EFFECTS OF A COMPUTER ASSISTED INTERVENTION IN SECOND GRADERS WITH ATTENTION AND LITERACY PROBLEMS

By

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Previous research has linked inattention with reading problems. Moreover, children with combined reading and attention problems have significantly worse later academic outcomes. Few studies have focused on the effectiveness of computer-assisted interventions for children with reading and attention problems. The purpose of this study was to examine the effects of a computerized early literacy intervention on the on-task behavior and oral reading fluency of three second-graders with teacher- and parent-rated attention problems. A multiple baseline design across participants was utilized in order to examine the intervention effectiveness. Results suggest that the *Earobics* intervention was effective in increasing oral reading fluency and on-task behavior across participants, providing additional evidence to suggest the intervention is effective for increasing reading fluency as well as attention to literacy instruction via computer-assisted program. Limitations and implications of the findings are presented.

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CHAPTER I: INTRODUCTION AND LITERATURE REVIEW

Attention-deficit hyperactivity disorder (ADHD) is a psychological diagnosis applied to children who exhibit a developmentally inappropriate pattern of hyperactivity-impulsivity and/or inattention, affecting approximately three to seven percent of school-age children (American Psychiatric Association [APA], 2000). ADHD symptoms typically appear during the preschool years and can extend into adulthood for many individuals. Children with ADHD are often inattentive and exhibit significantly higher rates of off-task behavior compared to nondiagnosed peers (DuPaul, 2007). Due to symptomology typical of the disorder, children diagnosed with ADHD may experience problems with classroom work and academic performance and are at higher than average risk for behavioral problems and academic difficulties (APA, 2000; DuPaul & Stoner, 2003).

ADHD is related to low academic achievement, poor school performance, grade retention, school suspensions/expulsions, poor peer and family relations, anxiety, depression, aggression, conduct problems, delinquency, driving violations, and difficulties in relationships (Barkley, 1997). Students frequently struggle in school because of academic performance deficits, low academic engagement, lower than expected work completion rates, and inconsistent work productivity (DuPaul & Eckert, 1998). Children with ADHD predominately inattentive type exhibit frequent distractibility, difficulties with sustaining attention, disorganized thoughts and behaviors, and inadequate task persistence (Spira & Fischel, 2005). Difficulties associated with inattention put students at particular risk for significant academic problems in school, as well as other environments and domains, and across academic areas.

Frequently, the ADHD predominately inattentive type in particular has been linked to underachievement specifically in grade level reading. Strong, efficient reading skills are an

important beginning foundation for developing content knowledge in many other academic areas. Poor early readers are more likely than typical readers to continue struggling with reading tasks and experience limited encounters with other tasks involving language skills. The societal demand for literacy is increasing, and as a society we must address ways to increase literacy among young children, especially those at-risk for reading problems (Lonigan, 2006). Because children with ADHD are a population at great risk for academic failure, and specifically reading ability, great care should be taken to screen these children for at-risk reading failure and implement interventions to remediate weak literacy skills.

Inattentive Symptomology

The symptoms of ADHD are thought to arise out of poor behavioral inhibition, including the relationship between response inhibition and the four executive functions (i.e., working memory, self-regulation of affect/motivation/arousal, internalization of speech, and reconstitution), which rely on inhibition to function effectively. The types of problems with inattention seen in the predominately inattentive type appear to have their onset later than would be associated with the hyperactive-impulsive behavior. Barkley (1997) provides evidence that the inattentive subtype is a separate dimension that is qualitatively different from the hyperactive-impulsive subtype. Common behavioral symptoms the inattentive type include daydreaming, being easily confused, staring frequently, being lethargic, passive, hypoactive, "spacing out," and being "in a fog." They may also experience deficits in focused and/or selective attention, which are symptoms typically not observed in children with the predominately hyperactive-impulsive subtype, as well as speed of information processing (Barkley, 1997; Barkley, DuPaul, & McMurray, 1990).

Poor sustained attention is a consequence of executive function deficits, and indicates

impaired goal-directed persistence as a result of poor inhibition and the impact of that impairment on self-regulation. The symptom of distractibility recognized in individuals with ADHD occurs due to poor inference control, permitting outside stimuli and events to disturb the executive functions that support self-control and task persistence. As a result, the individual exhibits difficulty in demonstrating persistent effort toward tasks that offer little immediate reward and instead hastens from one incomplete activity to the next (Barkley, 1997). Hence, inattention is described as "a consequence of the impairment that poor behavioral inhibition and interference control create in the self-regulation or executive control of behavior" (Barkley, 1997, p. 84). It is these impairments that make focusing and remaining on-task in the classroom such a struggle for children with attention disorders, which consequently impacts academic performance, task persistence, frustration tolerance, academic engagement, and work completion.

Attention Problems and Achievement

Many studies have demonstrated that ADHD symptomology is associated with lower academic outcomes (e.g., DuPaul & Eckert, 1998; Maguin & Loeber, 1996; Spira & Fischel, 2005). An estimated eighty percent of students diagnosed with ADHD may exhibit academic performance problems (APA, 2000). On norm-referenced achievement tests, children diagnosed with ADHD score anywhere from ten to thirty points lower than children in control groups (DuPaul, 2007). Children with the inattentive type tend to fare worse on achievement measures, especially reading achievement, when compared to children with the combined and predominately hyperactive/impulsive types (Spira & Fischel, 2005). This would suggest that particular attention should focus on the academic outcomes of those children with the predominately inattentive subtype.

A dual pathway model to explain the association between ADHD and achievement has been proposed, in which both cognitive (i.e., vigilance and memory deficits) and behavioral (i.e., disruptive behavior) mediators link ADHD and achievement. ADHD may be associated with one or more educational difficulties, such as a learning disability, that further compromise school functioning and that necessitate specialized intervention services (DuPaul, 2007). Because of their increased risk for academic failure, it is crucial that researchers find successful behavioral and academic interventions that focus on and help alleviate the academic difficulties linked with ADHD (Clarfield & Stoner, 2005).

The Keys to Early Literacy

Lonigan aptly suggested that "well-developed reading skills serve as the cornerstone to acquiring content knowledge in other domains both in school and throughout life" (Lonigan, 2006**,** p. 92). The importance of early literacy has been recognized and is the subject of a growing body of research over the past few decades (Bruck, 1992; Chall, Jacobs, & Baldwin, 1990; Alexander & Entwisle, 1996; Juel, 1988; Shaywitz, et. al, 1999; Torgesen, Wagner, & Rashotte, 1994). In particular, Alexander and Entwisle (1996) suggested that reading performance scores from the second grade could be used to predict high school achievement outcomes. This reflects the significance of early reading on later achievement across a variety of subjects. Early success in reading is predictive of success many years later in high school, and therefore is a critical skill necessary for success across the lifespan.

According to Lonigan (2006), pre-reading skills related to school readiness establish the developmental foundations for the standard reading and writing skills needed throughout the course of formalized education. Literacy acquisition takes place over time and begins early in a child's development. Inside-out skills, the ability to translate written word into meaningful

sounds or phonemes, includes letter knowledge and phonological awareness skills. It is critical for children to learn these inside-out skills early in the development of literacy, when accuracy and fluency is most important (Lonigan, 2006). Children who experience difficulty learning these fundamental skills are at-risk for school difficulties in the future and are likely to fall behind their peers academically.

The following are three fundamental problems that prevent the attainment of early reading skills, according to Snow, Burns, and Griffin (1998)**:** (a) difficulty comprehending and applying alphabetic principles to gain accurate and fluent reading proficiency, (b) unsuccessful attainment of verbal and written knowledge and comprehension strategies, and (c) lack of motivation to read and/or lack of appreciation of the benefits of adequate reading skills. The first reason is of significant concern, and it illustrates the importance of intervening early in the educational development of children at-risk for reading failure. It also suggests providing specific, explicit instruction in alphabetic principles and phonological awareness in order for children to be accurate, fluent readers. Reading First, which is the component of the No Child Left Behind (NCLB) legislation that concentrates on developing better reading outcomes for children, calls for reading instruction focusing on the hierarchy of skills that students need to promote reading (i.e., phonemic awareness, phonics, fluency, vocabulary, and comprehension). NCLB promotes the increased understanding of the development of skilled reading, effective instruction, appropriate assessment techniques, and evidence-based interventions (Lonigan, 2006). The systematic approach, which focuses on building skills using the bottom-up learning strategy (i.e., building on lower level skills before learning higher level skills), creates a strong foundation for literacy development for those students who required explicit instruction in reading.

Most children do not require explicit teaching of phonemic awareness and phonics to learn to read. However, without systematic instruction in these skill areas, it will be difficult for at-risk children to acquire these fundamental reading skills and continue to the next phase of fluency. Research has shown that phonemic awareness is a strong predictor of early achievement in reading (Snow et al., 1998). Two crucial factors in the acquisition of successful reading skills are (a) the ability to identify individual words in print accurately and fluently and (b) adequate language comprehension abilities (Torgesen, 2002a). This requires explicit teaching in phonemic awareness in young students (i.e., preschool through first grade) and sight-word recognition in elementary-age students (i.e., second grade and beyond) who have not acquired those fundamental skills naturally, and who are at-risk for reading failure, in order to prevent them from falling behind in reading and becoming poor readers. Success in early reading depends on phonemic awareness, which is a subskill falling under the more broad ability called phonological awareness.

Many poor beginner readers have a fundamental phonological processing deficit. The alphabetic code that connects graphemes in written language to the phonemes in oral language is problematic for students with poor phonological processing skills. Poor readers often suffer deficits in phonological processing, which cause them to rely too much on contextual cues within the written material rather than using phonics to aid them in decoding unfamiliar words. Due to incorrect reading of words, limited experience with print, and little motivation to read because of earlier frustrating experiences, these students demonstrate considerable problems learning the vast amount of sight-words necessary to develop into a fluent reader (Stanovich, 1986; Lonigan, 2006). This demonstrates the importance of phonological awareness in beginning reading and suggests that, with specific instruction in this area, children are more likely to be fluent readers

later in their reading development.

Learning to read is influenced by foundational preliteracy skills. The National Reading Panel (National Reading Panel, 2000) indicated that both decoding skills and sight word recognition were essential in developing into proficient readers. Moreover, children entering first grade with phonemic awareness skills will experience more success in learning to read than their peers who enter first grade with little or no phonemic awareness (Browder, Ahlgrim-Delzell, Courtade, Gibbs, & Flowers, 2008). The National Early Literacy Panel conducted a meta-analysis of studies that included data concerning the relationship between skills in preschool or kindergarten and reading outcomes for children learning to read. They found that early measures of reading, such as decoding words and nonwords, were the best predictors of later reading. Alphabetic knowledge and phonological awareness had considerable connections with decoding skills and reading comprehension. Therefore, phonological processing skills are vital determinants of literacy acquisition for children in preschool and kindergarten (Lonigan, 2006).

