stimuli (i.e., to hand-printed words). Future researchers should extend this research by determining if these procedures enhance students' understanding when targeted words are presented in connected text (e.g., sentences and passages).

Researchers have provided a rationale for teaching sight words when students repeatedly fail to benefit from phonemic-based instruction (Bliss, Skinner, & Adams, 2006; Browder & Lalli, 1991; Burns, 2002; Burns & Sterling-Turner, 2010; Harris & Sipay, 1985). Across all three studies, the students seemed motivated to learn using the computer program and excited that they were learning words. Therefore, future researchers should conduct longitudinal studies designed to determine if the CBSWR intervention and similar sight-word reading instruction enhances students' broad reading skill development, enthusiasm for reading, and the probability that they choose to read.

The series of studies we conducted with the CBSWR intervention system displayed the sight-word first, then after a delay (i.e., 5-s or 1-s), an audio recording of the word was played. Researchers may want to vary the sequence of audio-visual stimuli. For example, future researchers may want to design a study where a recording of the word is played, then the word appears on the computer screen, then the participant has to repeat what he/she just heard (i.e., hear, see, say). Changing the sequence of the audio-visual component of the CBSWR intervention may shed more light on the theoretical and applied nature of sight-word reading and lead to a greater understanding of how we can effectively and efficiently increase learning rates.

Summary

In the evolution of applied educational research it has become commonplace to include measures of treatment integrity and evidence supporting the quality of dependent variables (Skinner, 2010). In the same way, researchers, educators, and school psychologists should apply more precise measures of student learning rates when implementing and comparing interventions (Skinner, 2010). Conducting effectiveness and efficiency studies of this kind are critical in determining which intervention will result in more rapid learning rates. Not only do educators need interventions that work, but they need interventions that remedy skill deficits quickly.

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Appendix A

List of Tables and Figures

Table 1.1

Empirical student data collected from most recent evaluation.

	Cognitive Test	**Standard Score**	**Achievement Test**	**Standard Score And GE or AE**	**Diagnosis**
Alan *Grade 3*	Stanford Binet, Fifth Edition (SB5)	FSIQ 84 Verbal 86 Nonverbal 83	WIAT-II	*Reading Comprehension* 64 (1%)	SLD Reading Comprehension
Michael *Grade 3*	Comprehensive Test of Nonverbal Intelligence (CTONI)	Nonverbal 110	Woodcock Johnson III	*Basic Reading* 72 (K.9) *Reading Comprehension* 66 (K.6)	SLD Basic Reading
Lucas *Grade 3*	Differential Ability Scales (DAS) WISC-IV	Verbal 65 Nonverbal 74 WISC-IV WMI 71 WISC-IV PSI 80	Woodcock Johnson III	*L-W Id* 50 (<.1%) *Word Attack* 74 (4%) *Basic Reading* 58 (.3%) *Passage Comp* 51 (.1%) *Reading Vocab* 58 (.2%) *Reading Comp* 44 (<.1%)	Functional Delay
Andrew *Grade 4*	WISC-IV	FSIQ 75 VCI 83 PRI 86 WMI 71 PSI 80	Woodcock Johnson III	*Broad Reading* 66 (1.3 GE) *Basic Reading* 77 (1.2) *Reading Comp* 59 (K.9) *Reading Fluency* 66 (<K.0) *Word Attack* 68 (K.8)	Autism

Table 1.2

Words mastered, maintained, and re-learned across conditions.

Student	**Response Interval**	**MAAT Intervention**		**Maintenance and Generalization (M&G) phase (*Average across three sessions*)**	**Brief Post-Maintenance Relearning (BPMR) phase (*Average across three sessions*)**
		Maximum words mastered	***Maximum words mastered per minute***		
Alan	5-s Intervention	50	1.38		
	1-s Intervention	51	1.42		
	Control	5			
Michael	5-s Intervention	27	.82	16	22
	1-s Intervention	25	.76	21	24
	Control	3			
Lucas	5-s Intervention	34	.94	18	28
	1-s Intervention	33	.92	24	31
	Control	3			
Andrew	5-s Intervention	53	1.47	40	50
	1-s Intervention	52	1.44	44	50
	Control	8			

Table 2.1

Empirical student data collected from most recent evaluation.

	Cognitive Test	Standard Score	Achievement Test	Standard Score And GE or AE	Diagnosis
Michael *Grade 4*	Comprehensive Test of Nonverbal Intelligence (CTONI)	Nonverbal 110	Woodcock Johnson III	*Basic Reading* 72 (K.9) *Reading Comprehension* 66 (K.6)	SLD Basic Reading
Lucas *Grade 4*	Differential Ability Scales (DAS) WISC-IV	Verbal 65 Nonverbal 74 WISC-IV WMI 71 WISC-IV PSI 80	Woodcock Johnson III	*L-W Id* 50 (<.1%) *Word Attack* 74 (4%) *Basic Reading* 58 (.3%) *Passage Comp* 51 (.1%) *Reading Vocab* 58 (.2%) *Reading Comp* 44 (<.1%)	Functional Delay
Andrew *Grade 5*	WISC-IV	FSIQ 75 VCI 83 PRI 86 WMI 71 PSI 80	Woodcock Johnson III	*Broad Reading* 66 (1.3 GE) *Basic Reading* 77 (1.2) *Reading Comp* 59 (K.9) *Reading Fluency* 66 (<K.0) *Word Attack* 68 (K.8)	Autism

Table 2.2

Words mastered, maintained, and re-learned across conditions.

