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The Use of a Repeated Readings with Computer Modeling Treatment Package to Promote Reading Fluency with Students Who Have Physical Disabilities

Marion Elizabeth Coleman

ACCEPTANCE PAGE

This dissertation, THE USE OF A REPEATED READINGS WITH COMPUTER MODELING TREATMENT PACKAGE TO PROMOTE READING FLUENCY WITH STUDENTS WHO HAVE PHYSICAL DISABILITIES by MARION ELIZABETH COLEMAN, was prepared under the direction of the candidate's Dissertation Advisory Committee. It is accepted by the committee members in partial fulfillment of the requirements for the degree Doctor of Philosophy in the College of Education, Georgia State University.

The Dissertation Advisory Committee and the student's Department Chair, as representatives of the faculty, certify that this dissertation has met all standards of excellence and scholarship as determined by the faculty. The Dean of the College of Education concurs.

_____
Kathryn Wolff Heller, Ph.D.
Committee Chair

_____
Paul A. Alberto, Ph.D.
Committee Member

_____
Mary Beth Calhoon, Ph.D.
Committee Member

_____
Laura D. Fredrick, Ph.D.
Committee Member

_____
Date

_____
Peggy A. Gallagher, Ph.D.
Chair, Department of Educational Psychology and Special Education

_____
Randy W. Kamphaus, Ph.D.
Dean and Distinguished Research Professor
College of Education

AUTHOR'S STATEMENT

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Marion Elizabeth Coleman
135 Lacey Oak Lane
Loganville, GA 30052

The director of this dissertation is:

Dr. Kathryn Wolff Heller
Department of Educational Psychology and Special Education
College of Education
Georgia State University
Atlanta, GA 30302-3979

VITA

Marion (Mari Beth) Coleman
135 Lacey Oak Lane
Loganville, GA 30052
678-442-1875
Email: mari.beth@yahoo.com

EDUCATION

Ph.D.	2008	Georgia State University Education of Students with Exceptionalities
M.Ed.	1999	University of Georgia Multiple and Severe Disabilities
B.A.	1988	University of Georgia Psychology

PROFESSIONAL EXPERIENCES

2005 – Present	Clinical Instructor, Georgia State University
2004-2005	Assistant Project Director of the Georgia Bureau for Students with Physical and Health Impairments
1998-2004	Special Education Teacher, Gwinnett County Public Schools, GA Itinerant Teacher 2003-2004 Self-Contained Classroom Teacher 1998-2003;
1992-1998	Special Education Teacher, Oglethorpe County Schools, GA Special Needs Preschool Teacher, 1996-1998 Self-Contained Classroom Teacher, 1992-1996

PUBLICATIONS

Coleman, M. B., & Heller, K. W. (in press). Assistive technology considerations. In K.W. Heller, P. Alberto, P. Forney, S. Best & M. Swartzman (Eds). *Understanding physical, health and multiple disabilities* (2nd Ed.). Merrill/Prentice-Hall.

Heller, K. W., & Coleman, M. B. (in press). Classroom adaptations for students with physical, health, & multiple disabilities. In K.W. Heller, P. Alberto, P. Forney, S. Best & M. Swartzman (Eds). *Understanding physical, health and multiple disabilities* (2nd Ed.). Merrill/Prentice-Hall.

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Coleman-Martin, M. B. & Heller, K. W. (2004). Using a modified constant prompt-delay procedure to teach spelling to students with physical disabilities. *Journal of Applied Behavior Analysis, 37,* 469-480.

NATIONAL PRESENTATIONS

Heller, K. W., & Coleman-Martin, M. B. (April, 2006). Strategies for Promoting Literacy with Students with Physical Disabilities. Presentation at the international Council for Exceptional Children conference. Salt Lake City.

Coleman-Martin, M. B., & Heller, K. W. (April, 2005). Using Computer-Assisted Instruction and the Nonverbal Reading Approach to Teach Word Identification. Presentation at the international Council for Exceptional Children conference. Baltimore.

Swinehart-Jones, D., & Coleman-Martin, M. B. (2002). Overview of the Bureau for Students with Physical and Health Impairments. Poster Session presented at International Conference for the Council for Exceptional Children, New York City.

PROFESSIONAL ORGANIZATIONS

The Council for Exceptional Children (1992 - present)
Divisions: Division for Early Childhood, Division for Developmental Disabilities, Division for Technology and Media,
Division for Physical and Health Disabilities (President-Elect, 2008 – present; Executive Board 2003- present).
Orthopedic Impairments Consortium (2004 – present).

ABSTRACT

THE USE OF A REPEATED READINGS WITH COMPUTER MODELING TREATMENT PACKAGE TO PROMOTE READING FLUENCY WITH STUDENTS WHO HAVE PHYSICAL DISABILITIES
by
Marion Elizabeth Coleman

Reading is an essential skill for students with physical disabilities which opens up opportunities in many areas of an individual's life including the acquisition of knowledge, the ability to read for enjoyment, and the chances of gaining employment. Students with physical disabilities often do not read fluently; however, there is a lack of research on instructional methods to address reading fluency with this population. Methodologies used with students who have physical disabilities are often borrowed from other populations (e.g., the use of repeated readings to increase fluency with students with learning disabilities). Additionally, advances in technology suggest the possible use of computers to model reading. This study employed a changing criterion design to examine the use of a treatment package consisting of repeated readings, computer modeling, error correction, and performance feedback on improving reading fluency with students with cerebral palsy. The areas of reading comprehension and accuracy were also examined. An analysis of the data demonstrated that all students were able to increase reading fluency, accuracy, and comprehension from first to final readings within a session (positive nontransfer effects). Analysis of the percentage of nonoverlapping data revealed that three of the four students also showed slight increases in reading fluency on

novel passages (positive transfer effects). Although the results of this study indicated that the treatment package was effective with students who have physical disabilities, more research is needed to examine individual components of the treatment package and to evaluate the use of such methods over a lengthier period of time.

INDEX WORDS: Physical disabilities, reading fluency, computer-assisted instruction, repeated readings, computer modeling.

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by
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CHAPTER 1

THE USE OF A REPEATED READINGS WITH COMPUTER MODELING TREATMENT PACKAGE TO PROMOTE READING FLUENCY WITH STUDENTS WHO HAVE PHYSICAL DISABILITIES: A REVIEW OF THE LITERATURE

Introduction and Purpose

Reading is a skill that is important not only for academic purposes but across all aspects of life. In today's society with so many jobs depending on the use of computers, reading skills are more necessary than ever for employment. When an individual has a physical disability which limits the possibility of performing manual tasks, reading is especially important because literacy opens up many opportunities for employment and participation in the community not otherwise available (Koppenhaver & Yoder, 1993).

One reading problem experienced by some students with physical disabilities is slow reading rate, or fluency (Heller, Coleman-Martin, & Swinehart-Jones, 2006). Students with physical disabilities often read at rates that are significantly below that of their grade level peers (Heller, Rupert, Coleman-Martin, Mezei, & Calhoon, 2007). There are several factors that may contribute to this lack of reading fluency. Some students' reading fluency is inhibited because of functional factors such as motor, cognitive, speech, and sensory limitations, fatigue and endurance, and different background experiences in reading. Psychosocial factors such as self-efficacy, motivation, and behavioral and emotional functioning may affect a student's ability to read. Finally, students with physical disabilities may experience environmental factors that inhibit reading such as decreased access to reading materials, ineffective learning environment,

and decreased expectations (Heller, Alberto, Forney, & Schwartzman, 1996; Heller et al., 2006).

Because students with physical disabilities have so many factors that may affect their reading fluency, it is important for teachers to use teaching strategies that are appropriate for each student's needs. Often, for this population, there is a need for assistive technology to maximize learning potential (Heller & Swinehart-Jones, 2003). Because there are such differences for students with physical disabilities – even two with the same medical diagnosis – combinations of strategies may be necessary to realize maximum benefits in reading fluency. Research examining reading fluency for students with physical disabilities is sparse. Therefore, the purpose of the review of the literature is to examine the impact of physical disabilities on reading fluency and possible interventions that may be beneficial to these students for increasing reading fluency. There will be a particular emphasis on computer modeling, repeated readings, error correction, and performance feedback.

Review of the Literature

Types of Physical Disabilities that Affect Reading Fluency

There are three main types of physical disabilities that could affect a student's reading performance: neuromotor impairments (e.g., cerebral palsy, spina bifida), degenerative diseases (e.g., muscular dystrophy), and musculoskeletal disorders (e.g., arthrogryposis) (Heller et al., 1996). The term orthopedic impairments is used to refer to students who have physical disabilities that affect their educational performance to the degree that they require special education services. In Georgia, this definition stipulates that the student should have cognitive functioning in the mild range of intellectual

disability or higher.

(http://public.doe.k12.ga.us/DMGetDocument.aspx/exceptional_eligibility_oi.pdf?p=4BE1EECF99CD364EA5554055463F1FBBF5D074D5FB1F2CAEB3B63B3ECB220CDD26C2114F3C57D8D25C69F04B76A08C8D&Type=D). Two of the most common physical disabilities of students served in programs for orthopedic impairments are cerebral palsy and spina bifida. Each of these disabilities may affect a student's reading ability.

Cerebral palsy is a nonprogressive movement disorder which is the result of damage to the motor centers of the brain that occurs during the prenatal or perinatal phases of the birth process or during the first few years of life (Heller et al., 1996). Because the nature of this disability is related to impairments in fine and gross motor abilities and often there are concomitant disabilities (such as sensory, cognitive, learning, or speech impairments), cerebral palsy may severely impact reading performance.

The most common types of cerebral palsy are spastic, athetoid, and ataxic. Often, individuals will have mixed cerebral palsy where they have characteristics of more than one type. Each type of cerebral palsy results in movement difficulties that may decrease access to reading materials. Spastic cerebral palsy is an increase in muscle tone which often limits fine motor movements needed for literacy activities such as reading and writing (Best, Heller, & Bigge, 2005). This increased muscle tone may result in decreased range of motion, decreased ability to control hand movements, and contractures, or shortening of the muscles which limit arm and hand movement (Heller et al., 1996). Athetoid cerebral palsy involves uncontrolled, non-purposeful movements with fluctuations in muscle tone (Best et al., 2005). This condition often results in the

inability to control arm and hand movements and a limitation of range of motion. Ataxic cerebral palsy is characterized by shaky movements and poor balance. Students with ataxia may have trouble controlling hand movements and maintaining balance while moving their arms. All of these abnormal motor patterns can make turning pages in a book or accessing other reading materials difficult or impossible for some students.

In addition to fine motor difficulties, students with cerebral palsy often demonstrate gross motor impairments that can affect reading processes. Both spastic and athetoid cerebral palsy may result in deficient trunk control making proper positioning of the student and positioning of materials crucial for reading activities. Because of the abnormal or increased movement patterns and differences in muscle tone, students with cerebral palsy often fatigue easily or lack endurance to complete tasks during academic instruction.

In addition to the effects of fine and gross motor deficits, students with cerebral palsy often have sensory impairments, cognitive or learning impairments, or speech impairments that may affect reading. Many students with cerebral palsy have vision impairments such as strabismus or nystagmus (Heller et al., 1996). These conditions frequently impact perceptual functioning and may limit a student's ability to scan, search, and fixate on text (Junkala & Talbot, 1982).