Numerous intervention research studies suggest that explicit, systematic instruction in early reading skills can assist in decreasing the percentage of children experiencing significant reading failure to approximately five percent of the population (Torgesen, 2002b). Systematic, explicit teaching of literacy skills provides a crucial foundation for the development of reading. Reading skills are important because children are expected to read and comprehend complex materials throughout their lives. Three fundamental skills that develop during the preschool period and are predictive of children's reading ability at school-age are phonological awareness, print knowledge, and oral language (Farver et al., 2007). Young children who have more of these early literacy skills profit more from reading instruction, learn to read sooner, and read better than children who have fewer of these skills. Assessments of these early literacy skills before

formal reading instruction in kindergarten or first grade are predictive of children's reading ability one or more years later (Lonigan et al., 2000). Moreover, early assessments provide screening information to determine if a child is meeting grade-level expectations or is at-risk for future reading difficulty, and this information could be utilized to determine students who may benefit from early intervention in reading.

The Link between Inattention and Literacy Problems

There seems to be a relationship between academic achievement and behavior. Problems with inattention, hyperactivity, and impulsivity place children at increased risk for school failure by interfering with the ability to concentrate on and take advantage of teacher instruction and the curriculum. Students with inattention and poor behavioral capabilities may be at a continual disadvantage throughout their education if they acquire less of these critical reading skills before entering school (Spira & Fischel, 2005). Specifically, the link between reading outcomes and attention problems has been frequently noted throughout literature and research (Rabiner, Coie, & CPPRG, 2000; Maguin & Loeber, 1996; Morgan, Farkas, Tufis, & Sperling, 2008).

Walcott, Scheemaker, and Bielski (2009) conducted a longitudinal study that examined the link between early inattention and emerging literacy development. Inattention is defined as difficulty in maintaining attention, as well as the tendency to be easily distractible. They found that teacher-reported attention difficulties during the preschool years significantly and negatively impacted phonemic awareness and letter naming scores one year later, suggesting that early inattention interferes with children's ability to acquire specific early reading skills. From an information processing perspective, attention is an essential element of the process of learning. This may be particularly true for the development of reading because children need to be able to attend to and form awareness of sounds that compose words. Their study measured three

emerging literacy skills (i.e., rapid automatic naming, phonemic awareness, and alphabet knowledge) in preschoolers with inattention problems over a period of one year. After controlling for initial language ability and preschool emerging literacy skill level, preschool inattention was found to be a significant predictor of phonemic awareness and letter naming one year later (Walcott, et al., 2009). This suggests that early inattention might interfere with the development of certain preliteracy skills, specifically phonemic awareness, and that when preschoolers with attention problems struggle to gain important emerging literacy skills, they remain at a disadvantage. These students risk falling farther behind their peers because of their difficulties in early acquisition of fundamental preliteracy skills that serve as the foundation for higher-order reading abilities.

Approximately ten to fifty percent of individuals with ADHD exhibit comorbid learning disabilities, and the most frequent area of disability is reading (Bental & Tirosh, 1997). Children with reading disabilities are at increased risk for other psychiatric disorders, particularly with ADHD and Conduct Disorder. For the purpose of this review, the focus on ADHD, predominantly inattentive type, is emphasized. Children with reading difficulties are vulnerable to other disorders through a variety of mechanisms, including environmental or genetic risks. Shared genetic risk has been examined extensively in relation to ADHD. Twin studies have demonstrated noteworthy bivariate heritability between ADHD and reading disabilities. Another pathway to comorbidity is the possibility that one disorder increases risk for the second. For example, a reading problem may contribute to a student being inattentive and/or disruptive in school (Carroll, Maughan, Goodman, & Meltzer, 2005).

Maguin & Loeber (1996) maintain that attention problems and intelligence are predictive of academic performance and delinquency in young boys. A possible interference with the

learning processes and other cognitive processes has been posited as an explanation for lack of academic progress in these with attention and hyperactive problems children. They also suggest that interventions to decrease attention problems will help improve academic success (Maguin & Loeber, 1996). In their study examining the potential uniqueness of symptomology of comorbid ADHD and reading disorder, Bental and Tirosh (2007) compared four groups of children (i.e., pure ADHD, pure reading disorder, combined ADHD and reading disorder, and control) using measures of reading, attention, executive function, phonemic awareness, and rapid naming. They found that the group of participants with both ADHD and reading disability had deficits related to both attention/hyperactivity and phonological deletion. Moreover, they showed a unique deficit for rapid naming and severe deficit in verbal working memory compared to the other groups. They demonstrated that the comorbid group shared primary deficits of both pure clinical groups of ADHD and reading disorder. This low rapid naming speed and weak verbal working memory point to the influence of impaired executive functioning on reading efficiency (Bental & Tirosh, 2007). This provides identification of the mechanisms of ADHD that negatively impacts reading and provides evidence of the difficulties students with a high level of inattention will face in reading development specifically.

In a study by Rabiner, Coie, and the Conduct Problems Prevention Research Group (2000), attention problems in the first grade were found to be predictive of reading difficulties at the end of fifth grade. Even after controlling for earlier reading ability and IQ, a significant predictor of reduced reading achievement in first graders was attention problems (Rabiner, Malone, & CPPRG, 2004). Researchers also found that first graders with reading problems were more likely to exhibit off-task behavior and poor self-control, as well as both externalizing and internalizing behaviors, two years later. Also, first graders displaying off-task behavior were

more likely to experience reading problems two years later (Morgan, Farkas, Tufis, & Sperling, 2008; Rabiner, Malone, & CPPRG, 2004). Therefore, it is difficult to determine the direction of causality or whether or not inattention and reading problems have a bidirectional influence. Regardless of directionality, it is clear that there is a frequent connection between reading and attention difficulties and by better understanding the link and mechanisms by which cause difficulties, strategies may be developed to target specific processes to improve outcomes for these individuals.

Rowe and Rowe (1992) have also found a significant link between inattention and reading underachievement. These researchers found that inattention had a significant, negative effect on student achievement, and this relationship is mediated by attitudes toward reading, family socioeconomic status, and reading activity in the home setting. They also found that reading activity at home has a profound influence on students' attitudes toward reading and functions as a mediating factor between reading achievement and inattention. Therefore, reading activity at home and attitudes toward reading have significant influences on reducing inattentive behaviors in the classroom. Socioeconomic status had a negative impact on inattention and a positive effect on student attitude toward reading. They advocate for the use of interventions that simultaneously treat both the reading and attention problems in order to increase reading achievement (Rowe & Rowe, 1992). Some researchers argue that it is not too late to begin promoting phonemic awareness skills in children aged five to ten, in order to bridge the gap in reading proficiency by late elementary school (Browder, Ahlgrim-Delzell, Courtade, Gibbs, & Flowers, 2008). This would suggest that even students as old as ten-years-old, in fourth or fifth grade, may benefit from phonemic awareness instruction, along with sight-word identification strategies, in order to bolster reading skills.

Academic Interventions for Children with Attentional Difficulties

Early identification of students who need extra help with reading development is important to prevent these children from falling behind in all aspects of formal schooling (Adams, 1990). It is important to be able to identify those children who are likely to develop a reading disability or who are significantly below average reading skills before they begin formal schooling or kindergarten in order to prevent substantial reading problems in students at-risk.

Throughout the elementary school years, difficulties in learning to read are associated with pre-reading skills that are acquired within the preschool and kindergarten developmental period, with reading development at a standstill (Farver et al., 2007; Lonigan, 2006). Interventions that provide systematic, explicit instruction in phonological awareness, print awareness, letter knowledge, and vocabulary produce the most gains for children who are at high risk for early reading difficulties and disabilities. Studies for the effectiveness of early interventions support the importance of these skills for helping struggling readers and preventing reading disabilities. (Farver et al., 2007; National Reading Panel, 2000). The first step in helping these children be successful in school is to accurately identify children in need of early intervention. Of course, the identification of appropriate and effective preschool interventions in the domains of oral language, phonological awareness, and print knowledge will be required (Farver et al., 2007).

Because students with ADHD are at risk for lower academic achievement, there is a great need for more effective intervention strategies to address academic difficulties associated with ADHD (Clarfield & Stoner, 2005). However, it is important that the behavioral aspects of the intervention are not forgotten. It is crucial that we ensure that children in the primary grades move on to subsequent grades with the requisite reading skills and self-regulatory, task-focused

behaviors. Researchers have concluded that the most effective types of interventions are likely to be those that target both reading and behavior problems at the same time (Morgan, Farkas, Tufis, & Sperling, 2008; Rowe & Rowe, 1992; Shaywitz & Shaywitz, 2008; Spira & Fischel, 2005).

School-based interventions for students with ADHD focus on reducing problem behaviors while enhancing on-task behavior. A comprehensive intervention plan is required for students with ADHD because the disorder is often coupled with impaired academic achievement. Instructional strategies that alter how tasks and instructional materials are presented to students are critical. Tasks that include engaging stimuli within the task are more likely to maintain student attention, providing students with the opportunity to focus their attention on academic stimuli (DuPaul & Eckert, 1998; DuPaul & Weyandt, 2006).

Because children with ADHD often experience difficulties in several areas, such as behavior, academics, and social interactions, it is important that interventions address each of these functioning areas when possible. Interventions should be delineated for each child individually by taking into account the student's personal strengths, weaknesses, and classroom or environmental factors (DuPaul & Weyandt, 2006). Specific academic interventions that have been thoroughly researched and proven effective with many students with ADHD include instructional modifications, task modifications, strategy training, peer tutoring, and computer-assisted learning (DuPaul & Eckert, 1998; Ota & DuPaul, 2002).

Computer assisted instruction

Computer assisted instruction (CAI) has demonstrated utility as an intervention strategy when working with students with ADHD and academic problems by increasing their on-task and work production behaviors, targeting not only the student's academic deficits but their behavioral problems as well (Clarfield & Stoner, 2005; DuPaul & Eckert, 1998). The specific

instructional objectives and features of computerized interventions allow students to focus their attention on academic stimuli through the use of multiple sensory modalities, highlighting essential material, breaking content into smaller pieces of information, and providing immediate corrective feedback to the student (DuPaul & Eckert, 1998; DuPaul & Weyandt, 2006). These specific programmatic features may be particularly helpful for students with attention problems because it emphasizes manageable presentation of material and engaging elements to maintain the student user's attention as they are learning academic material.

Shaywitz and Shaywitz (2008) also recommend the use of intervention strategies focused on improving both preliteracy and attention concurrently. They assert that research focused on CAI has indicated that computerized programs may be a practical solution for children with attention and reading problems. Through the integration of game-format and attractive stimuli, inattentive students may find CAI more appealing than interventions requiring simply drill and practice. CAIs that utilize a game format and animations, rather than drill and practice programs, are recommended for students with ADHD to increase on-task behavior and work production (DuPaul & Ekert, 1998).