Student	**Response interval**	**MAAT Phase**		**Maintenance and Generalization (M&G) Phase**		**Brief Post-Maintenance Relearning Phase (BPMR)**	
		Maximum words mastered	***Maximum words mastered per minute***	***Average words maintained across three sessions***	***Average words maintained per minute***	***Average relearning across three sessions***	***Average words per minute following BPIR***
Michael	5-s Intervention	24	.53	20	.44	22	.46
	1-s Intervention	23	1.53	18	1.2	22	1.27
	Control	2		2		2	
Lucas	5-s Intervention	20	.44	14	.31	19	.40
	1-s Intervention	18	1.2	13	.87	16	.95
	Control	0		0		0	
Andrew	5-s Intervention	30	.66	22	.49	28	.58
	1-s Intervention	38	2.53	28	1.87	36	1.91
	Control	1		1		1	

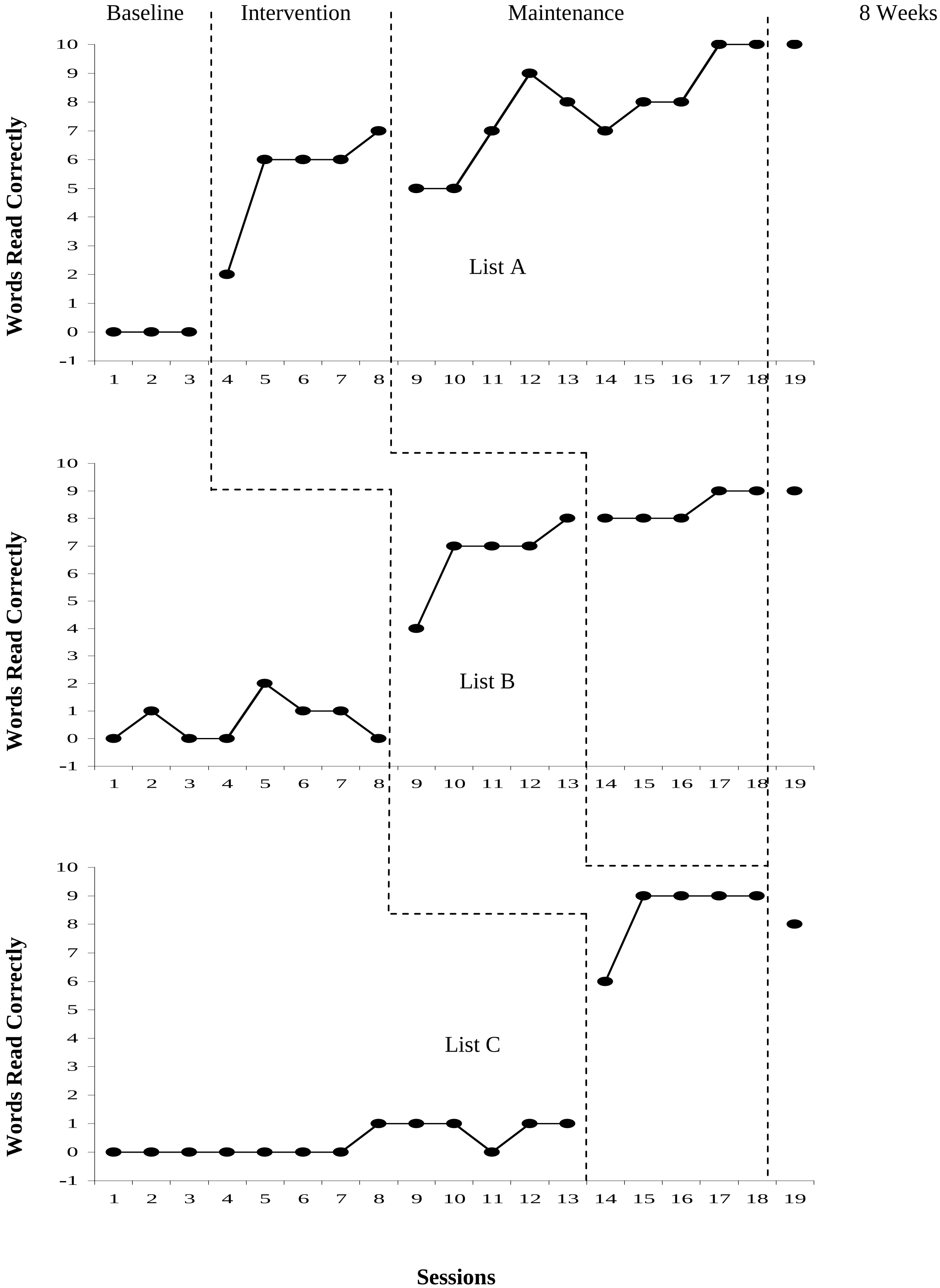

Figure 1.1. Words read correct within 2 s.