Individuals with cerebral palsy may exhibit IQ scores from the gifted range to the range of profound mental retardation. However, more severe forms of cerebral palsy have an increased incidence of mental retardation. Students with cerebral palsy often have decreased academic achievement not explained by IQ (Dorman, Hurley, & Laatsch, 1984). Vermeer and Dekker (1993) found that children with cerebral palsy had decreased

learning potential compared to controls with physical disabilities that were not neurocognitive in nature. They also found differences within the individuals with cerebral palsy related to how much of the brain was affected. For example, students with hemiplegia (paralysis on one side of the body) performed better than students with diplegia (paralysis more significant in lower extremities). The authors believed this was related to more localized brain damage in hemiplegic cerebral palsy. Cognitive and learning impairments greatly affect reading abilities including decoding, fluency, and comprehension.

Another impairment often associated with cerebral palsy is speech impairment. Many students with cerebral palsy exhibit dysarthric, or motor-impaired, speech (Kotler & Thomas-Stonell, 1997). Dysarthria and anarthria (i.e. lack of speech) not only impact reading from the standpoint of the teacher not being able to hear what the student is reading, but also impact the student's ability to acquire phonological processing skills which are necessary for decoding (Foley & Pollatsek, 1999; Annika Dahlgren Sandberg, 2001; A. D. Sandberg & Hjelmquist, 1996).

Like cerebral palsy, spina bifida is a physical disability that may impact a student's reading performance. Spina bifida is the result of a neural tube defect during the development of an embryo that results in the outpouching of the spinal column and often the spinal cord. In the two most severe forms of spina bifida, meningocele and myelomeningocele, there is nerve damage that affects muscles, sensations, and body systems (Heller et al., 1996; Rowley-Kelly & Reigel, 1993). Spina bifida may affect reading because of decreased fine and gross motor functioning as well as cognitive and learning impairments that often are associated with spina bifida.

Depending on the level where the damage to the spinal column occurs, spina bifida may affect only the lower extremities or it may affect the arms and hands as well. If paralysis occurs in the hands and arms, students with spina bifida will have trouble accessing reading materials. Students with spina bifida may have paralysis in the trunk resulting in the need for special positioning for the student or the student's materials for reading. These students may also experience fatigue and endurance issues related to their motor impairments and mobility difficulties that impact academic performance (Franks, Palisano, & Darbee, 1991).

The majority of individuals with spina bifida have intellectual functioning within the average range of intelligence (Heller et al., 1996; Rowley-Kelly & Reigel, 1993); however, approximately one third have intellectual disabilities and many individuals with spina bifida who have an IQ in the normal range experience learning difficulties. It is suspected that these issues are related to hydrocephalus (i.e. excessive fluid on the brain) which occurs frequently in individuals with more severe forms of spina bifida. Many of the children with spina bifida receive shunts within the first few days of life to drain excess fluid from the brain into another area of the body (e.g., the peritoneum).

Individuals with spina bifida who also have hydrocephalus often have IQ scores in the average range of intelligence; however, they fall in the lower average range or below significantly more often than individuals with spina bifida without hydrocephalus and individuals without disabilities (Iddon, Morgan, Loveday, Sahakian, & Pickard, 2004). Sometimes, teachers overestimate the intelligence or achievement potential of a student with spina bifida because of the existence of pragmatic language differences (Heller et al., 1996). This is the phenomenon where these children engage in very adult-

like, socially appropriate conversations, but do not really comprehend the meanings of higher level concepts.

Students with spina bifida may exhibit a number of learning problems that can impact reading. Problems with attention, memory, visual perception, and language comprehension all may play a part in decreased reading ability (Heller et al., 1996; Rowley-Kelly & Reigel, 1993). Poor attention of students with spina bifida leads to trouble across all aspects of life from maintaining attention during a conversation to acquiring academic skills and concepts. The inability to attend to relevant information affects memory and perception and can have a tremendously negative impact on learning to read. Dennis and Barnes (2002) found young adults with spina bifida had poor phonological memory which resulted in difficulty learning functional numeracy. This can also significantly impact the ability to learn reading decoding. Students with spina bifida also have poor visual memory and memory problems tend to increase if the student has hydrocephalus. Students with spina bifida, particularly those with hydrocephalus, often have visual-perceptual problems such as difficulty with spatial relationships. This may cause trouble with print processing and lead to reading problems. Finally, language comprehension problems often occur in students with spina bifida. This not only interferes with development of background knowledge, but also with reading comprehension. All of these learning problems may play a part in decreased academic achievement for students with spina bifida (Heller et al., 1996; Rowley-Kelly & Reigel, 1993). It is characteristic for children with spina bifida to have math difficulties; however, frequently they have reading problems as well.

Specific Characteristics that Affect Reading

While cerebral palsy and spina bifida have differing affects on individuals, there are common characteristics that often impact reading for individuals with physical disabilities. Numerous functional, psychosocial, and environmental factors play a part in reading achievement for these students.

Functional limitations that can affect reading include motor limitations, restricted communication, fatigue, endurance, and pain issues, health factors, experiential and concept development deficits, neurocognitive impairments and interactional effects of additional disabilities (Heller & Swinehart-Jones, 2003). Cerebral palsy and spina bifida can affect the student's ability to access reading materials because of motor limitations. When the upper extremities are affected, manipulating books, worksheets, and other reading materials (e.g., flashcards, sentence strips, letter tiles) may be difficult or impossible. Often, alternate access to reading materials must be provided via assistive technology (e.g., computerized books) to accommodate for motor limitations.

Restricted communication may play a part in decreased reading ability. Students who have unintelligible speech or the lack of speech because of dysarthria will not be able to read aloud for the teacher to assess their progress and problems. Additionally, dysarthria and anarthria affect the ability to perform phonological processing tasks such as blending, segmenting, and manipulating speech sounds. When students are unable to perform these tasks, the process of rehearsal is impacted and may impede acquisition of reading decoding skills. Problems with language comprehension interfere with learning concepts necessary for reading comprehension such as vocabulary and grammar.

When a physical disability exists, fatigue, endurance, and pain often interfere with learning. When students must exert extra energy for mobility or for motor planning, they may tire easily and be unable to sustain long periods of activity. Many students with physical disabilities experience pain related to the physical condition, positioning or mobility equipment, physical therapy, or associated medical problems. When a student is fatigued or in pain, his ability to concentrate on reading tasks will be limited. Some students, particularly if they also have vision impairments, will experience visual fatigue when reading. Students with physical disabilities may require frequent breaks which will decrease the amount of time for reading instruction because of fatigue, the lack of endurance, and pain.

Health factors often coincide with physical disabilities. Students with cerebral palsy and spina bifida have an increased chance for seizure disorders, respiratory illnesses, decreased immunity as well as other health factors. Many times, these students take medications that can inhibit attention and alertness to academic activities. Often, these students require time away from school because of illness, medical appointments, or therapies. Individuals with spina bifida usually require catheterization which can take time away from academic instruction. They may require frequent medical visits because of shunt problems or bladder issues. Students with cerebral palsy may have Intrathecal Baclofen pumps which require appointments for refilling. Both students with cerebral palsy and spina bifida may require orthotics and mobility devices that require appointments during school hours. Additionally, the increased need for assistance and time for self-care (e.g., toileting, feeding, dressing) may take away from instructional time for students with physical disabilities.

Because students with physical disabilities often have restricted mobility when they are very young, their ability to interact with their environment may result in decreased experiences and concept development. Children learn by exploring their surroundings. When they are unable to move around freely and to manipulate toys, they may lack understanding of the surround world. Because of mobility difficulties, some parents of children with physical disabilities have trouble or do not realize the importance of exposing the child to activities such as exploring the park, playing in the dirt or grass, or going to a shopping mall. These activities build background knowledge that later allows the child to understand concepts found in books and stories. Many children with physical disabilities have trouble with reading comprehension because of this difference in concept development (Heller et al., 2006).

Neurocognitive impairments can play a part of reading problems for students with physical disabilities. As mentioned previously, there is an increased chance of intellectual functioning in the lower range of average or range of intellectual disability in individuals with cerebral palsy and spina bifida. Additionally, there is a higher incidence of learning problems related to memory, attention, and cognitive processing for people with cerebral palsy and spina bifida. Because of physical disabilities, students with physical disabilities have an increased demand for physical planning which may unbalance the cognitive load during reading activities.

Additional disabilities frequently occur with physical disabilities. As mentioned, intellectual disabilities, learning disabilities, or health impairments may add to the impact on reading for students with physical disabilities. Sensory impairments are also increased for individuals with physical disabilities. There is an increased risk of visual impairment

along with cerebral palsy and spina bifida (Heller et al., 1996; Rowley-Kelly & Reigel, 1993). Problems with visual acuity and visual perception may greatly impact a student's ability to learn how to process information through reading.

Psychosocial factors such as behavioral and emotional functioning, motivation, and self-efficacy play a large part in learning to read for students with physical disabilities. Students with physical disabilities may experience behavioral challenges because of ineffective discipline and decreased expectations because of the presence of a disability. Some individuals with physical disabilities experience lower self-concept or self-esteem which can impact performance in school and life activities (Gillian A. King, Schultz, Steel, Gilpin, & Cathers, 1993; Magill-Evans & Restall, 1991). Some children with physical disabilities do not develop appropriate social skills because of isolation or decreased social opportunities (Gillian A. King et al., 1997). This may impact their willingness to participate in reading activities such as reading in front of a teacher or the class. Self-efficacy is crucial to motivation. Many individuals with physical disabilities experience decreased feelings of self-efficacy (Tam, 2000). Self-efficacy beliefs can lead to a downward spiral for the area in which the individual does not feel adequate (Pajares, 1996). If an individual feels she is not a good reader, her motivation to read will decrease and thus, the opportunities to engage in reading and to benefit from reading experiences will decrease. This can lead to problems with reading achievement. Many students with physical disabilities experience learned helplessness because activities are done for them that they could perform. They learn that they do not have to make an attempt because if they just sit and wait, someone jumps in to perform the task for them. This learned helplessness can spread from physical to academic tasks and impact reading.

Environmental factors that may impact reading include physical barriers to accessing materials, barriers to participation, ineffective learning environments, and decreased expectations for individuals with physical disabilities. Because of limitations in gross and fine motor abilities, students with physical disabilities may experience physical barriers that impact academic performance. Accessing reading materials can be problematic for students whose upper extremities are impaired or who have positioning problems. Hemmingson and Borell (2002) found that barriers of time, place, and pace were detrimental to the participation of children with physical disabilities in mainstream classrooms. Ineffective learning environments may play a part in decreased reading skills for individuals with physical disabilities. Mike (1995) found that as little as 30 minutes per day was allocated for literacy instruction in a classroom for students with severe physical disabilities. Also, there were very little opportunities for reading connected text. Often, teachers are not trained to adequately teach literacy to students with physical disabilities because of the impact of the functional factors mentioned previously. Many states do not recognize orthopedic impairments as an area for teacher certification. Even in states which do recognize orthopedic impairments as a certification area, some school systems do not have teachers trained in this area and place the students in special education classrooms for other disability areas. Thus, many children with physical disabilities do not receive appropriate literacy instruction to meet their specific needs. Finally, some people assume that physical disability is always accompanied by intellectual disability or limited learning capacity and have decreased expectations. This may affect the way a teacher interacts with his student who has a physical disability and may ultimately reduce the student's learning in the area of reading.

There are many functional, psychosocial, and environmental factors that may have a negative impact on learning for students with physical disabilities. Each individual student may have one or a combination of these factors. Generally, the more significant the physical disability, the more factors that might impact the student's school performance and ability to acquire reading skills.