Surprisingly, very few controlled empirical studies have evaluated the effects of CAIs for students with attention disorders, especially those for reading problems. However, some single-subject research design studies have indicated the effectiveness of computer-assisted instruction as an academic remediation strategy for children with an attention disorder, and are discussed next (Clarfield & Stoner, 2005; Mautone, DuPaul, & Jitendra, 2005; Ota & DuPaul, 2002).

Ota and DuPaul (2002) evaluated the effectiveness of CAI with three fourth- to sixth-grade children diagnosed with ADHD. Using a multiple baseline design across participants, researchers implemented the *Math Blaster* computer software intervention for mathematics and

collected a variety of math skill probes and systematic direct observations for each of the students during the baseline and intervention phases. Although the extent of improvement varied across the subjects, they found that the CAI was a valuable intervention to maintain and increase the on-task behavior and math-related skills of the fourth-, fifth-, and sixth-grade students who participated in the study (Ota & DuPaul, 2002). Mautone, DuPaul, & Jitendra (2005) extended the research by Ota & DuPaul (2002) by implementing the *Math Blaster* intervention with three second- through fourth-graders diagnosed with ADHD. They found that the intervention positively affected each of the participants' mathematic fluency (i.e., digits correct per minute) and on-task behavior.

Clarfield and Stoner (2005) investigated the use and effectiveness of a CAI reading program, *Headsprout*, on the oral reading fluency and task engagement of three students with ADHD and reading problems in kindergarten and first grade. *Headsprout Reading Basics*, an internet-based reading program, was selected because of its use of explicit instruction in phonemic awareness, fluency building tasks, and building sight word recognition. The lessons are automatically adapted to the student user's pace and the program gives students corrective feedback and encouragement as necessary. The program was implemented consecutively using a multiple baseline design across participants and the results were examined through visual methods.

On ratings of reading fluency and task engagement, they found that the program stimulated greater oral reading fluency scores and less off-task behaviors as compared to the baseline rates. They found that each of the three students participating in the computerized intervention *Headsprout* evidenced gains in oral reading fluency as evidenced by higher mean levels on the oral reading fluency measure compared to the baseline levels. Moreover, there were

no overlapping data points across the series of data, with all scores obtained during the intervention phases being greater than scores obtained during the baseline. Also, the slopes of words read correctly were computed for each of the participants and indicated that the students achieved significant growth rates after implementation of the intervention, when compared to expected rates of growth for students in general and special education. With regard to on-task behavior, during the intervention phase attention increased dramatically and attention increased immediately across participants after introduction of the computerized intervention (Clarfield & Stoner, 2005). This study provides more evidence and adds to other research findings that propose CAIs as promising strategies for students with ADHD and academic problems.

Ford, Poe, and Cox (1993) examined the effects of assorted CAIs on the on-task behavior of twenty-one children diagnosed with ADHD. Researchers utilized a within-subjects group design, in which four CAI programs (i.e., math drill and practice, math instructional game, reading drill and practice, and reading tutorial) were implemented with each of the participants for a total of four weeks. Each of the software programs included a game and nongame design, which were compared for each of the participants. The results indicated that participants were more on-task when the software program integrated the game format with animation. When the intervention included only tutorial instruction or drill and practice, more off-task behaviors were observed (Ford, Poe, & Cox, 1993). In this study, Ford and colleagues (1993) focused on attention during intervention sessions, but did not specifically examine the effect on measures of mathematic and reading performance. With the exception of participants' on-task behavior, it is unknown what the effects of these interventions were, particularly when considering academics (Ota & DuPaul, 2002).

Issues of cost should be considered when schools are searching for literacy interventions,

as CAIs can be expensive. However, there are currently many inexpensive, user-friendly computer assisted literacy programs available. Additionally, the benefits of the computerized program may be substantially less expensive than those related to long-term, teacher-directed remediation programs and special education services that may be a result if children with pronounced reading problems and disorders do not remediate before they fall significantly behind their peers. Another concern to consider is technical difficulties, such as slow internet connection and accessibility to the program and computers (Clarfield & Stoner, 2005).

Earobics Reading Intervention

For reading in particular, the *Earobics* software is designed to help improve the preliteracy skills of students and has been shown to be an effective, high-quality, evidence-based intervention, particularly for at-risk or struggling children. The program can be used to supplement reading instruction in the regular classroom in order to support the development of word recognition and reading fluency. The software allows users to interact with lively animal characters as they work to develop the foundational literacy skills, such as recognizing and blending sounds, rhyming, and discriminating phonemes within words, that are essential to the development of successful reading.

This program focuses on phonological encoding, which is the operation of converting sensory input about sound structure into a representational form that can be stored in memory, and phonological awareness, which is the more conscious attention to and ability to manipulate the phonological segments represented in an alphabetic orthography. The program also allows the interventionist to customize the software games to each child's individual needs and ability level (Diehl, 1999). Instruction builds on and adjusts to the ability level of the student, allowing them to work at their own pace. Included in the program are other multimedia materials and

tools, such as printed materials and videos, to supplement the computer software and extend the intervention into the classroom and into small group activities, furthering the integration and generalizability of the literacy instruction (Pokorni, Worthington, & Jamison, 2004).

The multi-level games are Calling All Engines, Paint by Penguin, Pesky Parrots, Hippo Hoops, and Duck Luck. Calling All Engines requires the student to carefully listen to a spoken series of sounds and repeat the sequence by clicking on windows of a building in the correct order. In Paint by Penguin, the student listens to sound patterns and uses the mouse to click on the correct number of sounds they hear. As the student progresses through this activity's difficulty level, they must identify the number of sounds they hear and also associate colors with different sounds and reproduce the sequences. Pesky Parrots involves listening to spoken syllables or sounds of words and blending these sounds together to create whole words (e.g., "skel-e-ton" is "skeleton"). In Hippo Hoops, the student identifies words that are not the same in a sequence, whether or not they hear a particular sound in a word, and what position within the word (i.e., initial, middle, ending) they heard the sound. Duck Luck engages the student in a carnival game that requires the student to identify the correct duck out of three possible choices that says a word containing a specific sound (e.g., at), and identify words when sounds or syllables are taken away (i.e., sound deletion) (Discovery Education, 2010).

This CAI addresses both auditory processing problems and phonological awareness and is described as ideal for any student who needs supplemental reading instruction, including students with attention or processing deficits and learning disabilities. The program consists of five games that merge phonological awareness and auditory processing elements. It is important to choose a software program that reflects the present processes and knowledge within reading instruction and research and is appropriate for use with the targeted population (Diehl, 1999).

According to the U.S. Department of Education's What Works Clearinghouse, the *Earobics* software is listed as an effective intervention for early reading skills, and was found to have positive effects on alphabetic and potentially positive effects on reading fluency. The program has been used in thousands of schools nationally, within at-risk, general education, and special education students. Twenty-eight studies that examined the effects of the software were analyzed by the What Works Clearinghouse (What Works Clearinghouse, 2009).

McDuffy (2009) examined the effects of the *Earobics* computerized reading intervention for three first grade students with teacher-rated attention and reading problems. The intervention was implemented with each participant for four weeks, four days a week, with twenty-minute sessions. The multiple baseline design across participants was utilized to examine the effectiveness of the computerized intervention. During baseline and implementation of the intervention, the participant's scores on oral reading fluency, phoneme segmentation fluency, and task attention were measured. All scores on those measurements increased after the intervention was implemented, suggesting that the *Earobics* intervention was effective in improving student reading outcomes.

Purpose of Study

The objective of the current study was to investigate the effect of the CAI program *Earobics* on literacy skill development for second grade students with attention problems and reading deficits. Because researchers have identified CAI as an effective intervention for students with attention disorders, the current study examined the utility of a computer-based intervention that uses game-format and colorful animations to increase on-task behavior and reading outcomes. This study replicated the study that Clarfield and Stoner (2005) conducted in which children with both attention and reading problems were provided a CAI intervention for

reading and data were collected on their reading fluency and on-task behavior during the intervention periods.

This study also replicated the study McDuffy (2009) conducted, in that the *Earobics* software was used as the reading intervention. In order to systematically replicate this specific study, the aim was to investigate the effects of the *Earobics* intervention on an older group of students, specifically second grade students. Hypotheses proposed were that with the introduction of the *Earobics* intervention, participants' oral reading fluency and on-task behavior would both increase when compared to baseline rates.

Research Questions

In this study, we examined the following questions: Do participants demonstrate an increase in oral reading fluency after the intervention? What are the effects of the intervention on on-task behavior? Are the effects consistent across participants and in response to the implementation of the intervention?

Significance of Study

These research problems and the study are substantial and add to the growing knowledge base of effective interventions to use with children who exhibit attention problems and experience early difficulties with regards to phonological awareness and other literacy skills. Because children with both reading and attention problems are at an increased risk for academic failure, it is critical that early intervention strategies are found to be effective for these students.

This proposed research study is a replication of the studies conducted by Clarfield and Stoner (2005), as well as McDuffy (2009), in which the effect of a CAI was used for students with inattention and reading problems. The current study focused on an older subset of early readers, whereas the McDuffy (2009) study recruited children in the first grade. If this

intervention proves to increase reading fluency and decrease off-task behaviors for these participants, it may be likely that this intervention could be effective for other same-age students in the school who exhibit similar attention and reading problems.

CHAPTER II: METHOD

Participants

The participants were three children in the second grade at an elementary school in a medium-size city in the southeastern United States. Teacher interviews and standardized assessments were conducted to find students who have exhibited literacy problems and significant inattentive symptoms in the classroom environment. Consent forms were distributed by the classroom teachers to the parent or guardian of the children who met the criteria and conditions for inclusion in the study. Identification of potential participants was possible through teacher interview and examination of students' cumulative files.

Five children were nominated by teachers as exhibiting substantial literacy and attention difficulties and consent forms were sent home to their parents. Each of the five parents agreed for their children to be screened for the study. The five students were screened according to the following inclusion criteria: 1) were between the ages of eight and ten; 2) exhibited significant level of inattentive symptoms (as rated using the Behavior Assessment System for Children, Second Edition [BASC-2] Attention Problems Scale); 3) exhibited substantial problems in reading (as assessed using the DIBELS Oral Reading Fluency measure placing them in the "at-risk" or "deficient" range for second graders). Because this was a systematic replication study, the exclusion criteria for this study were a formal diagnosis of ADHD, comorbidity with another disorder that could have affects on reading achievement, being an English language learner, taking prescription medication, or receiving special education services. These criteria were chosen because the researcher strived to identify and choose participants in the same manner as those in the study by McDuffy (2009).