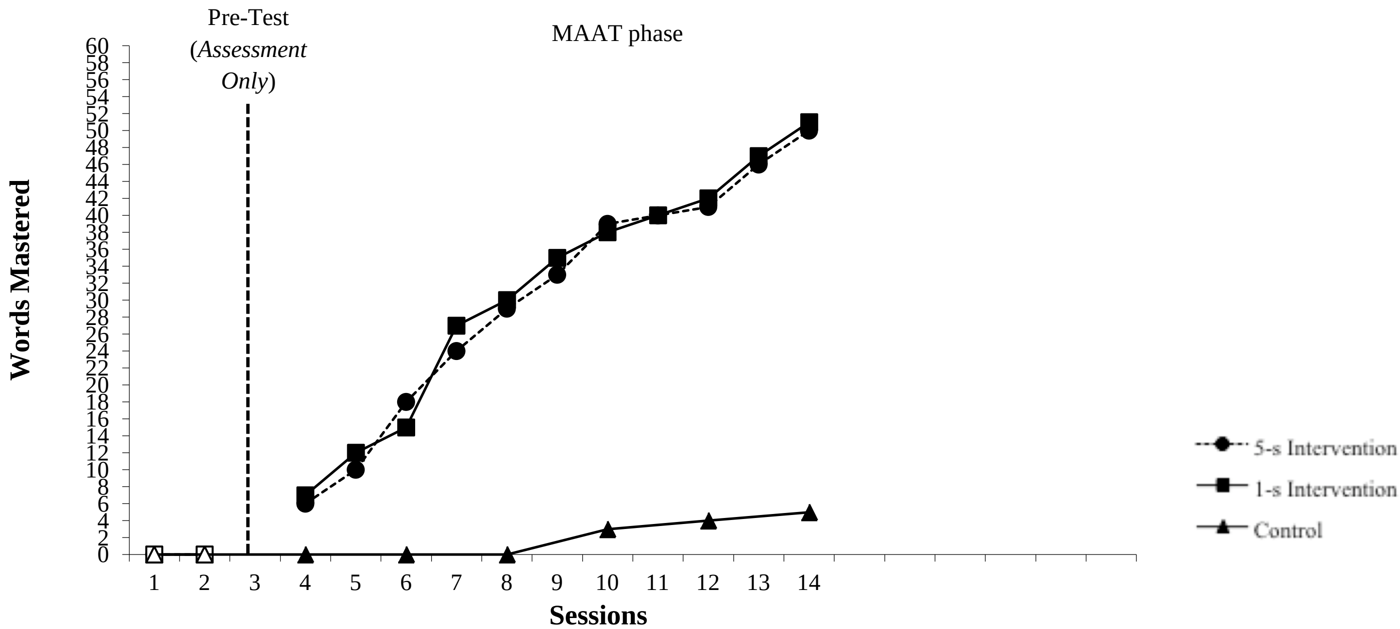

Figure 2.1. Number of words Alan mastered per session.

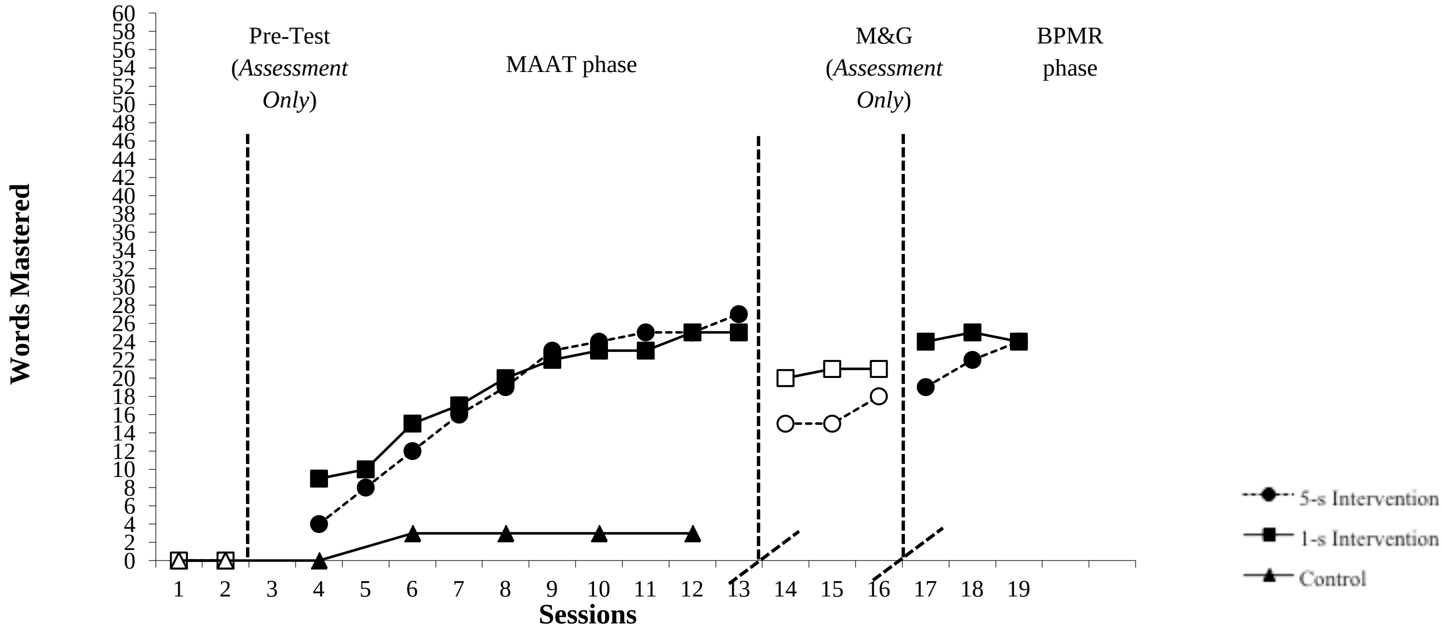

Figure 2.2. Number of words Michael mastered per session.