Reading

Reading processes. The ultimate purpose for reading is comprehension of text and the acquisition of information available because of this understanding. Reading involves the construction of mental representations of text such that the knowledge is stored in long term memory and is available for retrieval later (Hacker, 2004).

Ehri and McCormick (2004) discuss four stages of reading that a child must pass through to become a proficient reader. The first stage is the prealphabetic stage. During this stage, students recognize logographs and begin to develop print awareness. The second stage is partial alphabetic. During this stage, children begin to make the connection between graphemes and phonemes. Next is the full alphabetic stage. This is when students are able to apply graphophonic knowledge to decode, but require a lot of time and energy to do so such that comprehension suffers. The final stage is consolidated alphabetic where students are able to read with automaticity for decoding and are able to comprehend what they are reading. Children with physical disabilities may have difficulty reaching the consolidated alphabetic stage because of functional, psychosocial, and environmental factors. Reading fluency, or the ability to read with automaticity, is critical to the ultimate goal of comprehension. Often, reading fluency proves to be a stumbling block for students with physical disabilities (Heller et al. In print).

Reading Fluency. The National Reading Panel (National Institute of Child Health and Human Development, 2000) proposed that reading fluency has been a neglected area of reading instruction for much of the 20th century. This panel speculated that fluency instruction was neglected because researchers assumed fluency was a direct result of an individual's word recognition ability and thus did not focus on instruction in fluency itself. In the last three decades, more attention has turned back towards how instruction and experience impact reading fluency development (NICHHD, 2000). Reading fluency is often defined as "rate plus accuracy" (Archer, Gleason, & Vachon, 2003). In 1974, LaBerge and Samuels proposed a theory of automaticity in reading. This theory argued that children who struggle with decoding use up their allocated attentional resources for lower level processes; thus, they are unable to allocate adequate attention to comprehension (LaBerge & Samuels, 1974; Samuels, 2004).

The LaBerge and Samuels model proposes three memory stores: visual, phonological, and semantic. According to this model, when a word is recognized automatically, the visual word code is transferred directly to semantic memory without attention. When student encounters a difficult word for which they do not have automaticity, the spelling pattern codes that are excited in visual memory require attention in order to excite phonological codes, episodic codes and semantic codes to recognize the word. All of this attention takes away from the comprehension process (Samuels, 2004; Samuels 1997; Samuels, 2002). When a word is recognized automatically, attention is available for comprehension.

Chard, Vaughn, and Tyler (2002) propose that working memory that is clogged by slow, choppy, word-level reading prevents understanding at the content level. To

effectively comprehend, a reader must utilize cognitive and metacognitive strategies that consume attention (Hacker, 2004). If attention is allocated toward decoding, it is not available for these higher order processes (Hacker, 2004; LaBerge & Samuels, 1974). Because comprehension is the means through which information is acquired from text, it is essential to increase the reading fluency of students who read slowly to allow them to concentrate on comprehending text.

Archer et al. (2003) propose that deficits in reading fluency can create a cyclical effect whereby the struggling reader avoids reading because it is laborious, thus getting less practice which then impedes the ability to increase reading skills. This concept has been termed "Matthew effects" based on a statement in the book of Matthew in the Bible which can be summarized as "the rich get richer and the poor get poorer" (Stanovich, 2004). Stanovich (2004) states, "Children with inadequate vocabularies – who read slowly and without enjoyment – read less and, as a result, have slower development of vocabulary knowledge, which inhibits further growth in reading ability" (p. 481). Thus, fluency is tied to reading volume, reading improvement, as well as reading motivation. Reading fluency has also been linked to higher levels of work completion as well as increased general knowledge from exposure to more text (Archer et al., 2003). Therefore, it is necessary for teachers to find effective strategies to increase reading fluency for students who have not developed reading at the level of automaticity.

Reading Fluency Strategies

There are several strategies that have been used to increase reading fluency for students with and without disabilities. Often, these strategies are combined in treatment

packages. The strategies found most frequently in the literature are repeated readings, modeling, error correction, performance feedback, and reinforcement.

Repeated readings. Samuels (1979) developed the method of repeated readings as the process of rereading a short passage until increases in fluency occur. The method of repeated readings is based on the LaBerge and Samuels theory of automaticity in reading whereby the purpose is to move children to a level of automaticity in text processing. Samuels conceptualized the idea for repeated readings based on the method used by athletes and musicians in developing skill proficiency: practice on small parts until mastered. Extensive research has been done in the area of repeated readings. Numerous studies have demonstrated this method to be effective for students without disabilities and students with learning disabilities (Stout, 1997). Only one study was located that demonstrated the use of repeated readings with students with physical disabilities (Heller et al., 2007).

Modeling. Bandura (1997) proposed that children are able to learn through observing a model. Modeling is an instructional method often used for students with disabilities for instruction of tasks from basic self-care to academic instruction. Modeling has been demonstrated to be an effective strategy for increasing reading fluency. Chard et al. (2002) noted several studies that demonstrated modeling to be effective in increasing reading fluency for elementary students with learning disabilities. There are numerous issues to consider with modeling. Modeling can be done several ways. One of these is listening passage preview. In this method, the reader will listen to the entire passage prior to reading it. Another method is echo reading. This involves the teacher modeling small portions of text at a time for the student. Another way to provide modeling is through

simultaneous modeling. This involves the student and teacher reading together at the same time. Simultaneous modeling is also called unison reading or choral reading. These methods evolved from the neurological impress method which was used in the 1970s to increase reading fluency.

Modeling may be done by an adult, a peer, an audiotape, or a computer. When considering modeling as an instructional method for reading fluency, the teacher must consider rate of the model, voice quality of the model, and visual stimuli involved in the modeling process (e.g., pointing to each word or having each word highlighted by a computer model.) Peer modeling strategies are used frequently in large group fluency interventions or for students with learning disabilities (Fuchs & Fuchs,).

Modeling has been used in several studies with students without disabilities and with students with learning disabilities. Often, modeling is paired repeated readings. There is only one study available demonstrating the use of repeated readings with unison reading with students who have physical disabilities (Heller et al., 2007).

Error correction. Providing feedback to students during instruction has been demonstrated to be an important part of instruction (Barbetta, Heward, & Bradley, 1993). Different types of feedback may play a role in the instruction process. Error correction is a strategy often used with students who have developmental disabilities (Berbetta & Heward, 1993). Error correction is feedback that is used to elicit correct responding on a specific task based on errors made. Error correction may be effective in increasing reading fluency because it allows the student to recognize errors and increase their reading accuracy. Some issues to consider with error correction are the timing (immediate or delayed) as well as the type of error correction (phonetic cue or entire

word.) Barbetta et al (1993) found that immediate, whole-word error correction led to superior results as compared to delayed feedback or provision of a phonetic cue. Error correction is an efficient strategy since it requires little teaching time for the strategy itself.

Performance feedback and Reinforcement. Other strategies for increasing reading fluency are performance feedback, or charting, and reinforcement (Chafouleas, Martens, Dobson, Weinstein, & Gardner, 2004). Performance feedback is a strategy where the student is given information about his/her performance on the instructional session and is often accompanied by the student assisting in graphing his/her data. Chafouleas et al. (2004) found that for a student with lower reading abilities, performance feedback and reinforcement increased performance in fluency. Often, performance feedback is used in conjunction with a changing criterion design so that student input can be used for setting criterion levels (Nes Ferrara, 2004; Pattillo, Heller, & Smith, 2003).

Effectiveness of Reading Fluency Strategies.

There are issues surrounding the effectiveness of reading fluency strategies. Some of these issues are how fluency is measured, comprehension, and nontransfer and transfer effects. Fluency is often measured in terms of words correct per minute (wcpm). This reflects the total number of words read reduced by the number of errors and divided by the number of minutes. Some researchers determine fluent reading as having a prosody, or expressiveness, component. (Cowie, Douglas-Cowie, & Wichmann, 2002). Measurement of prosody can be problematic, however, and students with physical disabilities often exhibit different speech patterns due to breath support or motor speech impairments. Thus, this study will not consider prosody in the measurement of reading

fluency. Another issue in reading fluency is comprehension. While the goal of increasing reading fluency is to free up mental resources and increase reading comprehension (Samuels, 2004), many fluency studies do not address comprehension. The issue of nontransfer and transfer effects is most frequently discussed in light of the method of repeated readings.

Repeated readings literature. In the area of reading fluency, the method used most in the literature is the method of repeated readings. Numerous studies have examined the effects of repeated readings with a wide variety of participants. One issue to consider in repeated readings studies is whether transfer or nontransfer effects were the focus of the study. Nontransfer effects in repeated readings indicate that students were able to make progress upon each subsequent reading of the same text. So, within a session, the student's reading fluency increases from the first to the final reading. Transfer effects, however, show that generalization has occurred when a student's reading fluency on novel passages increases over time. This shows that the intervention is causing an increase in actual reading ability (Therrien, 2004).

The National Reading Panel (National Institute of Child Health and Human Development, 2000) conducted a meta-analysis of research in reading fluency. Fourteen studies were included in this meta-analysis that measured the immediate effects of repeated readings interventions with a total of 752 participants. All studies found clear improvements in reading rate, accuracy, and comprehension between first and final readings when using repeated readings. The National Reading Panel directly evaluated 16 articles using group experiments that used pretest and posttest measures of reading separate from the material used for the experiment. The National Reading Panel found

that repeated oral reading procedures yielded significant differences in all but two of the studies for word recognition and fluency. Lesser effects were found for comprehension; however, the National Reading Panel stated that "the impact of these procedures on comprehension is not inconsiderable, and in several comparison it was actually quite high" (p. 3-18). Twelve single-subject design studies were included in the National Reading Panel's analysis. Of these studies, only one did not find substantial increases in reading accuracy, speed, or comprehension. Based on the effectiveness of the studies included in their meta-analysis, the National Reading Panel concluded that "repeated readings and other procedures that have students reading passages orally multiple times while receiving guidance or feedback from peers, parents, or teachers are effective in improving a variety of reading skills" (p. 3-20). Overall, their findings indicated that repeated readings procedures help improve reading abilities in students with average reading abilities up through grade 5 and in students who experience reading difficulties until at least 9th grade.

Therrien (2004) conducted a more defined analysis of repeated readings strategies to examine the effectiveness of repeated readings, nontransfer and transfer effects with component analysis of repeated readings programs, and the effectiveness of repeated readings with students with learning disabilities. As found in the National Reading Panel's results, Therrien found that repeated readings led to large nontransfer effects on fluency and comprehension for students with and without learning disabilities. In regard to transfer effects, Therrien summarized that the method of repeated readings does have the potential to improve overall reading fluency and comprehension for students with and without learning disabilities. One interesting finding was that transfer interventions where

students read to adults were three times larger than when peers conducted the interventions. Therrien also determined that three or four readings yielded more than a 30% increase in fluency over two readings while more than four readings did not lead to significant additional gains. Studies which included corrective feedback and performance criterion in addition to repeated readings also yielded significant effect size differences. Furthermore, Therrien found when a performance criterion was used, effect sizes were four times larger than repeated readings studies that used a fixed number of readings. This suggests that providing readers with a goal may be beneficial in helping them achieve higher levels of reading fluency.