Based on screening results, two students were excluded in order to keep the students as

similar as possible. By providing consideration for key variables of similarity, the researcher was attempting to ensure an adequate degree of experimental control. One of the excluded student's oral reading fluency was significantly lower than the others and one student's oral reading fluency was higher than the others, and it was determined that they might not benefit as much from the intervention as the other three students chosen. Participants 1 and 2 came from the same classroom and Participant 3 came from a separate classroom. Issues are raised concerning participants from different classrooms because different teachers will provide different instruction techniques. Although one of the students was from a separate classroom, both teachers were using the same standard reading instruction program as all 2nd grade teachers at the school. Participant 1 was an eight-year-old Caucasian male in the second grade who was reading on a first grade level during the baseline phase. Participant 2 was an eight-year-old African American male in the second grade who was reading on a second grade level during the baseline phase. Participant 3 was a nine-year old Caucasian male in the second grade who was reading on a first grade level during the baseline phase. By selecting participants who are most alike based on the predetermined variables, experimental methodology was demonstrated to support the multiple baseline design. When these variables are very similar, it is less likely that the influence on outcomes is due to differences inherent in the individuals or their environment.

Each of the participants spent 100% of the school day in the regular education classroom and none of them have been diagnosed with ADHD or any other disabilities. None of the participants was taking medication during the study. Each participant received small group reading instruction from their teacher during the school day. Participant 3 had been retained in the second grade this year. These students were rated by their teachers as having significant attention and reading difficulties. According to the results from the BASC-2 Attention Problems

Scale, Participants 1, 2, and 3 were reported by their teachers to have elevated attention problems, with their scores being 66, 66, and 64 respectively. Participants parents also rated their attention in the at-risk to clinically significant range, with T-scores being 72, 64, and 72, respectively. The table describing the participant's characteristics is presented next.

Table 1: Descriptive Characteristics of Participants

Participant	Age	Gender	Teacher-rated Attention Score*	Parent-rated Attention Score*	Literacy Score**
1	8	male	66	72	22.6
2	8	male	66	64	43.3
3	9	male	64	72	38.7

*Described as the Attention Problems T-score from BASC-2

**Described as average words correct per minute during baseline

Study Variables

Independent Variable.

The independent variable is the *Earobics Connections* intervention software. The *Earobics Connections* program is designed for second and third graders, aged seven to ten. This software is designed for individual use by students who need additional instruction in early literacy skills and extends their skills in phonological awareness, auditory processing, and phonemic awareness. Users are required to recognize and blend sounds, identify rhyming words, and discriminate phonemes within words. The software uses explicit and systematic instruction in phonics, utilizing manipulatives and music to actively engage students in learning. As users answer questions, the tasks and items adjust to the student's level of ability to reduce frustration.

Dependent Variables and Instrumentation.

The dependent variables are oral reading fluency and attention. Reading fluency and on-task behavior were measured two times a week on Mondays and Wednesdays.

Reading achievement. The DIBELS measure of Oral Reading Fluency was administered frequently throughout the study. For these individually administered measures, the examiner presents an instructionally appropriate level reading probe to the student. After the student reads aloud for one minute, the task is ended and the score is calculated as the number of words read correctly within one minute. Words that are self-corrected within three seconds are counted as correct. Errors include word omissions, word substitutions, and hesitations of greater than three seconds. The criterion-validity coefficients range from .52 to .91, while the test-retest reliabilities range from .92 to .97 (Good & Kaminski, 2002).

On-task behavior. To assess on-task behavior during baseline and intervention sessions, task attention was measured by systematic direct observations twice a week by the researcher. On-task behavior was defined as the participant actively attending to and engaging in the computer software, which included looking at the computer screen, using mouse to engage in the activities, and asking the teacher or experimenter any technical questions that arise. Fifteen minutes of interval coding, with time increments of fifteen seconds, were used to determine if the participants were displaying on-task behavior. The percentage of each student's on-task behavior was determined by dividing the number of intervals coded as on-task by the total number of observation intervals during the fifteen-minute observation period. During the baseline phase, on-task behavior was observed during small group reading instruction, while on-task behavior was observed during the *Earobics* intervention sessions during the intervention phase.

Procedure

The intervention sessions were conducted within the normal school day during reading instruction in the regular classroom. On Mondays and Wednesdays, the intervention was implemented by the experimenter, while the regular classroom teacher agreed to implement the intervention two other days of the week. A computer in the classroom of one of the participating teachers was utilized for the sessions and headphones were provided to the participants to hear the directions and to minimize environmental distractions. Participants engaged in the intervention program for approximately fifteen to twenty minutes, and two days a week a researcher examined the participants' on-task behavior and answered participants' questions concerning the program as needed.

Second-grade teachers were interviewed and the students who exhibited both literacy problems and attention problems, as evaluated by oral reading fluency measures and BASC-2 teacher ratings, were identified as possible participants. Due to the exclusionary criteria applied to participant selection, only three of the five students were chosen to participate in the intervention phase of the study. The parents of the students were given a letter describing the study and consent forms for their children's participation in the study. Individuals whose parents gave consent for participation took part in the study.

At the beginning of the study, each participant's inattentive behavior was assessed using the parent and teacher rating scales of the BASC-2 (Reynolds & Kamphaus, 2004). The BASC-2 is a broad-band rating scale that is designed to facilitate the differential diagnosis of a variety of emotional and behavioral disorders among children and adolescents. The BASC-2 asks for ratings to describe a child's behavior, as well as the presence and severity of symptoms related to specific behavioral problems, and then organizes these behaviors into externalizing problems,

internalizing problems, school problems and adaptive behavior composites. For the purposes of this study, the focus was on the items comprising the Attention Problems scale score.

A background questionnaire was created by the researchers to be completed by the parent or guardian, which provided demographic information such as age, gender, primary language spoken in the home as well as background information on children's computer usage (e.g., frequency at home, types of software used, and skill level). Parents were also asked if their child had been diagnosed with an attention disorder, or any other disorders, and whether or not their child was currently or had taken medications for the past for ADHD.

Throughout the study, progress monitoring took place and focused on measures of reading fluency and attention, which were collected for all of the participants two days a week. The initial pre-assessments included the oral reading fluency from DIBELS and systematic direct observations to assess on-task behavior, which were administered by graduate students, as well as the teacher and parent ratings of student attention problems on the BASC-2. Each student's instructional level in reading was determined by the pre-assessment measures, and throughout the entirety of the study each student was provided assessment measures based on their instructional level to in order to decrease frustration.

Each of the participants worked on the CAI during academic time during the day at school. Classroom teachers were taught by graduate student researchers how to implement the intervention. A trained graduate student administered the reading achievement assessment and systematic direct observations during the intervention sessions. Inattention was measured using teacher ratings from the BASC-2. Each of the graduate students had completed the CITI module, taken graduate-level courses in school assessment, and had direct experience in administering general outcome measures and curriculum-based measurements.

The baseline data were collected twice a week using the oral reading fluency measure and systematic direct observation during regular small-group reading instruction. After a stable baseline was reached, the participants worked on the age-appropriate modules of the CAI program on computers located in a familiar room at the school that the participants attend. The program selected employs interactive and educational tasks with colorful images and characters in a game context. The computerized activities are designed to be individualized to the developmental level of the student. Throughout the intervention sessions, participants heard audio material via headphones, and completed and responded to tasks using the keyboard and mouse. A trained graduate research assistant worked with each of the participants on an individual basis during the first session to provide additional instruction as needed and demonstrate the implementation of the intervention to the teacher.

During the first week of intervention, the student's instructional level in oral reading fluency was determined using the initial data obtained. After the first session, the teacher took over as the primary interventionist on days that the researcher was not present. If a participant failed to understand the program, the teacher instructed them in how to load the program and begin the tasks, without providing coaching in how to accomplish the tasks. Throughout the intervention sessions, participants were encouraged to work at their own pace. The software is designed for regular weekly use and intervention sessions were to occur at least four to five days a week for approximately fifteen to twenty minutes. The sessions continued during the spring semester for five weeks for each student. The total amount of training time provided and time spent on each of the individual tasks was to be recorded by the teacher at the end of each of the sessions. After completing the session, participants were allowed to select a reward, such as a sticker, for participating. These were supplied by the researcher and distributed by the teacher.

After the last session, each participant's progress was computed and their success was to be assessed using visual analysis of multiple baseline graphs, as well as by the progress assessment tool within the software.

Research Design

Because the purpose of this study was to determine the effectiveness of the CAI intervention across students, the design utilized for the problem was the single-subject, multiple baseline design across participants. After a stable baseline was established for the first participant based on the oral reading fluency measure, the intervention was implemented with that participant for five weeks. During that time, baseline was maintained for all the other participants for a predetermined amount of time. After one week of the first participant beginning the intervention, the second participant began the intervention, and baseline was still maintained with the third participant. The multiple baseline design varies the time schedule of the baseline for each participant**.** The length of time of the baseline may vary from participant to participant, and the intervention is implemented to determine if the change in academic performance is associated with beginning the intervention. If the baseline for each participant changes only after introducing the intervention, the outcomes can be credited to the intervention.

By controlling for possible confounds, it can be assumed that no other variables aside from those measured caused the change in behavior. The participants are in the same grade, in the same two classrooms, and the same age, which reduces the effects of classroom and age. The multiple baseline design controls for threats to interval validity by varying the length of the baseline across participants in order for changes in the dependent variable to be attributed to the intervention. Increases in oral reading fluency only after the intervention is implemented is evidence that the intervention is increasing the student's reading fluency and improvements are

not attributed to an unrelated factor. If a third variable were causing the change in the dependant variable (i.e., oral reading fluency), changes would occur across all participants at the same time without regard to when the intervention was implemented with each of the participants (Riley-Tillman & Burns, 2009).

Single-subject, multiple baseline design allows researchers to evaluate the influence of an education procedure on participants' performance by replicating the effect with the same individuals over time. The subjects function as their own controls. If each baseline changes when the intervention is introduced, the effects can be attributed to the intervention. Causality is established by the change in one baseline when the intervention is introduced, while there is no concurrent change in another subject's baseline, for whom the intervention has not yet been introduced. Replication of the results is achieved by applying the treatment to the additional baselines. This repeated demonstration that dependent variable, or behavior, changes in response to the independent variable, or intervention, usually makes it unlikely that the changes are the influence of extraneous variables.

The different baselines in the design serve as control conditions to evaluate what changes could be expected without the intervention. The advantages of using this design is that it allows for a smaller number of participants, is effective for evaluating interventions, allows for continuous progress monitoring of the learning and retention stages, and does not require the withdrawal of treatment in order to establish a causal relationship (Askov, Weidler, & Maclay, 1985).