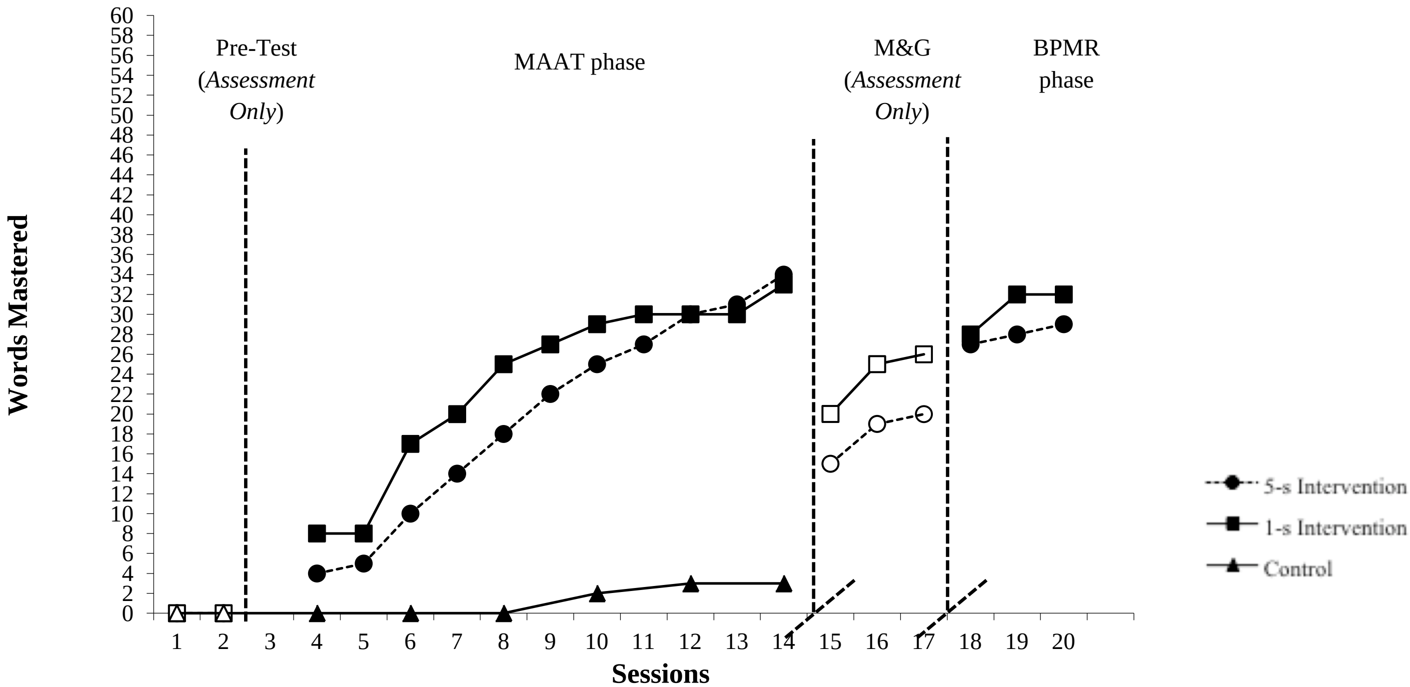

Figure 2.3. Number of words Lucas mastered per session.

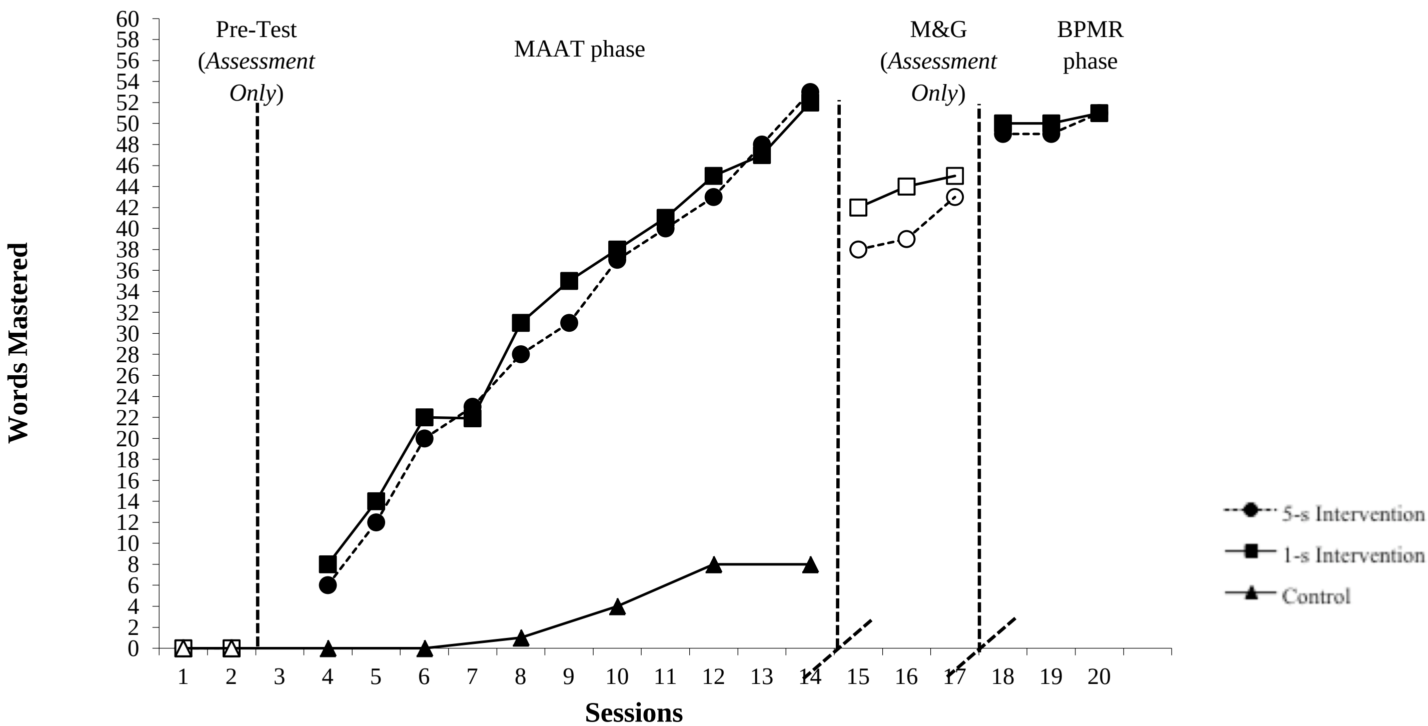

Figure 2.4. Number of words Andrew mastered per session.