Repeated readings have been used with students with a variety of disabilities to increase reading fluency. Numerous studies have demonstrated the effectiveness of repeated readings with students who have learning disabilities (Steventon & Fredrick, 2003; Stout, 1997; Swain & Allinder, 1996). Students with other disabilities, such as vision impairments, also benefited from repeated readings. Koenig and Layton (1998) found repeated readings to be effective for students with vision impairments. Pattillo, Heller, and Smith (2003) demonstrated that repeated readings paired with computer assisted reading was effective for increasing reading fluency in students with vision impairments.

Only one study in the literature used repeated readings with students with physical disabilities. Heller et al. (2007) conducted three case studies to examine two repeated readings conditions with students who have physical disabilities. The first case study looked at repeated readings with error feedback for a student with spina bifida and arthrogryposis. The second case study examined the effects of repeated readings with

error feedback and unison reading for a student with cerebral palsy. The final case study compared repeated readings with error feedback and repeated readings with unison reading for the student with cerebral palsy. For all three case studies, the student demonstrated nontransfer effects during the repeated readings intervention. In the second case study, the student's rate of reading on novel passages also increased, suggesting transfer effects occurred. Because of multiple elements and the case study design, it is difficult to draw conclusions about the overall effectiveness of repeated readings for increasing reading fluency on novel passages with students with physical disabilities.

Modeling Literature. Modeling is a teaching strategy used with students with a variety of disabilities to teach everything from self-care to academic skills (Rivera & Smith, 1987). Often, modeling is used as part of a treatment package. For reading fluency, modeling has been done with video self-modeling, paired with repeated readings, or examined as one possible independent variable in brief experimental analyses to identify instructional components.

Hitchcock, Prater, and Dowrick (2004) examined the effectiveness of a treatment package that included tutoring by community partners and self-modeling videotapes of students reading passages for increasing reading fluency and comprehension in students with reading difficulties. Videotapes were created of the student being coached to read segments of a book fluently. The film was then spliced so that the tape provided a model of the student reading the entire book fluently. During this treatment package, students' fluency rates increased significantly during sessions when the video model was in place.

Other studies using modeling to increase reading fluency were in packages that included repeated readings. Therrien (2004) noted eleven repeated readings articles that

looked for transfer effects in which models were provided. In all of these studies, the models were peers. Significant transfer effects were not found for modeling interventions. However, Therrien noted that peer-conducted interventions did not have as large of effect sizes as adult-run interventions which might have minimized the impact of modeling.

Chard et al. (2002) synthesized research on fluency instruction specifically for students with learning disabilities. One element within repeated readings interventions that they examined was modeling. They found 10 studies in which modeling was provided by adults, more proficient peers, or technology (audiotape or computer). Overall, Chard et al. determined that repeated readings with a model seemed to be more effective than repeated readings without a model especially if the students have low fluency. While taped or computer–provided models appeared to be more effective than repeated readings without modeling, Chard et al. noted that they did not appear as effective as those in which the model was provided by a person.

Modeling has been used in combination with other interventions in several studies. Noell et al. (1998) used modeling as part of a treatment package to increase oral reading fluency for three boys with attention deficit hyperactivity disorder. This treatment package included different reinforcement contingencies as well as modeling and practice. Modeling in their experiment involved the instructor reading the passage to the participant at a rate of 20% increase over the previous fluency level demonstrated by the student. Their findings indicated that one participant was able to increase reading fluency with modeling and practice at different levels of materials while the other two performed best with a combination of reward, modeling, and practice.

An audiotaped model, or listening passage preview (LPP), was used in several studies to determine instructional components needed to improve oral reading fluency. Findings were mixed and seemed to indicate that some individuals benefit from the listening passage preview whereas other students benefit more from different instructional components such as reinforcement, repeated readings, sequential modification, and lower level passages. Daly, Martens, Hamler, Dool, and Eckert (1999) included LPP as one element in a brief functional analysis for determining interventions for students who were referred for reading problems. For two out of four students, LPP was effective as part of a combination of interventions. Similar studies have found that some children responded to LPP while, for some students, it did not seem to be an effective intervention (Daly, Martens, Dool, & Hintze, 1998; Daly, Murdoch, Lillenstein, Webber, & Lentz, 2002).

Error Correction. Error correction has been used effectively in reading instruction with students who have disabilities. Barbetta and her colleagues (Barbetta & Heron, 1993; Barbetta et al., 1993; Barbetta, Heward, Bradley, & Miller, 1994) performed three studies examining the factors associated with error correction for teaching sight words to students with developmental disabilities. The first investigation (Barbetta & Heron, 1993) found that it is important for students to actively respond during the error correction process. This study had the student repeat the missed word after the teacher modeled it correctly. Other elements of error correction examined were timing and type of error correction. This study found that immediate error correction was superior to delayed error correction (Barbetta et al., 1994) and whole word prompting yielded better results than phonetic cueing during error correction (Barbetta et al., 1993).

Nelson, Alber, and Gordy (2004) used a combined intervention consisting of systematic error correction with repeated readings for students with learning disabilities or attention deficit with hyperactivity disorder who were all one full year behind in average reading rate. During their first condition, error correction only, students increased in accuracy; however, there was no considerable increase in fluency. The second condition, error correction plus repeated readings, demonstrated accuracy and fluency increases for all participants with the range of increase in correct words per minute being from 12.6 to 24.6.

Performance Feedback and Reinforcement. Several studies have addressed the role of contingent reinforcement in reading fluency. Chafouleas et al. (2004) studied the effects of repeated readings alone as well as repeated readings in combination with two performance-based interventions on reading fluency for students with reading problems. For the two participants with the highest reading performance at the beginning of the study, repeated readings was the most effective treatment. For the student who was served in a special education classroom, however, greater benefits were seen with repeated readings when it was combined with performance feedback or performance feedback plus contingent reward.

Factors and Effectiveness of Technology-provided Modeling. Modeling provided by an auditory tape or by a computer is a strategy used to increase reading fluency in some research studies. Computer-assisted instruction (CAI) has been used to improve reading skills for several different populations of students. One form of CAI is the use of a computer model for reading. In their meta-analysis of repeated readings studies, Chard et al. (2002) looked at modeling as one factor. Chard et al. found three studies that used

audiotaped models and one that used modeling by a computer speech synthesizer. They found that teacher modeling yielded better results than audiotapes, but possibly not enough to justify efficiency of technology provided models. The study using a speech synthesizer yielded decreases in reading fluency, but found that fluency was higher during follow-up sessions. Leong (1995) evaluated text-to-speech software for reading comprehension with variable results. Montali and Lewandowski (1996) also examnined text reading software and compared bimodal, visual, and auditory presentation for increasing reading comprehension. Findings showed bimodal presentation (highlighted text and auditory text) yielded better results than visual or auditory presentation alone. The authors propose that computer modeling provides a more interactive experience via the bimodal presentation of text. In another study using computer modeling, Pattillo et al. (2003) examined the effectiveness of repeated readings with computer modeling on the fluency of students with vision impairments. All students in this study improved their reading fluency and most improved their reading rate to a level 83% over baseline. The software used in Pattillo et al. was Kurzweil 1000 which does not provide highlighting of words on the screen along with the auditory model.

Reading Fluency for Students with Physical Disabilities. Research in the area of physical disabilities is limited – especially in traditional academics. As previously mentioned, Heller et al (2007) used three case studies to examine the effectiveness of repeated readings interventions with two students who have physical disabilities. Both students in that study made gains in reading fluency. Although it did not address reading fluency, one study addressing computer modeling for reading skills for students with physical disabilities was Coleman-Martin, Heller, Cihak, & Irvine, 2005. Coleman-

Martin et al. taught students with physical disabilities to decode words using the Nonverbal Reading Approach (Heller, Fredrick, & Diggs, 1999) presented by the computer in the form of PowerPoint presentations. In this study, the computer provided modeling of a decoding strategy to blend individual sounds into words. All participants were able to acquire target words to criterion using the computer modeled instruction.

No examples of the use of error correction and performance feedback for teaching reading fluency to students with physical disabilities could be located. Given the results of Heller et al. and Coleman-Martin et al., it is proposed that students with physical disabilities may benefit from a treatment package including repeated readings and computer-modeled instruction. Since many students with physical disabilities demonstrate academic performance lower than that of their peers, the use of error correction and performance feedback may also be beneficial. Because research in the area of physical disabilities is so limited, such a study would be novel to the literature by using strategies shown to be effective with other populations with students who have physical disabilities.

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CHAPTER 2

THE USE OF A REPEATED READINGS WITH COMPUTER MODELING TREATMENT PACKAGE TO PROMOTE READING FLUENCY WITH STUDENTS WHO HAVE PHYSICAL DISABILITIES

Statement of the Problem

Students with physical disabilities often experience reading difficulties related to a) their differences in background experiences, b) differences in early literacy experiences, c) decreased access to reading materials, d) fatigue and endurance, and e) health issues. These students often have neurocognitive impairments (e.g., visuospatial difficulties) or other disabilities (e.g., vision impairments) that impact reading performance. Furthermore, because of motor speech difficulties or language comprehension problems, students with physical disabilities may exhibit speech impairments that may impact their reading abilities (Heller, Alberto, & Meagher, 1996). Although students with physical disabilities may experience many factors which adversely impact reading performance, reading is especially important for this population because literacy opens up many opportunities for employment and participation in the community not otherwise available because of physical limitations (Koppenhaver, Evans, & Yoder, 1991; Koppenhaver & Yoder, 1993).

Students with physical disabilities often exhibit problems that may impact reading fluency. These include a) functional factors (motor, cognitive, speech, and sensory limitations, b) fatigue and endurance, different experiences), c) psychosocial factors (self-

efficacy, motivation, and behavioral and emotional functioning), and d) environmental factors (decreased access to reading materials, ineffective learning environment, and decreased expectations) (Heller, Coleman-Martin, & Swinehart-Jones, 2006). Heller et al. (2007) reported reading rates as low as 19 words per minute for a 5th grade student with cerebral palsy.

There are differing definitions of fluent reading in the literature. Archer, Gleason, and Vachon (2003) offer a "reductionist" definition of fluency: "rate plus accuracy" (p. 96). Many authors consider prosody an important part of fluent reading (Cowie, Douglas-Cowie, & Wichmann, 2002; Schwanenflugel, Hamilton, Kuhn, Wisenbaker, & Stahl, 1996). Prosody will not be addressed in this study because many students with physical disabilities experience different speech patterns related to their motor speech impairments which may affect prosody. For example, a student with cerebral palsy may have intelligible speech, but exhibit different breath patterns and raising and lowering of the voice than a student without a motor speech impairment. Therefore, this study will define fluency as rate plus accuracy as in Archer et al.

Reading fluency has been linked with improvements in reading comprehension. In 1974, LaBerge and Samuels proposed a theory of automaticity in reading. This theory argued that children who struggle with decoding use up their attentional resources and are unable to allocate adequate attention to comprehension (LaBerge & Samuels, 1974; Samuels, 2004). Many authors concur that slow, choppy, reading "clogs" working memory and interferes with content level understanding (Chard, Vaughn, and Tyler, 2002, p. 386). To effectively comprehend, a reader must utilize cognitive and metacognitive strategies that consume attention (Hacker, 2004). If attention is allocated

toward decoding, it is not available for these higher order processes (Hacker, 2004; LaBerge & Samuels, 1974). Because comprehension is the means through which information is acquired from text, it is essential to increase the reading fluency of students who read slowly to allow them to concentrate on comprehending text.