For Participant 1, baseline data were collected for one week, followed by implementation of the *Earobics* intervention for five weeks. During this time, Participant 2 established a stable baseline and maintained for one week longer than Participant 1. Then implementation of the

Earobics intervention began for Participant 2 for five weeks. Meanwhile, Participant 3 established a stable baseline and the *Earobics* intervention was implemented with Participant 3 for five weeks. This research design is used because it is unethical to withdraw the intervention once the target academic behavior has improved and because it is not expected for students to lose learned skills once the intervention is withdrawn.

Data Analysis

Data were examined by graphing each participant's progress over time. To determine if a stable baseline had been established, graphs of each of the oral reading fluency measure were visually analyzed. Then, it was determined whether each of the participants' scores improved on oral reading fluency and on-task behavior after the beginning of the intervention period. The data described above were analyzed to determine whether the intervention improved participant's reading achievement compared to baseline performance. Mean level changes across baseline and intervention phases, variability within phases, overlapping data across phases, immediacy/latency of effects, magnitude of change in the dependent variable, and consistency of intervention findings across participants were analyzed. Data were used to determine the effectiveness of the intervention in improving participant oral reading fluency and on-task behavior, as compared to baseline functioning.

CHAPTER III: RESULTS

The Oral Reading Fluency measure and systematic direct observation data were depicted by line graphs. The mean level changes, trend, slope, variability within phases, percentage of nonoverlapping data points, and immediacy/latency of effects were analyzed for each participant in order to examine major changes between the data in baseline and intervention phases. Consistency of intervention findings across participants were analyzed to determine the effects of the intervention across subjects, thereby replicating the intervention phase and providing evidence of intervention effectiveness. Participant data obtained for oral reading fluency is presented in Appendix A.

Effect on Oral Reading Fluency

Participant 1

During the baseline phase, Participant 1 read an average of 22.6 words per minute in passages presented, with a range of 15 to 31 words per minute. The median number of words read correctly was 21. During the intervention phase, Participant 1 read an average of 45.1 words per minute, with a median of 45.5 words read correctly per minute. The number of words read correctly during the intervention phase ranged from 29 to 62. From the baseline to the intervention phase, his oral reading fluency increased by 22.5 words. During the intervention phase, the trend line was in the positive direction with immediate effects. The slope during the intervention phase was 0.30, which in an increase from the baseline phase in which the slope was -0.29. According to Participant 1's data, containing fourteen data points during the intervention phase, twelve points were above the highest baseline point of 31 WCPM, resulting in a percentage of nonoverlapping data (PND) of 86%. The recommended PND to constitute a large effect size is at least 80% (Scruggs & Mastropieri, 1998). According to this criterion, Participant

1's reading fluency increased significantly as evidenced by a large effect size. His data revealed limited variability within phases. During the baseline phase, Participant 1 demonstrated a growth rate of 0.33 WCPM increase per week, compared to an increase of 1.88 WCPM per week during the intervention phase.

Participant 2

During the baseline phase, Participant 2 read an average of 43.3 WCPM, with a range of 30 to 53 WCPM across all assessment dates. The median number of WCPM was 43. During the intervention phase, he read an average of 58.9 WCPM, with a range of 47 to 66 WCPM. The median number of WCPM was 60.5. From the baseline to the intervention phase, his oral reading fluency increased by 15.5 WCPM. The trend line for his oral reading fluency during the baseline phase indicated a slope of -0.08. During the intervention phase, his trend line was in the positive direction, with a slope of 0.09, which indicates a slight increase in the trend of the oral reading fluency data. The effects of change were latent. According to Participant 2's data, containing twelve data points during the intervention phase, nine points were above the highest baseline point of 53 WCPM, resulting in a PND of 75%. During both the baseline and intervention phases, his data were slightly variable, becoming less inconsistent during the last half of the intervention phase. Participant 2's baseline growth rate was -0.5 WCPM, while his intervention phase growth rate was 0.75 per week.

Participant 3

During the baseline phase, Participant 3 read an average of 38.7 WCPM, with a range of 26 to 51 WCPM during the baseline phase. The median number of WCPM was 40. During the intervention phase, he read an average of 50.4 WCPM, with a range from 31 to 74 WCPM. The median number of WCPM was 52.5. From the baseline to the intervention phase, his oral reading

fluency increased by 11.7 WCPM. During the baseline phase, the slope of his trend line was -0.12. His trend line for the intervention phase is in the positive direction, with a slope of 0.63. The effects of change during the intervention phase were immediate. According to Participant 3's data, containing ten data points during the intervention phase, five points were above the highest baseline point of 51 WCPM, resulting in a PND of 50%. During both the baseline and intervention phases, his data were inconsistent and variable. During the baseline phase, Participant 3's growth rate was -1.4 WCPM per week, whereas his intervention phase growth rate was 4.5 WCPM per week.

According to the DIBELS Benchmarks (http://dibels.uoregon.edu/benchmark.php), all three participants fell within the "at-risk" range (i.e., less than 56 WCPM for midyear) during the baseline phase. At the conclusion of the study, Participant 1, Participant 2, and Participant 3 still fell within the "at-risk" range (i.e., less than 69 WCPM for end of year), despite an increase of 22.5, 15.5, and 11.7 words per minute, respectively. Across all participants, the *Earobics* intervention produced higher mean levels of oral reading fluency and greater rates of growth as compared to the baseline phase. Based on the data presented in Appendix A, the study resulted in an average of $R^2 = 0.29$, which is a large effect, and a PND = 70%.

Effect on On-task Behavior

Participant 1

During the baseline phase, Participant 1's on-task behavior was noted during an average of 68% of observed intervals, with observations indicating behavior ranging from 43 to 91% on-task. During the intervention phase, he was observed to be on-task during an average of 94% of the intervals, with observations ranging from 83 to 100% on-task, indicating a 26% increase from the baseline to intervention phase. His data resulted in a PND of 91%. In the baseline

phase, considerable variability in the data was observed, while the variability of his data decreased in the intervention phase.

Participant 2

During the baseline phase, Participant 2's on-task behavior measured an average of 40.6% during the observation intervals, with individual observations ranging from 28 to 52% on-task. During the intervention phase, his on-task behavior was observed an average of 88.9% of the time, with observations ranging from 78 to 97% on-task. This demonstrated a 48.3% increase from baseline to intervention phase. His data resulted in a PND of 100%. Between the baseline and intervention phases, there was no significant change in variability.

Participant 3

During the baseline phase, Participant 3's on-task behavior was observed an average of 18.5% of the intervals. The observations indicated on-task behavior ranging from 7 to 25% on-task during observed intervals. During the intervention phase, his on-task behavior was measured during an average of 95.6% of the intervals, and ranged from 92 to 98% on-task, indicating a 77.1% increase from baseline to intervention phase. His data resulted in a PND of 100%. Between the baseline and intervention phases, there was no significant change in variability.

Across each of the participants, on-task behavior increased significantly and immediately following the introduction of the intervention, as compared to the baseline phase. On average, each participant's on-task behavior increased 50% after intervention implementation, with an average PND = 97%. Immediate improvement was observed across all three participants when intervention was initiated.

CHAPTER IV: DISCUSSION

Reading is a critical skill for young students to acquire in order to be successful during their years in formal schooling. Often children with attention problems experience considerable academic difficulties, specifically reading problems. Typical interventions for students with attention problems include peer tutoring, task and instructional modifications, and strategy training. Although, not much research has focused on the effectiveness of computer assisted interventions for students with significant attention problems, a few studies have demonstrated evidence of positive effects of CAI programs.

The current study was conducted in order to examine the effectiveness of *Earobics*, an evidence-based computer assisted early reading intervention, on student's oral reading fluency and on-task behavior. The *Earobics* intervention was implemented with three second-grade students at the same elementary school. This program was utilized in order to address not only reading difficulties, but also significant attention problems. Principle design elements of the intervention simultaneously increase on-task attention while providing direct instruction in fundamental literacy skills.

From the results obtained, each of the participants benefited from the intervention, with each participant's on-task behavior and oral reading fluency increasing from the baseline to intervention phase, which supported both of the hypotheses. During the intervention phase, on-task behavior increased dramatically and immediately across participants after introduction of the computerized intervention, as compared to the baseline phase. The increases from baseline to intervention phases across all participants for on-task behavior suggest that the participants were significantly more engaged during the intervention sessions when compared to small group reading instruction.

Oral reading fluency increased for each participant only after the *Earobics* intervention was introduced, providing evidence that the intervention was effective in changing participant's reading outcomes. According to Fuchs et al. (1993), the expected growth rates for second grade students on the oral reading fluency measure is an increase in 1.5 to 2 WCPM per week. This increase is reflective of the student reading the same words at a faster pace after each subsequent week. Each of the participants in the study evidenced increases in growth rates across phases. Participants 2 and 3 both demonstrated a diminished growth rate during the baseline phase, but an adequate growth rate during the intervention phase, with Participant 3 demonstrating an unexpected growth rate of 4.5 words per week increase. Participant 1 began with a slow increase per week, but exhibited a noticeable improvement in growth during the intervention phase. These growth rates offer support that the intervention was effective in increasing the reading oral fluency of the participants in the study and demonstrate a change between the baseline and intervention phases for each of the participants.

From the results of the regression statistics, the data resulted in a large effect according to Cohen (1988). However, this statistic has been scrutinized as having questionable interpretability, and researchers have speculated that most data within research do not meet assumptions for parametric analyses (Riley-Tillman & Burns, 2009). According to the percentage of nonoverlapping data (PND) statistic, the average effect size across participants did not meet the requirement for a large effect size. Nevertheless, the oral reading fluency performance for each participant only increased after implementation of the intervention, suggesting that the intervention was effective in increasing oral reading fluency. Overall, the results indicate that the *Earobics* intervention was effective in increasing oral reading fluency as well as on-task behavior during reading instruction.

The results from the present study suggest that the intervention was successful in maintaining the attention of the participants and keeping them engaged to instruction during the computerized literacy intervention. These results provide evidence of treatment fidelity that the participants were observed to be highly engaged during the interaction with the *Earobics* program. Moreover, the results of the study indicate that the *Earobics* computerized literacy intervention was effective in increasing the on-task behavior and oral reading fluency of each of the three participants recruited. Visual analysis of the multiple baseline graphs reveal that for each of the participants the oral reading fluency and on-task behavior increased significantly only after the introduction of the computerized intervention. Although each of the participants still fell within the "at-risk" range for oral reading fluency, they each made gains when the means and trend lines of the phases were analyzed. In addition, the growth rates in words increased per week improved across all participants in the intervention phase compared to baseline phase. Fuchs et al. (1993) suggested that the expected growth rate for students in 2nd grade is 1.5 to 2 WCPM and each of the participants demonstrated this expected rate of growth in the intervention phase. These results provide evidence of intervention effectiveness and demonstrate that the *Earobics* program is a promising intervention for young children with reading and attention difficulties.