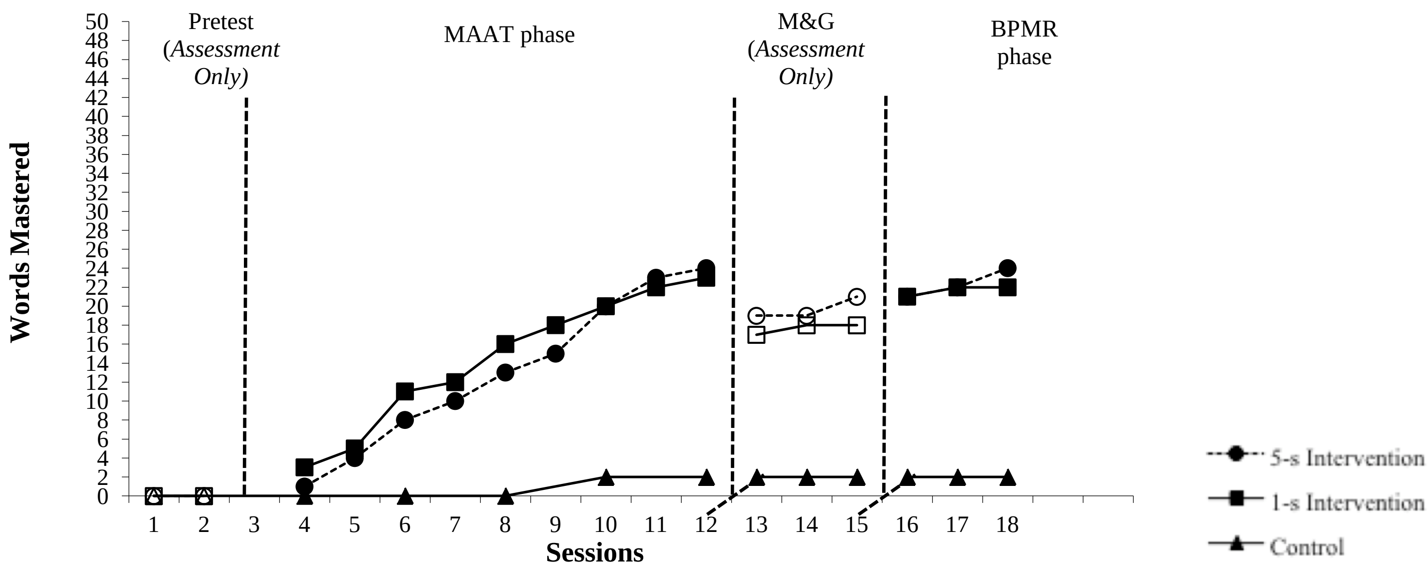

Figure 3.1. Number of words Michael mastered per session.

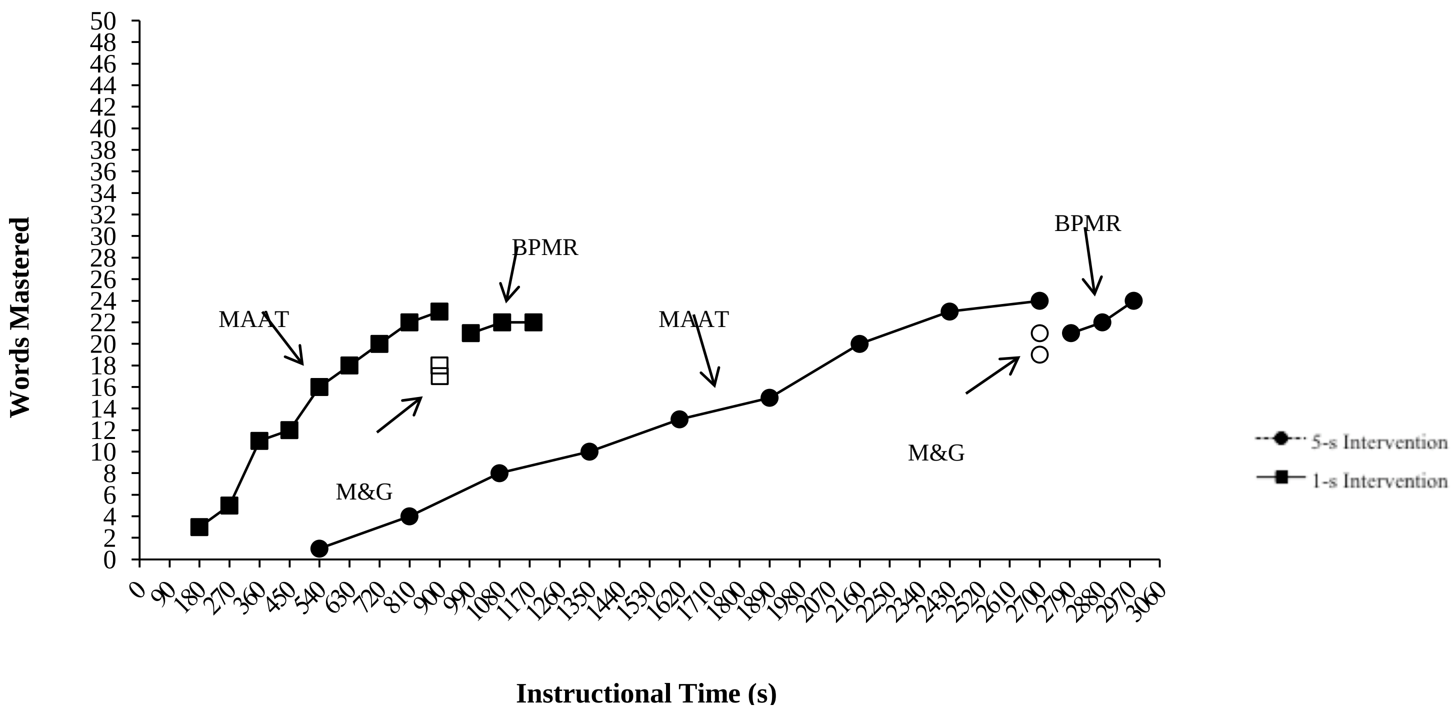

Figure 3.2. Number of words Michael mastered per instructional seconds.