In addition to increased comprehension, reading fluency has been linked to higher levels of work completion as well as increased general ability from exposure to more text (Archer et al., 2003). Fuchs, Fuchs, and Hosp (2001) make a case that oral reading fluency (ORF) is the most efficient tool for use by teachers to measure a student's ability to read with speed and accuracy. Several interventions have been used to increase ORF in struggling readers. Some of these include repeated readings, modeling, error correction, and performance feedback (Chard et al., 2002; Daly, Murdoch, Lillenstein, Webber, & Lentz, 2002; Homan, Klesius, & Hite, 1993).

The method of repeated readings was developed based on LaBerge and Samuels' model of automaticity in reading. Samuels (1997) conceptualized repeated readings based on the way that athletes and musicians increase their skills: repeated practice on small parts of the task and eventually the entire task. Over 100 studies have demonstrated the effectiveness of repeated readings with young children with and without disabilities as well as with older students with disabilities (Samuels, 1997).

Additionally, research has shown other strategies such as modeling, error correction, and performance feedback to be effective in increasing reading fluency. Modeling has been successfully used to teach reading fluency in several studies. Modeling has been provided by a teacher, peer, audiotape (Rose & Beattie, 1986), and by a computer (Pattillo, Heller, & Smith, 2003) to increase reading fluency. Error correction

and performance feedback also have been used as part of treatment packages to increase reading fluency (Daly, Martens, Hamler, Dool, & Eckert, 1999). Error correction is vital to instruction because it provides students the opportunity to learn the correct response. Performance feedback may benefit students by giving them responsibility for their learning.

Studies have examined combining reading interventions to address reading fluency. One example is to combine repeated readings with computer modeling. Computer modeling offers the benefits of increased practice with less teacher time and increased motivation for some users (Torgesen, 1986). Students with physical disabilities with decreased fine motor abilities often are limited in their ability to practice skills independently. The use of computers may increase independence and self-esteem because it enables these students to work without 1:1 teacher assistance (Coleman-Martin, Heller, Cihak, & Irvine, 2005)

Computer modeling has been used with variable success in improving reading fluency. Many of these studies used synthetic speech available in the 1980s and did not include reading of connected text (Cohen, Torgesen, & Torgesen, 1988; Olson, Foltz, & Wise, 1986; Torgesen, Waters, Cohen, & Torgesen, 1988). Clarfield and Stoner (2005) found a software program called “Headsprout” to be effective in increasing ORF and attention to task for students with attention deficit hyperactivity disorder. In a study that did use computer modeling for connected text, Pattillo, Heller, and Smith (2003) used a modified repeated readings strategy along with optical character recognition software to increase the fluency rates of students with vision impairments.

On the other hand, computer modeling does have potential drawbacks when used for instruction in reading fluency. One issue is related to prosody. Synthesized speech provides some prosodic features (e.g., pausing after commas, rising at the end of a sentence); however, it does not provide the same prosodic characteristics as human speech. This study will use the computer to provide a model of reading. Because of the inability of synthesized speech to model human prosody and the issues of different speech patterns in many students with physical disabilities, this study will not address prosody.

As discussed, there is very little research examining reading with students with physical disabilities. Additionally, research using computer modeling to increase reading fluency is not abundant. Furthermore, there are no known studies addressing the use of computer modeling to increase reading fluency for students with physical disabilities. That was the focus of this study.

Purpose

The purpose of this study was to examine the effects of a treatment package consisting of repeated readings with computer modeling, error correction, and performance feedback on oral reading fluency and comprehension for students with physical disabilities. For the purpose of this study, fluency was defined as in Archer et al. (2003): rate plus accuracy. This investigation was designed to determine if the treatment package would increase fluency with each repeated readings of the same material that occurs each session (positive nontransfer results). This is important to see if students are able to increase reading fluency with practice on an individual passage when provided with the treatment package. Also, this investigation examined whether the treatment

package increased reading fluency with unknown passages across sessions (positive transfer results). This is important to see if the treatment package is having an impact on the students' overall reading abilities. In addition, this study examined the effect of increased fluency on comprehension and errors.

Research Questions

1. To what extent is a treatment package using repeated readings with computer modeling, error correction, and performance feedback effective in increasing the nontransfer effects of oral reading fluency of students with physical disabilities?
2. To what extent is a treatment package using repeated readings with computer modeling, error correction, and performance feedback effective in increasing the transfer effects of oral reading fluency of students with physical disabilities?
3. To what extent is a treatment package using repeated readings with computer modeling, error correction, and performance feedback effective in decreasing the number of errors from the first reading to the last reading of a session (nontransfer effects)?
4. What is the effect of a treatment package using repeated readings with computer modeling, error correction, and performance feedback on the reading comprehension of students with physical disabilities for both transfer and nontransfer effects?

Methodology

Participants

Four participants were selected based on the following criteria: (a) met eligibility requirements for orthopedic impairments (OI) as defined by the state of Georgia (i.e.,

students with a physical disability with intellectual functioning in the mild range of mental retardation or higher), (b) had no articulation or voice disorders that would interfere with speech intelligibility, (c) were served in a resource or self-contained classroom for students with orthopedic impairments, (d) did not meet the criteria for low vision or blindness, (e) had prior experience using a computer by accessing it with a mouse or alternate input device, (f) were in third through fifth grade, and (g) had oral reading fluency at the fortieth percentile or lower for their grade level according to Hasbrouck and Tindal (2005).

All four participants were served in a self-contained classroom for students with orthopedic impairments in a large metropolitan school system in the Southeast United States. All four participants were African-American and had a diagnosis of cerebral palsy. They were all mainstreamed for social studies, science, and specials classes but attended the OI classroom for all other instruction. During the study, all four participants continued to receive their regular reading instruction in the Reading Mastery Plus series. All participants could operate a trackpad and keyboard on a laptop computer independently.

Table 1

Student Descriptions

Name	Age Grade Placement	Disability	Eligibilities	Fluency wcpm	Reading Scores
Simon	12 y 0 mo 4th grade	Cerebral Palsy WISC III Verbal Comp Index 69	Orthopedic Impairment, Emotional Behavioral Disorder	11	*Pre-primer **Word Rec. GE 1.0, SS 43
Marcus	11 y 5 mo 5th grade	Cerebral Palsy, Asthma	Orthopedic Impairment	14	*Pre-primer **Word Rec. GE 2.0, SS 65
Liz	9 y 9 mo 4th grade	Cerebral Palsy, Retinopathy of Prematurity, Periventricular Leukomalacia, Seizure Disorder, DAS Composite 67	Orthopedic Impairment, Other Health Impairment	18	*Pre-primer **Word Rec. GE 2.0, SS 78
James	9 y 8 mo 4th grade	Cerebral Palsy	Orthopedic Impairment, Speech-Language Impairment	10	*Pre-primer **Word Rec. GE 1.4, SS 70

* Basic Reading Inventory
**Brigance
DAS - Differential Abilities Scale
WISC III – Weschler Intelligence Scale for Children

At the beginning of the study, Simon was a 12 year 0 month old male who was in fourth grade. Simon has a diagnosis of spastic diplegic cerebral palsy and is dually labeled as having an orthopedic impairment and a behavior disorder. Simon uses a power wheelchair independently for mobility but can walk with a walker for short distances.

During the school year before the study, Simon was administered the verbal portion of the Wechsler Intelligence Scale for Children, 3rd edition (WISC III) and obtained a Verbal Comprehension Index of 69. He was also assessed using the Brigance and had grade equivalencies of 2.0 for Listening Vocabulary Comprehension (SS=67), 1.0 for Word Recognition (SS=43), and <1.0 for Math Computation (SS not available). Additionally, Simon's state-wide standardized assessment scores from the previous year were: CRCT: Reading Total 309, English/LA Total 274, Math Total 275; and ITBS: Reading Total 178, Language Total 152, Mathematics Total 150, Social Studies 161, Science 149.

At the time of the study, Marcus was an 11 year 5 month old fifth grade male with diagnoses of cerebral palsy and asthma. Marcus uses a power wheelchair independently for mobility but is able to ambulate in a gait trainer for short distances. Intelligence scores were not available for Marcus, but in the school year prior to the study, he received Brigance grade equivalencies of 2.3 in Listening Vocabulary Comprehension (SS=75), 2.0 in Word Reading (SS=65), 1.7 in Math Computation (SS=74), and 2.6 in Spelling (SS=75). Also during the previous school year, Marcus received the following scores on state-wide standardized testing: CRCT: Reading Total 798, English/LA Total 777, Math Total 258; and ITBS: Reading Total 189, Language Total 186, Mathematics Total 178, Social Studies 179, Science 172.

At the beginning of the study, Liz was a 9 year 9 month old female who was in the fourth grade. Liz has diagnoses of retinopathy of prematurity, periventricular leukomalacia, right side hemiplegic cerebral palsy, and a seizure disorder. She has dual eligibilities of orthopedic impairments and other health impairments. Liz wears a seizure

helmet and is ambulatory with a noticeably different gait. She is able to use both hands, but demonstrates weakness in the right hand. Liz had transferred from another school two months before the study and some testing information (e.g., ITBS) was not available. Her Brigance yielded scores as follows: Word reading: GE=2.0, SS=78; Math Computation: GE=1.7, SS=80; Spelling: GE=2.0, SS=77; Listening Vocabulary Comprehension: GE=3.0; SS=99. A Differential Abilities Scale (DAS) administered three years prior to the study (12/2003) resulted in scores of: Verbal:85, Nonverbal Reasoning: 78, Spatial Ability: 51, General Cognitive Ability: 65, and Special Nonverbal Composite: 67.

James was a 9 year 8 month old male fourth grader at the beginning of the study. He has eligibilities of orthopedic impairment and speech-language impairment. James has spastic quadriplegic cerebral palsy and demonstrates very slow physical movements. James independently uses a power wheelchair for mobility but can walk with a gait trainer and adult support for very short distances. His posture is poor and he tends to lean forward or to one side while in his wheelchair. He is unable to maintain adequate trunk support in midline for more than a couple of minutes. IQ scores were not available for James, but his Brigance scores were as follows: Word Recognition: GE=1.4, SS=70; Spelling: GE=1.6, SS=69; Math Computation: GE=1.0; Listening Comprehension: 100% on upper third grade level.

Setting

All sessions were conducted in a 1:1 format in one of two empty classrooms. The room used most frequently was empty except for a few tables and chairs. During statewide testing, that room was occupied and the orchestra room was used. This room had desks, tables, chairs as well as music-related posters on the walls. All student

readings took place with materials placed on the table either with or without a slantboard, or on the student's wheelchair tray. Computer modeling took place using the researcher's laptop computer on the table. All sessions were audiotaped for the purpose of interobserver reliability and treatment integrity using a mini digital recorder.

Adaptations and Assistive Technology

Students with physical disabilities often require adaptations to make reading activities and materials accessible (Heller et al., 2006). The assistive technology equipment needed for each individual student to promote classroom reading activities was used during intervention (e.g., slantboards).

Simon's reading passages were placed on a slantboard on the table. He was positioned in his power wheelchair and the wheelchair was positioned perpendicular to the table surface and as close to the table as possible. Simon was inconsistent in using finger pointing to track words on the line of print during the study. The researcher neither encouraged nor discouraged finger pointing.

Marcus' wheelchair position and placement of materials on the slantboard on the table was identical to Simon's. He was also inconsistent in finger pointing.

Liz sat in a regular classroom chair which was scooted as far under the table as possible. Her reading passages were placed on the table and she consistently used finger pointing while she read.