These findings extend work from previous investigations and are consistent with the results found by McDuffy (2009), who found that three first graders who had engaged in the *Earobics* computer assisted intervention demonstrated increases in both letter naming fluency and oral reading fluency after the intervention was introduced. Each participant's on-task attention increased during intervention sessions when compared to small-group reading instruction observations during the baseline phase. This provides evidence that the improved on-

task behavior and oral reading fluency were due to the engaging literacy intervention. The findings from the current study also support those of Clarfield and Stoner (2005), who found that *Headsprout*, a computerized reading program, was an effective intervention for three students diagnosed with ADHD in improving oral reading fluency and task engagement. The results from the current study add to those of previous studies suggesting that computerized interventions are promising strategies for students with attention problems and academic difficulties, specifically in the area of reading. Due to the engaging elements inherent in the program, the intervention was successful in maintaining the attention of the participants during the reading intervention, increasing the likelihood of observing improvements in the reading outcome measure.

Limitations and Directions for Future Research

Limitations of the current study were the lack of a treatment integrity measure for teacher-implemented intervention sessions and unforeseen technical difficulties with the computer and program. A potential threat to this study was whether or not the intervention was properly implemented, or lack of treatment integrity. Because the researchers did not implement the intervention themselves each day of the week but rather relied on the teachers to be the interventionist two days a week, there was a need for a treatment integrity measure to ensure the proper implementation of the intervention on the days the primary researcher was not present. To address this, a graduate student observed the treatment implementation, and also administered a measure of on-task behavior during the intervention two days a week. Although asked to do so, the teachers did not consistently record the days and amount of time the students spent participating in the intervention program on days that the teacher acted as interventionist. Therefore, it is difficult to determine if the students actually received the full four days of intervention each week. If the students were only receiving the intervention twice a week, solely

on days that the primary researcher was the interventionist, it would be expected that the oral reading fluency rates of the participants would be lower than if it had been implemented with greater intensity and integrity.

Another limitation or threat to internal validity is that the author served as the primary and only observer. In future studies, a second rater could be used in order to calculate interrater reliability for systematic direct observations. Despite these limitations, results from the current study suggest that the *Earobics* computerized reading intervention was effective in increasing the oral reading fluency and attention to task during the reading instruction sessions for three second grade boys. Hence, this specific computer assisted intervention is a promising intervention strategy for many young students who are experiencing reading difficulties and attentional problems or disorders.

Future research efforts should attempt to better account for treatment integrity, extend the length of treatment, and increase the length of time for sessions. Moreover, future studies should investigate the effects of other academic interventions using the same multiple baseline design across subjects to observe achievement outcomes for students with combined attention and reading difficulties, as well as other academic difficulties. Additional interventions that simultaneously teach reading skills and address inattention should be investigated for effectiveness in order to determine which specific interventions best address academic outcome and on-task behavior. Additional research should focus on intervention strategies designed to enhance on-task behavior, and to investigate whether these interventions produce improved academic achievement outcomes for students with attention difficulties.

Future studies investigating the utility of CAIs should consider the program's built-in progress monitoring and integrity check tools. It would be necessary to ensure that the program

is securely installed to the computer by the Information Technology specialist at the school to prevent the program from being removed each time the computers are turned off.

The computerized program could also be more effective when combined with another reading intervention or one-on-one reading as part of a multi-faceted intervention plan, and this would be another possible area for further study. The results of this and similar studies (DuPaul & Eckert, 1998; Rabiner, Malone, & CPPRG, 2004) suggest the need and utility of a multi-faceted approach to interventions that target both academic and behavioral concerns, and further investigation of later reading outcomes to observe whether or not the effects are enduring. It is evident that interventions for children with attention difficulties must address both the inattention and academic difficulties concurrently and would need to be more intensive than interventions for children with only reading problems or only attention problems. The combination of the two difficulties makes it crucial to find effective interventions that target both problems with an appropriate level of intensity in order to be effective in causing change in behavior. These interventions should be identified and subsequently used frequently as appropriate with this population of students studied.

Implications and Conclusions

If an effective early intervention strategy is proven to have utility with this targeted population of students and is implemented as needed, many children will be prevented from falling behind their peers with regards to literacy skill development and will be less likely to get referred to receive special services. In order to accomplish this, children who are at risk for reading difficulties must be identified, using various screening tools that are effective and appropriate to use with school-age children, before they are subjected to the negative effects of reading failure.

Teachers and other early education and reading specialists should be educated about the importance of beginning reading as well as the activities and interventions that promote learning and skilled reading acquisition. The most vital objective for elementary school teachers should be to ensure that their students are promoted having gained the valuable, essential experiences that will help them to be successful, skilled readers early in their education. It is especially important to expose children to print early in their development to set the foundation for becoming successful readers. There is a clear need for more research in this area in order to better understand the effects of a computerized intervention on a student‘s reading achievement.

Increases in oral reading fluency is an important outcome given that improved accuracy and fluency with written text provides the ability for readers to focus their attention on the comprehension and meaning of the text, which is an increasingly critical skill as the student progresses through schooling. The ability to effortlessly translate letters to sounds and combinations of sounds to words allows readers to decode automatically without conscious effort. The principle goal of the *Earobics* program is to explicitly and systematically teach these skills in a format that is appealing and maintains the attention of young students, while providing an individualized instructional format with high success rates and many opportunities to respond.

Implications for school psychologists and educators include additional evidence that the *Earobics* program is a research-based intervention that can be utilized by teachers, reading specialists, and speech-language pathologists within the classroom. Providing children with evidence-based interventions is essential in order to ensure that students are receiving interventions that have shown effectiveness for the purpose for which they are intended. A major role of school psychologists in particular is to evaluate academic and behavioral interventions and to present these interventions to teachers. For students with reading and attention problems,

specifically, this intervention has shown promise to increase their oral reading fluency as well as on-task behavior.

Results from this study suggest that the *Earobics* intervention is effective for students with attention problems, which builds on the results from other studies, such as Clarfield and Stoner's (2005) study, in which a computerized intervention was successful for students with ADHD. School psychologists and educators have a responsibility to seek out and provide students with effective interventions and reinforce elements taught in order for them to experience educational success. The *Earobics* intervention has been shown in several studies to be successful in improving reading and behavior outcomes, and therefore is a valuable intervention to include in any educator's repertoire of interventions to use with students who exhibit reading and attention difficulties in the classroom.

Overall, the results from this study indicate the potential of computer assisted interventions directly on the academic outcomes and indirectly on the behavioral outcomes of children with attention problems. Few studies have investigated the effectiveness of computerized interventions on academic outcomes of students with inattention. This study contributes to the growing literature relating to effects of interventions on academic and behavioral performance of children with attention problems, and specifically those that are computer-based.

REFERENCES

Adams, M. J. (1990). Beginning to read: Thinking and learning about print. Cambridge, MA: MIT Press.

American Psychiatric Association. (2000). *Diagnostic and statistical manual of mental disorders* (4th ed., Text Revision). Washington, DC: Author

Askov, E. N., Weidler, S. D., & Maclay, C. M. (1985). Single-subject, multiple-baseline designs in evaluating adult literacy programs. Paper presented at the National Adult Education Conference (Milwaukee, WI, November 1985).

Alexander, K. L., & Entwisle, D. R. (1996). Schools and children at risk. In A. Booth, & J. F. Dunn (Eds.). Family-school links: How do they affect educational outcomes? pp. 67-89. Mahway, NJ: Erlbaum.

Barkley, R. A. (1997). Behavioral inhibition, sustained attention, and executive functions: Constructing a unifying theory of ADHD. *Psychological Bulletin, 121*(1), 65-94. doi:10.1037/0033-2909.121.1.65

Barkley, R. A., DuPaul, G. L., & McMurray, M. B. (1990). A comprehensive evaluation of attention deficit disorder with and without hyperactivity. *Journal of Consulting and Clinical Psychology, 58,* 775-789. doi:10.1037/0022-006X.58.6.775

Bental, B., & Tirosh, E. (1997). The relationship between attention, executive functions and reading domain abilities in attention deficit hyperactivity disorder and reading disorder: a comparative study. *Journal of Child Psychology and Psychiatry, 48*(5), 455-463. doi:10.1111/j.1469-7610.2006.01710.x

Browder, D. M., Ahlgrim-Delzell, L., Courtade, G., Gibbs, S. L., & Flowers, C. (2008). Evaluation of the effectiveness of an early literacy program for students with significant

developmental disabilities. *Exceptional Children, 75*, 33-52.

Bruck, M. (1992). Persistence of dyslexics' phonological awareness deficits. *Developmental Psychology, 28*, 874–886. doi:10.1037/0012-1649.28.5.874

Carroll, J. M., Maughan, B., Goodman, R., & and Meltzer, H. (2005). Literacy difficulties and psychiatric disorders: Evidence for comorbidity. *Journal of Child Psychology and Psychiatry, 46*, 524–532. doi:10.1111/j.1469-7610.2004.00366.x

Chall, J. S., Jacobs, V., & Baldwin, L. (1990). *The reading crisis: Why poor children fall behind.* Cambridge, MA: Harvard University Press.

Clarfield, J., & Stoner, G. (2005). The effects of computerized reading instruction on the academic performance of students identified with ADHD. *School Psychology Review, 34*(2), 246-254.

Cohen (1988). *Statistical power analysis for the behavioral sciences* (2nd ed.). Hillsdale, NJ: Erlbaum.

Diehl, S. F. (1999). Listen and learn? A software review of *Earobics*®. *Language, Speech, and Hearing Services in Schools, 30*, 108-116.

Discovery Education (2010). Review Corner: Best Educational Software. *Earobics Step 2.* Retrieved May 2, 2009, from http://school.discoveryeducation.com/parents/reviewcorner/software/*Earobics*2.html.

DuPaul, G. J. (2007). School-based interventions for students with Attention Deficit Hyperactivity Disorder: Current status and future directions. *School Psychology Review, 36*, 183-194.

DuPaul, G. J., & Eckert, T. L. (1998). Academic interventions for students with attention-deficit/hyperactivity disorder: A review of the literature. *Reading & Writing Quarterly,*

14(1), 59-82. doi:10.1080/1057356980140104

DuPaul, G. I., & Stoner, G. (2003). *ADHD in the schools: Assessment and intervention strategies* (2nd ed.). New York: Guilford.

DuPaul, G. J., & Weyandt, L. L. (2006). School-based intervention for children with Attention Deficit Hyperactivity Disorder: Effects on academic, social, and behavioral functioning. *International Journal of Disability, Development and Education, 53,* 161–176. doi:10.1080/10349120600716141

Farver, J. M., Nakamoto, J., & Lonigan, C. J. (2007). Assessing preschoolers' emergent literacy skills in English and Spanish with the Get Ready to Read! screening tool. *Annals of Dyslexia*, *57*(2): 161-178. doi:10.1007/s11881-007-0007-9

Ford, M. J., Poe, V., & Cox, J. (1993). Attending behaviors of ADHD children in math and reading using various types of software. *Journal of Computing in Childhood Education, 4*, 183-196.