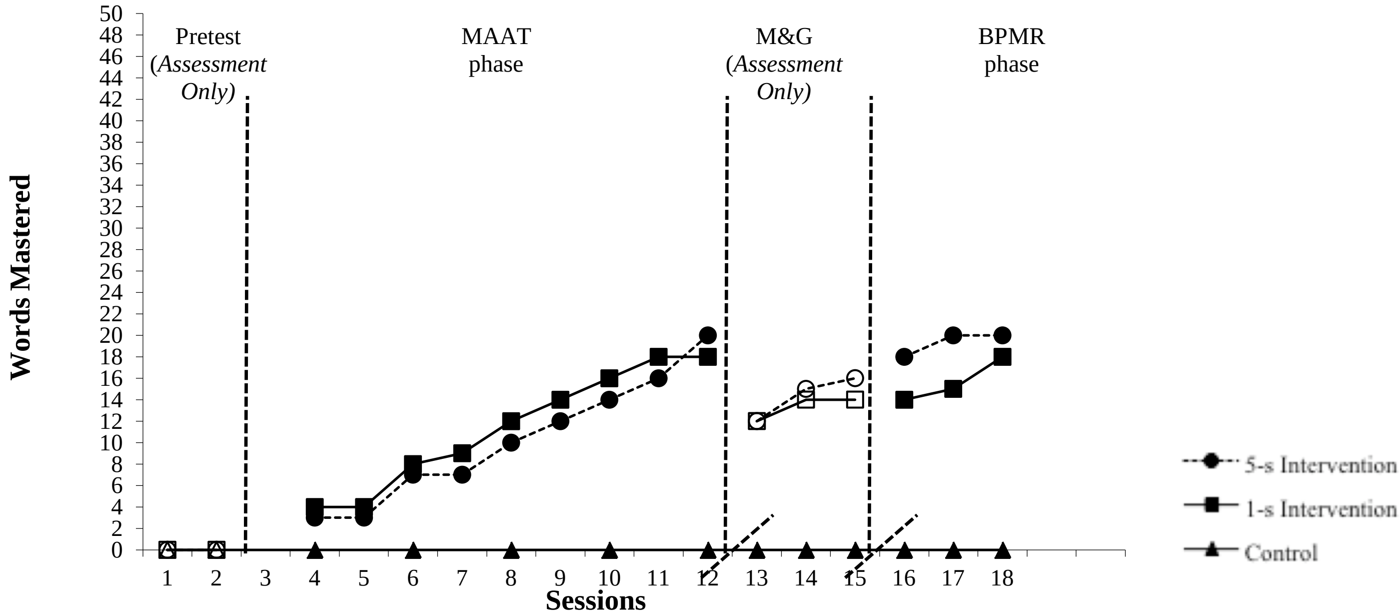

Figure 3.3. Number of words Lucas mastered per session.

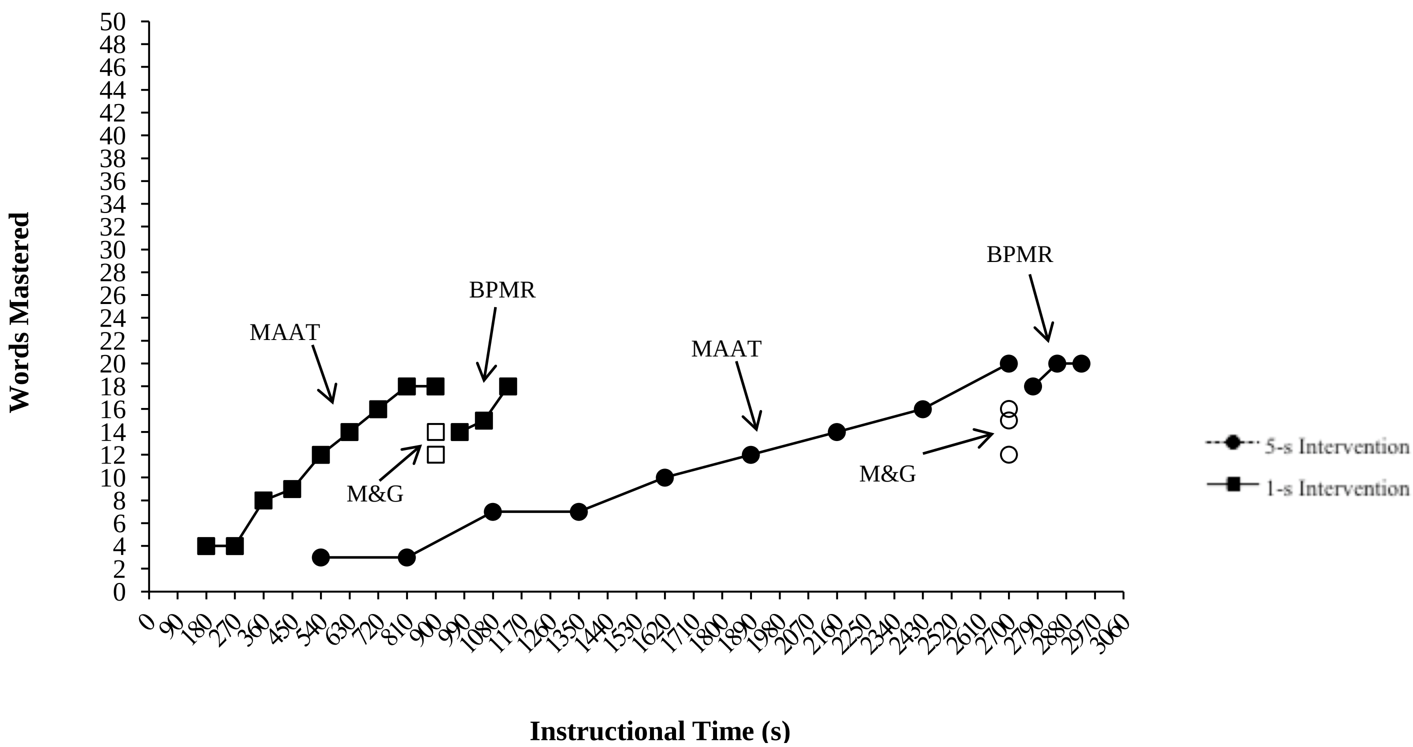

Figure 3.4. Number of words Lucas mastered per instructional seconds.