For James to maintain an adequate posture for reading, he had to tilt his wheelchair backwards during the reading sessions. James' reading passages were placed on a slant board on his wheelchair tray to make them accessible. James was physically

unable to use finger pointing during the study because of the position of the materials and his slow and uncontrolled movement pattern.

Materials

The materials required for this investigation consisted of Kurzweil 3000 software (version 9), Windows platform laptop computer, student reading passages, researcher copies of reading passages, a stopwatch, a digital voice recorder, and Microsoft Excel for graphing student progress.

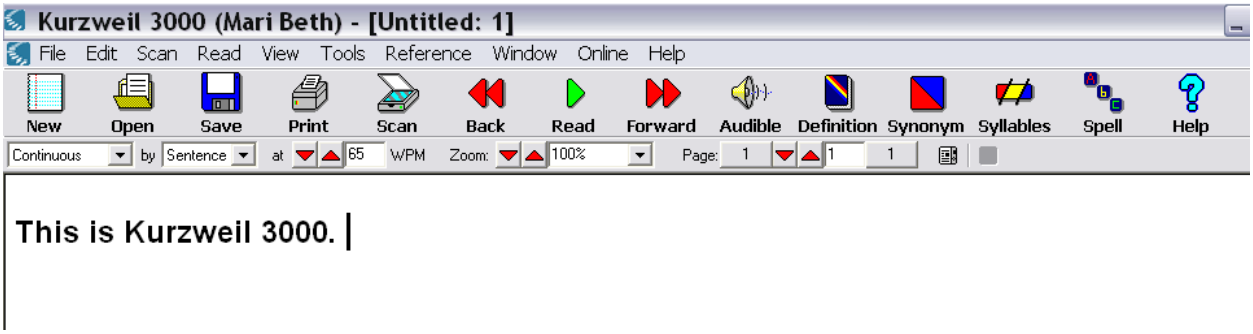
Kurzweil 3000 Software. The software used for computer modeling in this study was Kurzweil 3000 version 9. Kurzweil 3000 is a program used in some special education classrooms because of its effectiveness for enhancing reading, writing, and study skills for students with physical disabilities or learning disabilities. Kurzweil 3000 has the capability of a text reader as well as a talking word processor. This software has optical character recognition (OCR) capabilities so that materials can be scanned in and converted to text rather than graphic images. Kurzweil 3000 has features such as a dictionary, spell checker, capability to put notes and highlights in the text, as well as other features that help with student's organization and studying of the materials. For the purpose of this study, the only feature used was the text reading component.

Kurzweil 3000 provides an onscreen toolbar that allows the user to control many functions of the program through keyboard controls or the use of any input device (mouse, trackball, joystick, head-controlled mouse emulator, etc.). Prior to the study, students were shown the program and taught what the toolbar buttons do so that they were not distracted and did not ask questions once the study began. The only toolbar button used with the student was the "read" button. During reading sessions, the

researcher set the reading speed for each student and put the cursor on the "read" button. The student was then instructed to press "read" when ready. See figure 1 for a view of the onscreen toolbar.

Figure 1

Screen Shot of Kurzweil Toolbar



Several other text-to-speech programs were considered for this study since the drawback of this program for classroom use is the cost (approximately $1000). However, other text-to-speech programs have more variability in the actual rate of speech. Prior to beginning the study, reading samples of an adult were used to calculate wcpm. Three software programs were compared to the actual human wcpm calculations. Kurzweil 3000 was the most accurate in terms of words per minute; therefore, it was selected for use in this study. In Kurzweil 3000, the speech features can be adjusted to the number of words per minute desired between 35 wpm and 600 words per minute. Text can be read with each word being highlighted on the screen while it is spoken and the color of highlighting can be changed by the user. Montali and Lewandowski (1996) found that computer modeling with highlighting and auditory output was more effective than just auditory output in teaching reading comprehension. Text and background colors can be changed to meet the student's needs in Kurzweil 3000; however, for the purpose of this study, black text on white background was used for all students to maintain consistency

across users. No students had eligibility for vision impairments program which would have required the use of different colors.

Reading materials. Reading passages were selected from Level C3 books in an elementary school Reading Recovery Room. These books were previously leveled based on readability of text and Level C3 was one of the Kindergarten reading levels. Level C3 was chosen based on the students' performance on the Basic Reading Inventory. Because all students performed at the pre-primer level on this assessment, low level materials were necessary to find passages that were at an appropriate level for the students. Level C3 was the lowest level of books that had connected text. Reading materials were all examined using the Flesch-Kincaid index in Microsoft Word with little variability in reading level indicated. Thus, all passages used in the study were believed to be at as similar a reading level as possible.

Public Law 104-197 mandates exemptions in copyright law if text is being reproduced in a format to make it accessible to individuals with vision or physical disabilities. Text from the leveled readers was typed into a Word document to eliminate the need for page turning and to facilitate ease of reading. Size 16 font with double spacing was used for all passages and for computer modeling. This font size was consistent with the text used in the original materials. Double spacing was used to help facilitate visual tracking for students who were unable to point to each word while reading.

The researcher's data sheets contained one page with three smaller font-size versions of the passages along with instructions to be read to the student, procedures to follow, and the comprehension questions. Researcher copies of the reading passages were

used for interobserver reliability and procedural fidelity, but were labeled as reliability data so they were not confused with the researcher's original data.

Three comprehension questions were constructed by the researcher for each passage. Two questions were factual in nature and one was inferential. After questions were constructed, they were approved or revised by a professor with extensive experience in the area of literacy with students who have physical disabilities.

Procedures

Preintervention Assessment

Determining reading fluency. One preintervention assessment consisted of determining each student's reading fluency. This was important to determine if the student qualified for the study as well as to determine baseline rates. During this assessment, the student was asked to read passages from the *Basic Reading Inventory* (Johns, 2000). During the assessment, the researcher positioned herself so that she could see the student's reading passage, but so that the student could not see the researcher's copy where errors were marked. The researcher informed the student that no errors would be corrected (Pattillo et al., 2003) and that if the student got to an unknown word did not know to make his or her best attempt and then move on.

The researcher provided an attentional cue, "*Student's name,* are you ready?" When the student acknowledged, the researcher placed the passage in front of the student, said, "Begin," and started her stopwatch. The student then read the passage while the researcher timed the reading and recorded errors. Participants were not given any feedback (including not telling the student his fluency rate), but were given

nondescriptive encouragement at the conclusion of the session such as, “Wow, you really worked hard!”

The researcher counted errors for the following: (1) mispronunciations and dropped endings, (2) words read out of sequence, (3) hesitations of 3 seconds (word supplied by researcher), (4) omission of one word, (5) substitutions, (6) repeated errors (if the student consistently missed a word, each occurrence counted as an error). Transpositions (reversing order of two words) counted as two errors. When a student omitted more that one word, each word counted as an error. The following situations were not counted as errors (1) errors due to dialect or speech impairment, (2) self-corrections, (3) repetitions, and (4) insertions (Hasbrouck, 2006).

Fluency was determined by calculating the words correct per minute (wcpm). This was calculated by subtracting the number of errors from the total number of words and dividing this by the number of minutes read.

$$\text{wcpm} = \frac{\text{total words read - errors}}{\text{minutes read}}$$

Initial reading fluency levels were indicated by baseline performance. Baseline was continued until stable reading fluency (no more than 20% deviation) was achieved with a minimum of three baseline sessions. For inclusion in the study, students had to have an oral reading fluency at the fortieth percentile or lower for their grade level. Hasbrouck and Tindal Oral Reading Fluency Data were used to compare students’ percentiles. Each student was compared to his/her grade level percentiles for Spring. Hasbrouck and Tindal note that students scoring below the 50th percentile need instruction in reading fluency. The students in this study were in fourth (Simon, Liz, and

James) and fifth grade (Marcus). All students fell way below even the 10th percentile for their grade levels. The oral reading fluency score for the 40th percentile for fourth grade Spring quarter was 113 wcpm. The 10th percentile for fourth grade was 72 wcpm. The three fourth grade students' initial reading fluency rates were 11 wcpm for Simon, 18 wcpm for Liz, and 10 wcpm for James. The oral reading fluency rate at the 40th percentile for fifth grade Spring quarter was 127 wcpm. Marcus' fluency was at 14 wcpm which fell below the 10th percentile level of 83 wcpm for fifth grade.

While wcpm was the measure used to assess reading fluency, transfer effects were measured using a percent of nonoverlapping data (PND) technique. This method allowed for comparison between phases by showing the amount of increase from one phase to the next. PND indicates the percent of data points in one phase that are above the highest level of performance in the previous phase. It is calculated by first determining the highest data point in the comparison phase. Then, the number of data points in the subsequent phase that exceed the highest point in the previous phase are counted. That number is then divided by the total number of sessions in the phase to determine the percent of sessions that did not overlap with the previous phase.

$$\text{PND} = \frac{\text{Number of sessions in phase that fell above highest point in previous phase}}{\text{Total number of sessions in phase}}$$

Reading level assessment. Each student's reading level was assessed using the graded passages in the *Basic Reading Inventory* (Johns, 2000). The reading level assessment served as a starting place to determine the level of reading materials used during the study. All students' performance fell in the pre-primer level on the *Basic Reading Inventory*.

Intervention

Treatment package. Prior to beginning the intervention, the researcher explained the treatment package to the student including goals, how wcpm would be assessed, how criterion changes would be determined, the benefits of modeling in reading, and the importance of increasing reading fluency. The researcher explained how data would be graphed every day so the student and researcher could track the student's progress and work together to set criterion changes (Nes Ferrara, 2005; Pattillo et al., 2003)

The treatment package consisted of repeated readings with computer modeling, error correction, and performance feedback. The package was designed to provide three repeated readings to the student, interspersed with two computer-modeled readings. Thus, the treatment package consisted of five exposures to the text. Three exposures occurred during oral reading by the student and two consisted of silent reading with the computer model. After each student reading, the researcher provided error correction to the student. This consisted of the researcher pointing to each word that was counted as an error, reading the word to the student, and having the student read the word back to the researcher. Having the student read the word following the researcher was important because of the increased effectiveness of error correction when the student actively participates (Barbetta & Heron, 1993). To assist the student in monitoring progress, the researcher calculated wcpm after each session and showed the student his/her graph at the beginning of the next session in order to discuss progress and goals for that session. Research has demonstrated that some students benefit from performance feedback and are motivated to improve their performance by being an active participant in the graphing

process. After the first reading and the third reading, immediately after error correction, the researcher asked the student comprehension questions.

Table 2. Steps in Intervention Sessions

Steps in Intervention Sessions
1. Graph of performance reviewed 2. Student read novel passage 3. Comprehension questions asked 4. Error correction provided 5. Computer-modeled reading 6. Student read passage for the second time 7. Error correction provided 8. Computer-modeled reading 9. Student read passage for the third time 10. Comprehension questions asked 11. Error correction provided

Repeated readings. Each session began with the student reading a new passage. The student was told to read the passage as quickly as he could but at a level where he could still understand. Students were instructed if they encountered a word they were struggling over, to make a quick attempt then move on. The researcher told the student to begin when ready and started her stopwatch as soon as the student began to read. While student was reading, the researcher marked the exact error on the data sheet. If the student paused or struggled pronouncing a word for 3 seconds, the researcher provided the word and counted that word as an error (Noell et al., 1998; Strong, Wehby, Falk, & Lane, 2004).