Fuchs, L. S., Fuchs, D., Hamlett, C. L., Walz, L., & Germann, G. (1993). Formative evaluation of academic progress: How much growth can we expect? *School Psychology Review*, *22*, 27-49.

Good, R. H., & Kaminski, R. A. (Eds.) (2002). Dynamic indicators of basic early literacy skills (6th ed.). Eugene, OR: Institute for the Development of Educational Achievement. Retrieved May 2, 2009, from http://www.dibels.uoregon.edu

Juel, C. (1988). Learning to read and write: A longitudinal study of 54 children from first through fourth grades. *Journal of Educational Psychology*, *80,* 217–234. doi:10.1037/0022-0663.80.4.437

Lonigan, C. J. (2006). Development, assessment, and promotion of preliteracy skills. *Early*

Education and Development, 17(1), 91-114. doi:10.1207/s15566935eed1701_5

Lonigan, C. J., Burgess, S. R., & Anthony, J. L. (2000). Development of emergent literacy and early reading skills in preschool children: Evidence from a latent variable longitudinal study. *Developmental Psychology, 36,* 596–613. doi:10.1037/0012-1649.36.5.596

Maguin, E., & Loeber, R. (1996). Academic performance and delinquency. *Crime and Justice: A Review of Research, 20,* 145-264. doi:0192-3234/96/0020-0003

Mautone, J. A., DuPaul, G. J., & Jitendra, A. K. (2005). The effects of computer-assisted instruction on the mathematics performance and classroom behavior of children with attention-deficit/hyperactivity disorder. *Journal of Attention Disorders, 8,* 301-312. doi:10.1177/1087054705278832

McDuffy, K. (2009). Effectiveness of a Computer Literacy Intervention for Young Children with Attention and Reading Problems. (Master's Thesis). East Carolina University, Greenville, NC.

Morgan, P. L., Farkas, G., Tufis, P. A., & Sperling, R. A. (2008). Are reading and behavior problems risk factors for each other? *Journal of Learning Disabilities, 41*(5), 417-436. doi:10.1177/0022219408321123

National Reading Panel (2000). *Report of the National Reading Panel: Teaching children to read*. Washington, DC: U.S. Department of Health and Human Services.

Ota, K. R., & DuPaul, G. J. (2002). Task performance and mathematics performance in children with attention-deficit hyperactivity disorder: effects of supplemental computer instruction. *School Psychology Quarterly, 17*, 242-257. doi:10.1521/scpq.17.3.242.20881

Pokorni, J. L., Worthington, C. K., & Jamison, P. J. (2004). Phonological awareness intervention: Comparison of Fast ForWord, *Earobics,* and LiPS. *Journal of Educational*

Research, 97(3), 147-158). doi:10.3200/JOER.97.3.147-158

Rabiner, D. L., Coie, J. D., & Conduct Problems Prevention Research Group (2000). Early attention problems and children's reading achievement: A longitudinal investigation. *Journal of the American Academy of Child and Adolescent Psychiatry, 39,* 859-867. doi:10.1097/00004583-200007000-00014

Rabiner, D. L., Malone, P. S., & Conduct Problems Prevention Research Group (2004). The impact of tutoring on early reading achievement for children with and without attention problems. *Journal of Abnormal Child Psychology, 32*(3), 273-284. doi:0091-0627/04/0600-0273/0

Reynolds, C. R., & Kamphaus, R. W. (2004). *Behavior Assessment System for Children* (2nd ed.). Bloomington, MN: Pearson Assessments.

Riley-Tillman, T. C., & Burns, M. K. (2009). *Evaluating educational interventions: Single-case design for measuring response to intervention*. New York: Guilford Press.

Rowe, K. J., & Rowe, K. S. (1992). The relationship between inattentiveness in the classroom and reading achievement (Part B): An explanatory study. *Journal of the American Academy of Child and Adolescent Psychiatry, 31,* 357-368. doi:10.1097/00004583-199203000-00025

Scruggs, T. E., & Mastropieri, M. A. (1998). Summarizing single-subject research: Issues and applications. *Behavior Modification, 22,* 221-242. doi:10.1177/01454455980223001

Shaywitz, S. E., Fletcher, J. M., Holahan, J. M., Schneider, A. E., Marchione, K. E., Stuebing, K. K., et al. (1999). Persistence of dyslexia: The Connecticut longitudinal study at adolescence. *Pediatrics, 104,* 1351–1359. doi:10.1542/peds.104.6.1351

Shaywitz, S. E., & Shaywitz, B. A. (2008). Paying attention to reading: The neurobiology of

reading and dyslexia. *Development and Psychopathology, 20*, 1329-1349. doi:10.1017/S0954579408000631

Snow, C. E., Burns, M. S., & Griffin, P. (Eds.) (1998). *Preventing reading difficulties in young children*. Washington, DC: National Academy Press.

Spira, E. G., & Fischel, J. E. (2005). The impact of preschool inattention, hyperactivity, and impulsivity on social and academic development: A review. *Journal of Child Psychology and Psychiatry, 46*, 755-773. doi:10.1111/j.1469-7610.2005.01466.x

Stanovich, K. E. (1986). Matthew effects in reading: Some consequences of individual differences in the acquisition of literacy. *Reading Research Quarterly, 21*, 360-407. doi:10.1598/RRQ.21.4.1

Torgesen, J. K. (2002a). The prevention of reading disabilities. *Journal of School Psychology, 40*, 7-26. doi:10.1016/S0022-4405(01)00092-9

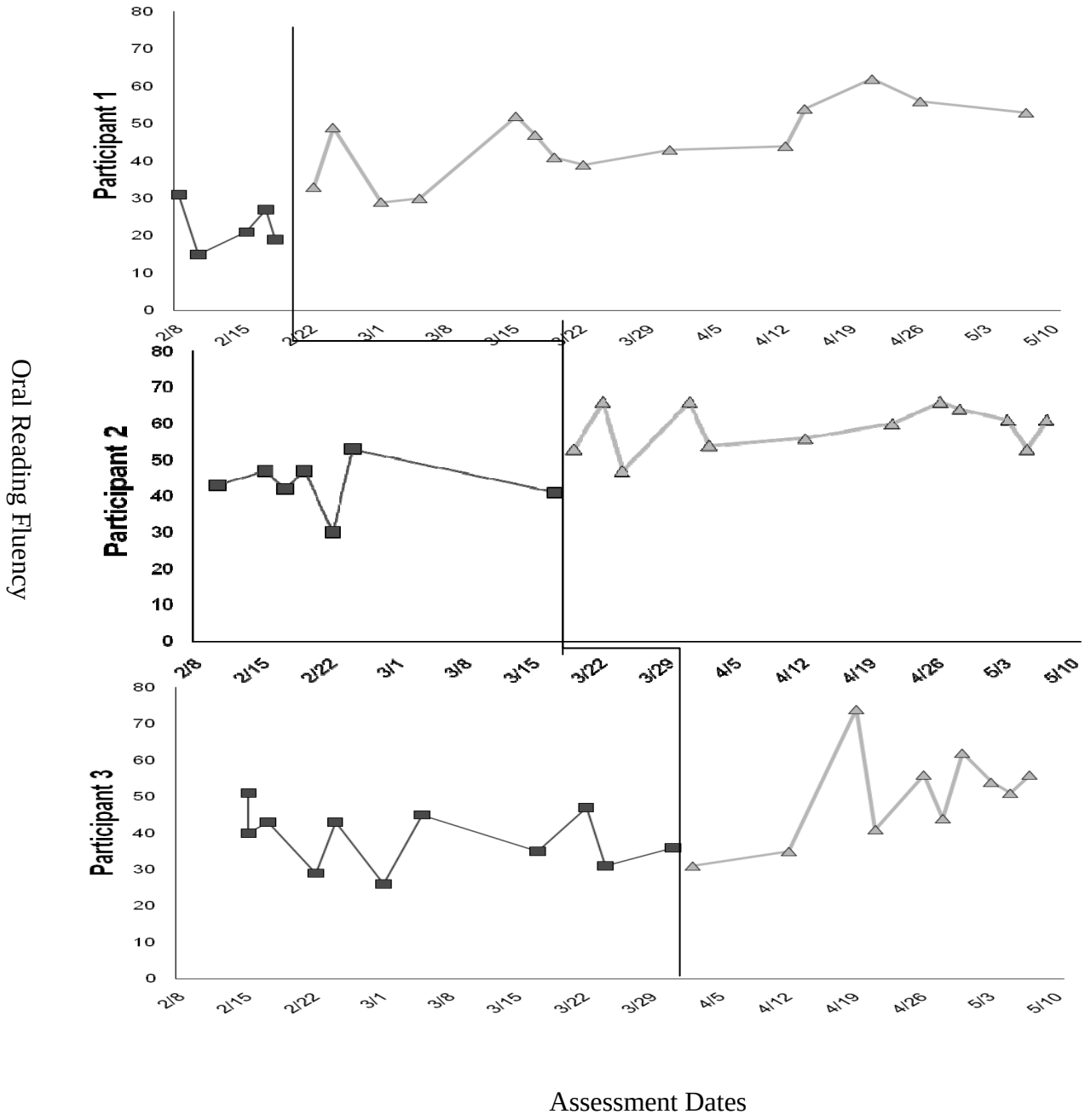
Torgesen, J. K. (2002b). Lessons learned from intervention research in reading: A way to go before we rest. In R. Stanthorp & P. Tomlinson (Eds.). *Learning and teaching reading* (pp. 89-104). *British Journal of Educational Psychology Monograph Series II, No. 1.*

Torgesen, J. K., Wagner, R. K., & Rashotte, C. A. (1994). Longitudinal studies of phonological processing and reading. *Journal of Learning Disabilities, 27*, 276–286. doi:10.1177/002221949402700503