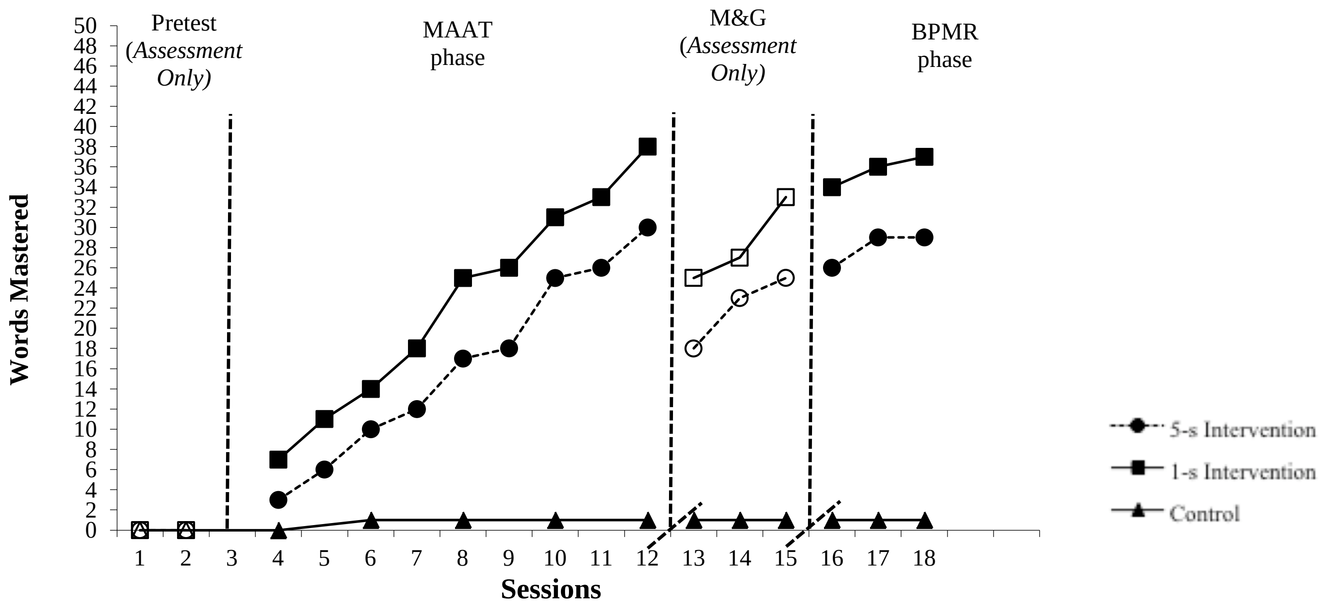

Figure 3.5. Number of words Andrew mastered per session.

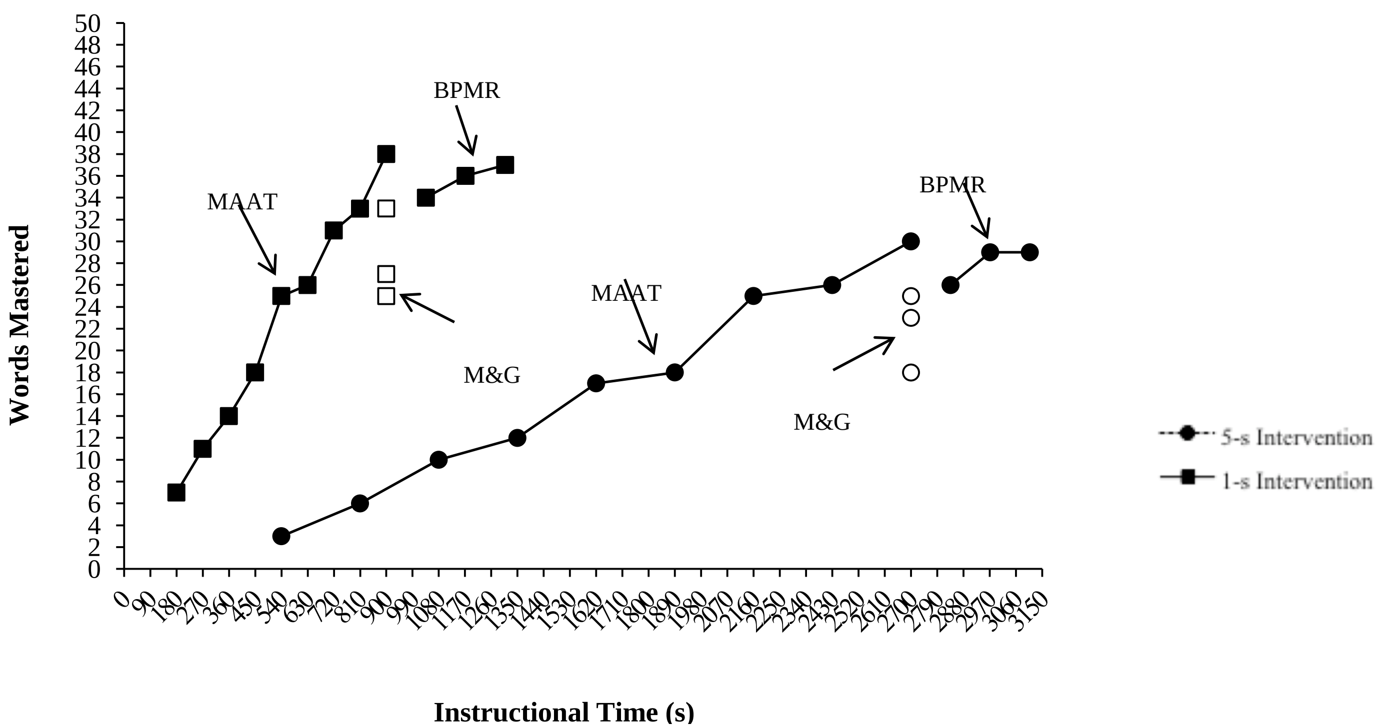

Figure 3.6. Number of words Andrew mastered per instructional seconds.