Computer-modeled reading. After the first reading, the researcher moved the computer in front of the student and the researcher provided instructions for the student to

read the same passage along silently while the computer read aloud. The speed of the speech in Kurzweil 3000 was set according to the student's criterion level. Pattillo et al. (2003) used a rate of 20-30 words above the criterion rate based on students' ability to follow text at a much higher rate than their oral reading rate. For this study, the speech rate was set at 30 words above criterion because all students' initial wcpm rates were very low. Kurzweil 3000 software allows the user to choose the number of words per minute (35 to 600) for spoken fluency. For some participants, a rate of 20 words above baseline during the first intervention phase was too slow for Kurzweil to accommodate so the computer reading speed was set to 30 words per minute above criterion. The student silently read on the computer screen as the words were highlighted and spoken aloud by the Kurzweil 3000 program. The researcher monitored the student to ensure the student was attending to the computer and quietly pointed to the screen if the student's eyes wandered away.

After the first computer-modeled reading, the researcher asked the student to read the passage aloud a second time. The same procedures were used as during the first reading in which the reading was followed by error correction. A second computer reading occurred next. The computer read at the same rate as the first computer reading of that session. Upon completion of the second computer-modeled reading, the student read the passage a third and final time.

Comprehension. Comprehension was assessed after the first and third student readings. Three researcher-generated comprehension questions were asked immediately following the student's oral reading of the passage. Two of the questions addressed facts from the reading passage and one was an inferential question. Questions were asked after

the first reading to evaluate if comprehension was affected when transfer effects exist. Comprehension was assessed after the final reading to see if comprehension increased after the student had multiple exposures to the passage. After the first and third readings, the researcher asked the comprehension questions.

Error correction. Error correction has been demonstrated to be effective in increasing reading accuracy and oral reading fluency (ORF) (Nelson, Alber, & Gordy, 2004). Error correction occurred after each of the three student readings per session. After the student completed the passage, the researcher went through each error and provided the student with specific correction. For example, if the student made a substitution error, the researcher pointed to the word, provided the correct pronunciation, and had the student read the word correctly. Error correction occurred after comprehension questions were asked after the first and third readings. While immediacy of error correction is important, providing error correction between the passage and comprehension questions could have interfered with the student's ability to recall information from the text. Therefore, comprehension was assessed before error correction was provided.

Performance feedback. After each reading session, the researcher calculated the student's wcpm for all three reading sessions as calculated in baseline and graphed the student's performance using Excel software. All three readings were graphed using different symbols and different colors (e.g., first reading was indicated by pink squares, second by blue triangles. The graph showed the student's wcpm along with the criterion line. At the beginning of the next session, the researcher showed the student his/her graph and discussed the performance. Ideally, performance feedback would have been provided

at the end of the session and at the beginning of the next session. However, time was needed to calculate the students' daily performance. Because there was a limited amount of time that each participant could be removed from his or her class, the researcher calculated wcpm after all four students had completed their daily sessions and reviewed individual performance with students at the beginning of the next session.

Research Design

A changing criterion design was employed to examine the effects of the treatment package. A changing criterion design is appropriate for evaluating the effectiveness of an independent variable that may change incrementally toward a terminal performance goal (Alberto & Troutman, 2006; Kazdin, 1982.) Additionally, setting a criterion may have a positive effect on the performance of reading fluency (Nes Ferrara, 2005).

Baseline. Baseline was a measure of the student's words correct per minute (wcpm) until a stable baseline was established with a minimum of three sessions. The preintervention assessment of reading fluency using Reading Recovery level C3 materials served as baseline for the study.

Intervention. Each intervention phase consisted of the treatment package of repeated readings, computer modeling, error correction, and performance feedback. During each session, students a) reviewed the graph of their performance, b) read a new passage, c) answered comprehension questions, d) received error correction, e) watched and listened to the computer read the passage, f) reread the passage, g) received error correction, h) watched and listened to the computer read the passage again, i) reread the passage for the final time, g) answered comprehension questions again, and f) received error correction.

Determining criteria for phases. In a changing criterion design, one of the first tasks is to determine the terminal criterion. Each student's terminal criterion and first phase change were based on the mean of his or her performance in baseline. Subsequent phase changes were based on performance in the previous phase. The third (final) reading of each session counted toward criterion and terminal criterion. The final reading was used because this study was examining nontransfer effects in addition to transfer effects. Nontransfer effects are increases in reading fluency that occur within the individual reading session and are evident by comparing the final reading to the first reading of that session. This differs from transfer effects when the first readings of each session are compared to see if there is an increase in fluency on novel passages.

In a study examining the use of repeated readings with students who have physical disabilities (Heller et al., 2007), the two students made mean gains of 40.21% and 103.36% on the third reading of the passage during their first exposure to the repeated readings procedure. Thus the mean gain for both students was 71.79%. Based on these findings, the terminal criterion value for this study was a 72% increase over baseline mean for each student on the final reading. This was in line with other disability areas (vision impairments) which used a changing criterion design to look at repeated readings interventions to increase reading fluency in which the terminal criterion was set at 83% (Koenig & Layton, 1998; Pattillo et al., 2003).

Simon's baseline mean was 11 wcpm and his terminal criterion (72% over baseline) was 19 wcpm. Baseline means and terminal criterion for other students were: Marcus: baseline = 14, terminal criterion = 24; Liz: baseline = 18, terminal criterion = 31; James: baseline = 10, terminal criterion = 17.

After terminal criterion was established for each student, the first criterion change was determined based on the mean baseline rate. The first level change was determined by half the mean of baseline as described in Alberto and Troutman (2006). Because performance in each criterion change after the first serves as a baseline for the next phase (Hartmann & Hall, 1976), subsequent criterion changes were based on the performance of the prior criterion. Subsequent criterion changes were equal to the highest rate or a mean of the three highest rates achieved in the previous phase. If performance in the phase was stable, criterion for the subsequent phase was equal to the highest rate achieved. Several times, students had one session during the phase where performance was significantly higher than the other sessions. Because the highest rate did not reflect typical performance, it was believed that using a mean of the three fastest wcpm during that phase would yield a more realistic goal and this was the method used to determine criterion.

Data Analysis

Data were analyzed through visual inspection of the graphs in terms of the changing criterion levels. A functional relationship was demonstrated in the changing criterion design when reading fluency increased to the specified criterion level in each phase.

Graphs were inspected for nontransfer effects (rate of improvement from first reading in a session to last) as well as for transfer effects (rate of improvement on first reading of each session). Transfer effects were demonstrated if the student's reading fluency increased on the first reading of each subsequent session reflecting an overall change in his ability to read fluently on unknown passages.

Reliability, Procedural Fidelity, and Social Validity

All baseline and intervention sessions were audio recorded and a minimum of 33% of sessions were selected for assessment of Interobserver Reliability and Procedural Fidelity. IOR and Procedural Fidelity were assessed for one baseline session and at least one session for each criterion change. A doctoral student in the area of physical disabilities who had ten years of classroom experience including teaching students with physical disabilities served as the second observer. He was trained to the 95% accuracy level prior to assessing IOR and procedural fidelity for this study.

Interobserver reliability. The second observer listened to audiotaped sessions and collected data on the students' reading accuracy by marking errors on a datasheet identical to that which was used by the researcher. The second observer also noted the total time for each passage to be read for agreement on reading rate. This was done by noting the starting and ending times on the playback software and subtracting to obtain the number seconds per reading session. Agreement occurred when the researcher and second observer's times fell within five seconds of each other. IOR was calculated as the number of agreements divided by the number of agreements plus disagreements times 100.

$$\text{IOR} = \frac{\text{Number of agreements}}{\text{Number of agreements plus disagreements}} \times 100$$

Procedural fidelity. Procedural fidelity checks were performed at the same time as IOR. The data sheet was arranged with all steps the researcher would follow along with the reading passages and error codes. The second observer listened to audiotaped sessions and noted whether or not the researcher followed all steps for the treatment protocol by

marking "+" or "-" for each step. Procedural fidelity was then calculated by dividing the number of correctly followed steps by the total number of steps for the session.

Social validity. Social validity was assessed through a post-treatment questionnaire with the participants. The instrument used was a 5 point Likert-type scale consisting of questions assessing the participants' perceptions of the elements of the treatment package (i.e., repeated readings, computer modeling, corrective feedback, and graphing). A number scale was placed in front of each student with the numbers one through five along with the corresponding rating information. For example, the words, "strongly disagree" were placed under the number one, "agree" under the number two, "maybe" under the three, "agree" under the four, and "strongly agree" under the five.

Results

The purpose of this study was to examine the effects of a treatment package consisting of repeated readings with computer modeling, error correction, and performance feedback on oral reading fluency and comprehension for students with physical disabilities. The results indicated that all students were able to increase their reading fluency during individual reading sessions (positive nontransfer effects) as well as improve accuracy. Results for transfer effects and comprehension were variable by student.

Simon

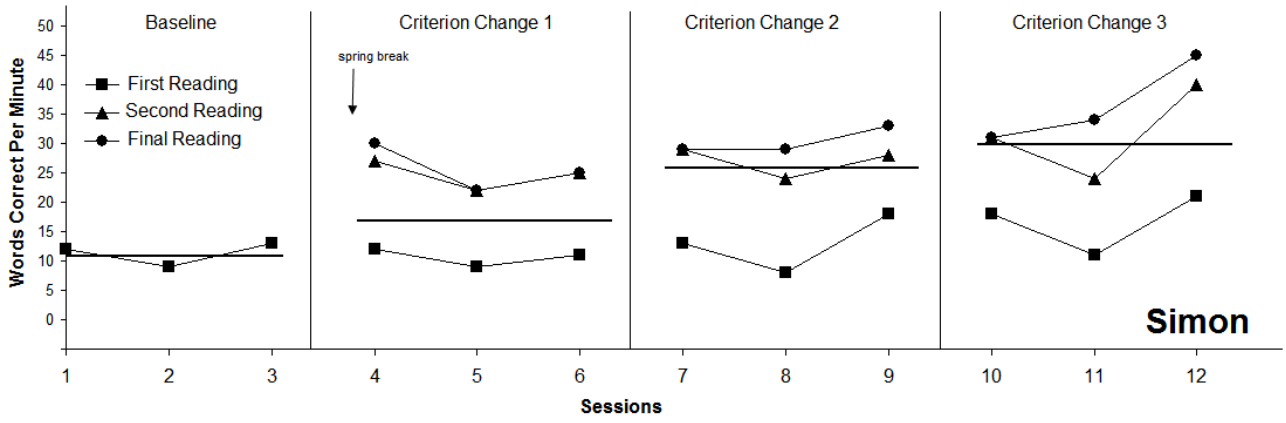
Reading fluency (wcpm). Simon completed the study in 12 sessions. During baseline, his mean wcpm was 11. Criterion for the first criterion change level was set at 17 wcpm which was 50% over the baseline mean. Simon met criterion during all three sessions with both the second and third readings being above 17. During the first session,

Simon's final reading was 3 wcpm higher than the second reading (27 wcpm); however, during the second and third sessions, Simon's second and third readings were at the same wcpm (25 wcpm and 29 wcpm respectively).

During the second criterion level change, criterion was set at 26 wcpm and Simon surpassed criterion for all three final readings and two out of three second readings. In the third criterion level change, criterion was set at 30 which Simon exceeded during all three final readings and two out of three second readings.

Figure 2.