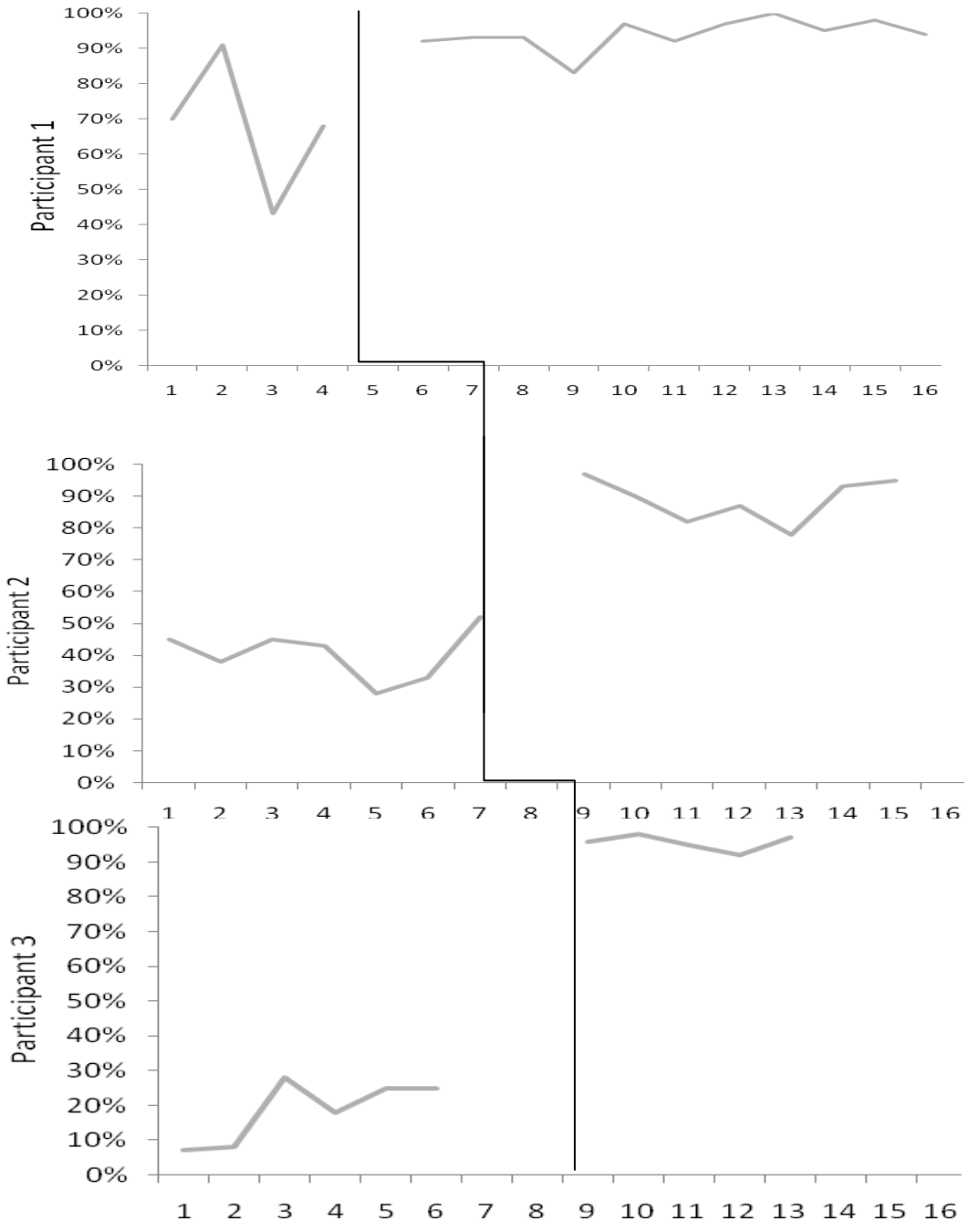
Walcott, C. M., Scheemaker, A., & Bielski, K. (2009). Research brief: a longitudinal investigation of inattention and preliteracy development. *Journal of Attention Disorders*. doi:10.1177/1087054709333330

What Works Clearinghouse (2009). *Earobics. What works clearinghouse intervention report.* Rockville, MD: *U.S. Department of Education Institute of Education Services*.

APPENDIX A: MULTIPLE BASELINE ORAL READING FLUENCY RESULTS



APPENDIX B: MULTIPLE BASELINE ON-TASK BEHAVIOR RESULTS



APPENDIX C: INFORMED CONSENT FORM

PARENT CONSENT FORM

Effectiveness of a Computer Literacy Intervention for Young Children

Your child is invited to take part in a research study on reading development supervised by Dr. Walcott, an ECU Professor, and conducted by two students in the Department of Psychology at ECU.

WHAT IS THE PURPOSE OF THIS STUDY?

The purpose of this study is to examine the relationship between specific types of reading skills and levels of inattention among children.

WHY WERE YOU SELECTED?

Your child is being invited to participate in this research study because his or her teacher thought your child would benefit from extra literacy instruction.

WHAT WILL BE DONE IN THIS STUDY?

If you consent for your child to participate, we will first ask his/her teacher to complete a behavior rating scale to measure attention skills, and we will observe him/her during regular small-group reading instruction for about one week to measure his/her level of attention during reading activities. Next, we will ask your child to do a computer-based reading intervention called *Earobics*® with a graduate or undergraduate student in Psychology. Your child will do the reading intervention four times a week: two days per week with the student, and two days per week with your child's teacher. Your child will do the computer-based reading program for 20 minutes each day for a period of about 6 weeks. Each time your child uses the computer reading program with the student, his or her level of attention will be measured by simply marking whether he or she appears or does not appear to be engaged in the program. In addition, your child will be given the short, two-minute literacy measure. This measure will help us to monitor your child's reading progress.

Description of Reading Intervention:

Earobics® is interactive software for children that provides individualized, explicit instruction in early literacy skills, including recognizing and blending sounds, rhyming, and discriminating phonemes within words. The program uses colorful and friendly cartoon characters that instruct students in how to complete the interactive exercises. The program contains a beginner, intermediate, and advanced level. As your child

answers each question, the exercises automatically adjust to his/her individual level of ability, and this adaptive technology helps to minimize your child's frustration. Your child will likely find this type of reading instruction fun and engaging because it has a game-like format. We will ensure that your child receives this reading program during his/her regular reading instruction so that he/she does not miss instructional time in other important subjects.

Description of Literacy Measures:

DIBELS Oral Reading Fluency: This is a measure of your child's accuracy and fluency in reading. It is a strong predictor of future reading performance. In this measure, the child is asked to read a grade-appropriate passage for one-minute and the number of words read correctly in one minute is determined.

ARE THERE ANY BENEFITS FOR PARTICIPATING IN THIS STUDY?

Participating in this reading intervention may help your child gain essential reading skills. Even if you do not think your child has significant reading problems, extra intervention can help to build reading fluency. Collecting this data will help us to better understand the relationship between inattention and development of reading skills in school-age children. Also, after collecting the data, we can share the reading results with your child's teacher.

WHAT ARE THE POSSIBLE RISKS OR DISCOMFORTS OF THE STUDY?

The tasks are academic in nature, so we do not anticipate any serious risks for the children who participate. The only possible minor risk is that the child may become frustrated if he/she finds the task to be difficult. However, the computer-based reading program is designed to automatically adjust to your child's reading ability in order to minimize frustration. In addition, the computer program is designed to teach reading skills with a fun and engaging game-like format.

WHO HAS ACCESS TO RECORDS?

The only people that will have access to the records are the researchers in the study, except for the reading results, which we will share with the children's teachers.

WHAT IF I WISH TO WITHDRAW OR NOT PARTICIPATE IN THE STUDY?

Participation in this study is voluntary, and you or your child can refuse to participate or withdraw at any time without penalty.

WHAT IF I HAVE QUESTIONS ABOUT THIS STUDY OR MY RIGHTS AS A PARTICIPANT?

If you have any particular questions about this study, please contact the investigator, Christy M. Walcott, Ph.D. by phone: (252) 328-1378, e-mail: walcottc@ecu.edu, or regular mail: 104 Rawl Bldg., ECU-Department of Psychology, Greenville, NC 27858.

If you have questions or concerns regarding your rights as a study participant, or are dissatisfied at any time with any aspect of this study, you may contact – anonymously if you wish – the ECU University and Medical Center Institutional Review Board at (252) 744-2914, e-mail: umcirb@ecu.edu, or regular mail: University and Medical Center Institutional Review Board, Life Sciences Building, Room 104, The Brody School of Medicine at East Carolina University, Greenville, NC 27834.

AUTHORIZATION

By signing below, you are agreeing to let your child _____ participate in the project called "**Effectiveness of a Computer Literacy Intervention for Young Children**" as described above.

Parent's Signature _____ Date _____

Parent's Name (please print) _____

Thank you and please return this part of the form to your child's teacher using the enclosed envelope addressed to Christy Walcott or Amanda Bostian.

APPENDIX D: IRB APPROVAL FORM

University and Medical Center Institutional Review Board
East Carolina University • Brody School of Medicine
600 Moye Boulevard • Old Health Sciences Library, Room 1L-09 • Greenville, NC 27834
Office **252-744-2914** • Fax **252-744-2284** • **www.ecu.edu/irb**
Chair and Director of Biomedical IRB: L. Wiley Nifong, MD
Chair and Director of Behavioral and Social Science IRB: Susan L. McCammon, PhD

04/13/2010 Corrected Letter – UMCIRB # Corrected

TO: Christy Walcott, PhD, Dept of Psychology, ECU—104 Rawl Building

FROM: UMCIRB KWB

DATE: January 8, 2010

RE: Expedited Continuing Review of a Research Study

TITLE: "Effectiveness of a Computer Literacy Intervention for Young Children"

UMCIRB #08-0771

The above referenced research study was initially reviewed and approved by expedited review on 2.6.09. This research study has undergone a subsequent continuing review using expedited review on 1.6.10. This research study is eligible for expedited review because it is a research on individual or group characteristics or behavior (including, but not limited to, research on perception, cognition, motivation, identity, language, communication, cultural beliefs or practices, and social behavior) or research employing survey, interview, oral history, focus group, program evaluation, human factors evaluation, or quality assurance methodologies. (NOTE: Some research in this category may be exempt from the HHS regulations for the protection of human subjects. 45 CFR 46.101(b)(2) and (b)(3). This listing refers only to research that is not exempt.). The Chairperson (or designee) deemed this **unfunded** study **no more than minimal risk** requiring a continuing review in **12 months**. Changes to this approved research may not be initiated without UMCIRB review except when necessary to eliminate an apparent immediate hazard to the participant. All unanticipated problems involving risks to participants and others must be promptly reported to the UMCIRB. The investigator must submit a continuing review/closure application to the UMCIRB prior to the date of study expiration. The investigator must adhere to all reporting requirements for this study.

The above referenced research study has been given approval for the period of **1.6.10** to **1.5.11**. The approval includes the following items:

- Continuing Review Form (dated 12.10.09)
- Informed Consent Document (dated 12.10.09)

The Chairperson (or designee) does not have a conflict of interest on this study.

The UMCIRB applies 45 CFR 46, Subparts A-D, to all research reviewed by the UMCIRB regardless of the funding source. 21 CFR 50 and 21 CFR 56 are applied to all research studies under the Food and Drug Administration regulation. The UMCIRB follows applicable International Conference on Harmonisation Good Clinical Practice guidelines.