Appendix B

Copy of target word lists A, B, and C for Leah

List A: all, am, ate, be, but, eat, four, he, yes, well

List B: are, at, black, brown, did, get, good, out, do, no

List C: on, pretty, ran, ride, she, so, that, there, soon, we

Appendix C

Certificate of Achievement

Appendix D

Experimental Integrity Checklist

1. The experimenter set up a workstation containing a computer, working headphones, and two chairs. ___________
2. The experimenter asked student to sit in his/her chair of choice and instructed student to open up his/her file (labeled with student's name). ___________
3. The student either opened up his/her file or was assisted in opening up his/her file to begin intervention for targeted words. ___________
4. The student was asked to put on his/her working headphones and adjust the volume as necessary to their level of comfort. ___________
5. The student was instructed to open up 5-s (i.e., or 1-s for counterbalancing) CBSWR intervention and awaited the examiners further directions. ___________
6. The student was instructed that upon clicking on the word START, words would be displayed, and they were to try to "beat the recording" and say the word before the examiners vocal assistance played. Students were also instructed to repeat the word after they heard the recording. ___________
7. The student then proceeded and clicked the word START ___________
8. When 5-s (or 1-s) intervention was completed, steps 5-7 were completed for 1-s (or 5-s). ___________
9. After intervention was completed each day, the student was instructed to open up the ASSESSMENT folder, containing both 5-s, 1-s, and Control Assessments. ___________
10. The student was asked to open up 5-s (or 1-s to counterbalance) first, and awaited further instruction from examiner. ___________
11. The student was instructed that upon clicking the word START, words would be displayed, and they were asked to say the words as they appeared. ___________
12. When 5-s (or 1-s) Assessment was completed, steps 10-12 were repeated for 1-s (or 5-s) Assessment words. ___________
13. Steps 10-12 were completed for Control list every other day. ___________
14. All Assessment sessions were recorded for interrater reliability data. ___________

Appendix E

Student Acceptability Form

Student Acceptability Form

	Very Much	Don't Care	Not At All
How much did you like using the computer program to learn sight-words?	 *N=3*		
How much do you think the computer program helped you learn the words?	 *N=2*	 *N=1*	
How much would you recommend the computer program to a friend trying to learn sight words?	 *N=3*		

	Faster	Slower
Which computer program did you like using more, the one that presented the words faster or slower?	*N=3* 	
Which computer program do you think your friends would like using more, the one that presented the words faster or slower?	*N=3* 	
Which computer program do you think helped you learn more words, the one that presented the words faster or slower?	*N=3* 	

Appendix F

Informed Consent

Dear Parent,

My name is Jared Yaw, and I am currently a graduate student pursuing my degree in School Psychology at the University of Tennessee. As part of my training, I am working with students and teachers at XXXXXX XXXXXX School. This year, I have been working with your child's teacher, Ms. XXXXXX, to develop a simple procedure to help your child and other students with reading. I am requesting permission for your child to participate in this study. If you agree to let your child participate, your child will be given a list of sight-words that they will listen to on a computer as the words are presented. They will practice saying the words aloud as they appear. We plan on working with your child for about 15 days for about 5 minutes each day. This simple procedure has worked very well in the past with other students at XXXXXX XXXXXX School.

The administrative staff and teachers at XXXXXX Grammar School have been informed about our project and have agreed to allow us to conduct this research. We hope to see gains in your child's ability to read words. I am also requesting your permission to share various student data and my results with other educators so that they can use these procedures to help their students learn. Your child's performance on this task will not affect his or her grades. Your child's name will not be linked with any of the information collected. Additionally, participation in this project is entirely voluntary, and your child may choose to discontinue participation at any time without penalty. Thus, I am asking permission to work with your child, and to present our procedures and results at professional conferences and submit them for publication to professional journals. I will be working with Dr. Christopher H. Skinner, who is a professor from the University of Tennessee.

We hope that these procedures and results will help other educators teach their students. Also, presenting our results and sharing various student data would be very exciting for me. If you are willing to let me work with your child with the supervision of Ms. XXXXX and to present our findings from this project, please sign and date this form and return it to your child's teacher. If you have any questions, you may contact me at (513) 252-8504 or my faculty advisor (Dr. Chris Skinner) at (865) 974-8043.

Thank you for your time and consideration

Jared S. Yaw

I have read the above information, and give permission for my child to participate in this study. I have received a copy of this form.

Childs Name____

Signature of Parent__________________________________Date__________________________

Vita

Jared Scott Yaw grew up in Cincinnati, OH. He graduated from Lakota East High School in 2004 and attended The Ohio State University. In 2007, Jared graduated from The Ohio State University with a B.S. in Psychology and a Minor in Italian Language. Jared entered the School Psychology Ph.D. program at the University of Tennessee, Knoxville in 2008. He is currently in his fourth year in the Ph.D. program and will be completing a year-long internship for the next academic year. Upon completion of his internship, Jared will have met all necessary requirements for a Ph.D. in School Psychology.