Simon's Words Correct per Minute



Terminal criterion for Simon was 19 wcpm which represented a 72% increase over baseline. Simon surpassed this level during all three sessions in the first intervention phase. Thus, the intervention was terminated after the third criterion change level because Simon had reached terminal criterion.

Nontransfer effects. Nontransfer effects are the changes within an individual reading session. For example, if the student reads 10 wcpm faster on the second reading than he did on the first, it would indicate a positive nontransfer effect. Simon

demonstrated positive nontransfer effects in every intervention session. The mean of difference between the first reading per session and the fastest reading per session was 17 wcpm with a range of 13 – 24 wcpm difference between the two.

Table 3

Simon's Change in wcpm from First to Final Reading

Phase	Session Number	First Reading wcpm	Final Reading wcpm	Change in wcpm from first to final reading
Baseline	1	12	---	--
	2	9	---	--
	3	13	---	--
Criterion	4	12	30	18
Change 1	5	9	22	13
	6	11	25	14
Criterion	7	13	29	16
Change 2	8	8	29	21
	9	18	33	15
Criterion	10	18	31	13
Change 3	11	11	34	23
	12	21	45	24

Transfer effects. Transfer effects are demonstrated when a student's performance on novel reading passages increases over the time of the study. This demonstrates that the student's reading fluency is increasing on unpracticed reading passages. A percentage of nonoverlapping data points (PND) method was used to calculate transfer effects. Calculating PND involved using the number of first reading data points that fell above the highest point in the previous phase. The number of points in the phase that fall above the highest point in the previous phase are divided by the total number of data points in that phase (Scruggs & Mastropieri, 1998). This percentage indicates the PND.

PND was calculated for first readings to see if the percentage of first readings in the intervention phases increased over the highest point in the previous phase. The highest wcpm in baseline was 13. During first readings for the three sessions in Criterion Change 1 phase, Simon's wcpm were 12, 9, and 11 thus making the PND 0%. In the next criterion change phases, Simon demonstrated some transfer effects. When comparing his wcpm in the Criterion Change 2 phase (13, 8, 18) to the highest point in the previous phase (12 wcpm), Simon's PND was 66.67%. In the Criterion Change 3 phase, Simon's PND was 33.33% because one session was higher than the highest point (18 wcpm) in the previous phase.

Table 4

Simon's Transfer Effects (Percent of Nonoverlapping Data)

Phase (wcpm for first readings)	Comparison phase highest wcpm	PND (%)
Baseline (12, 9, 13)	---	NA
Criterion Change 1 (12, 9, 11)	Baseline 13 wcpm	0%
Criterion Change 2 (13, 8, 18)	Criterion Change 1 12 wcpm	66.67%
Criterion Change 3 (18, 11, 21)	Criterion Change 2 18 wcpm	33.33%

Accuracy. Simon's mean accuracy was 83% during baseline. During all intervention sessions, Simon demonstrated positive nontransfer effects for accuracy. His

accuracy increased an average of 22.48% from first readings to final readings with a range of 10.91% - 38.47%.

Table 5.

Simon's Change in Percentage of Accuracy from First to Final Readings

Phase	Session Number	First Reading % Accuracy	Final Reading % Accuracy	% change from first to final readings
Baseline	1	92.60	---	--
	2	76.00	---	--
	3	78.85	---	--
Criterion Change 1	4	71.19	94.92	23.73
	5	64.41	89.83	25.42
	6	68.33	96.67	28.34
Criterion Change 2	7	77.05	93.44	16.39
	8	57.69	96.16	38.47
	9	80.00	96.36	16.36
Criterion Change 3	10	81.82	92.73	10.91
	11	69.05	97.62	28.57
	12	80.77	96.16	15.39

Comprehension. Students were assessed on three comprehension questions after the first reading and again after the final reading. This was done to evaluate the nontransfer effects of the treatment package on comprehension. Simon's average percentage correct for comprehension questions after the first readings was 75.00%. For his final readings, the average percentage correct was 88.89% indicating positive nontransfer effects of 13.89% change from first readings to final readings. Across phases, there was no consistent pattern to suggest transfer effects on comprehension for Simon. His averages of correct responses on initial readings were 88.89%, 44.44%, 88.89%, and 66.67%.

Table 6.

Simon's Comprehension

	Average % Correct on First Reading	Average % Correct on Final Reading
Baseline	88.89%	--
Criterion Change 1	44.44%	77.78%
Criterion Change 2	88.89%	100.00%
Criterion Change 3	66.67%	66.67%
Total Average % Correct	75.00%	88.89%

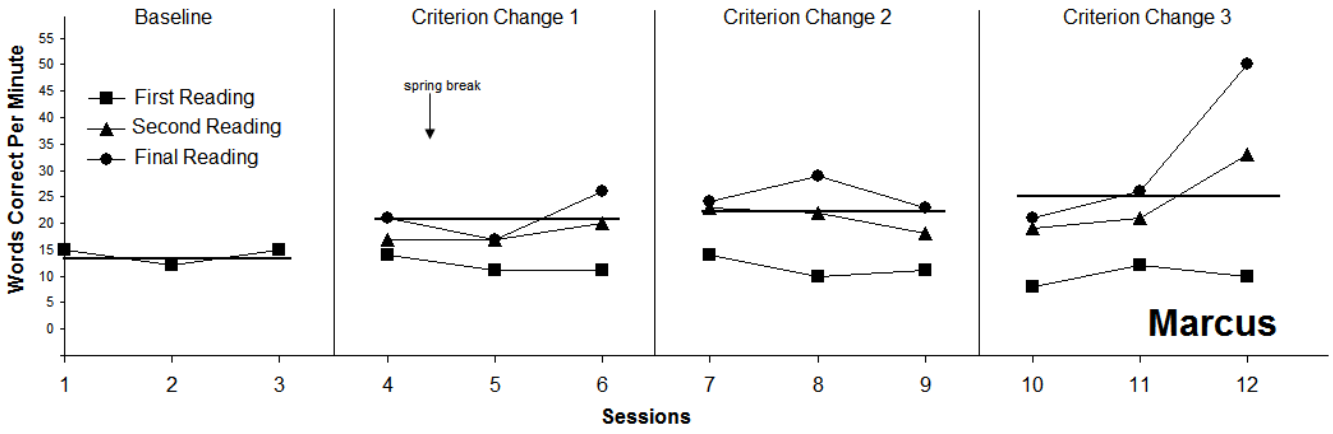
Total % of Change from First to Final Reading = 13.89%

Marcus

Reading fluency (wcpm). Marcus completed the study in 12 sessions. His baseline mean was 14 wcpm. The first criterion was set at 21 which was a 50% increase over baseline. Marcus achieved criterion of two sessions at or above 21 during the first and third intervention sessions.

Figure 3

Marcus' Words Correct Per Minute



Criterion for the Criterion Change 2 was set at 23. During this criterion level, Marcus reached criterion on his final reading for all three sessions. Criterion for the Criterion Change 3 phase was set at 25. Marcus met criterion during the second and third sessions at that criterion level.

The intervention was terminated with Marcus after three criterion level changes because he met the terminal criterion of 72% increase over baseline during the Criterion Change 3 phase. The criterion level for that phase was 25 which Marcus surpassed at 26 and 50 wcpm during the final two sessions.

Nontransfer effects. Marcus demonstrated positive nontransfer effects during all intervention sessions. His range of increase between the first and third reading per session was 7 – 40 wcpm. The mean difference between first and third readings was 15.

Table 7.

Marcus' Change in wcpm from First to Final Reading

Phase	Session Number	First Reading wcpm	Final Reading wcpm	Change in wcpm
Baseline	1	15	--	--
	2	12	--	--
	3	15	--	--
Criterion Change 1	4	14	21	7
	5	11	17	6
	6	11	26	15
Criterion Change 2	7	14	24	10
	8	10	29	19
	9	11	23	12
Criterion Change 3	10	8	21	13
	11	12	26	14
	12	10	50	40

Transfer effects. Marcus did not demonstrate positive transfer effects. The mean of his first reading wcpm actually decreased across phases. His PND was 0% for all phases.

Table 8.

Marcus' Transfer Effects (Percent of Nonoverlapping Data)

Phase (wcpm for first readings)	Comparison Phase Highest wcpm	PND (%)
Baseline (15, 12, 15)	--	NA
Criterion Change 1 (14, 11, 11)	Baseline 15 wcpm	0%
Criterion Change 2 (14, 10, 11)	Criterion Change 1 14 wcpm	0%
Criterion Change 3 (8, 12, 10)	Criterion Change 2 14 wcpm	0%

Accuracy. Marcus' accuracy increased from the first to the final reading in all intervention sessions (positive nontransfer effects) with a mean increase of 17.64% and a range of 8.48 – 26.67%.

Table 9.

Marcus' Change in Percentage of Accuracy from First to Final Readings

Phase	Session Number	First Reading % Accuracy	Final Reading % Accuracy	Change in % Accuracy from first to final reading
Baseline	1	92.59	--	--
	2	80.00	--	--
	3	88.46	--	--
Criterion	4	89.83	98.31	8.48
Change 1	5	74.58	98.31	23.73
	6	70.00	96.67	26.67
Criterion	7	85.25	98.36	13.11
Change 2	8	75.00	98.08	23.08
	9	76.36	90.91	14.55
Criterion	10	80.00	100.00	20.00
Change 3	11	84.62	92.32	7.7
	12	76.19	97.62	21.43

Comprehension. In the area of comprehension, Marcus demonstrated positive nontransfer effects. His average on first readings was 77.78%. On final readings, his average was 92.59%. This indicates a positive average change of 14.81% from first readings to final readings. Transfer effects on comprehension were not evident as Marcus' average on first readings across phases was 77.78%, 77.78%, 88.89%, and 44.44%.

Table 10.

Marcus' Comprehension

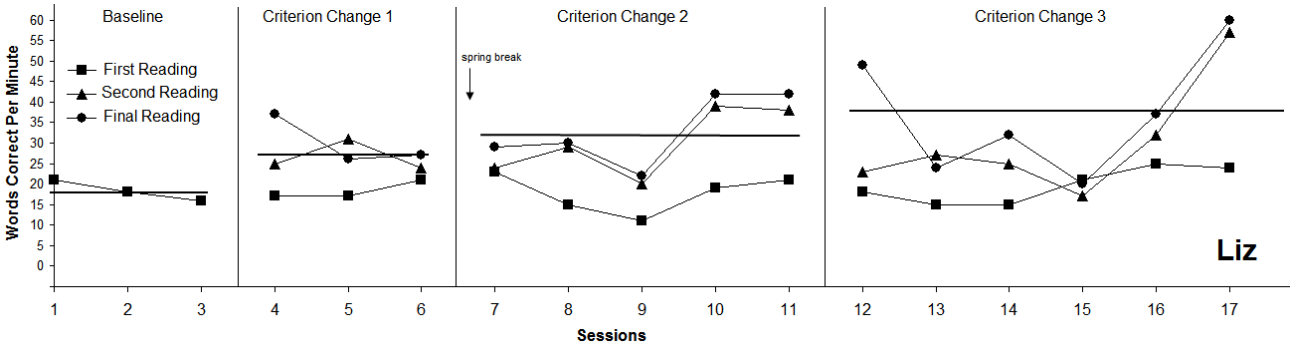
Phase	Average % Correct on First Reading	Average % Correct on Final Reading
Baseline	77.78	--
Criterion Change1	77.78	88.89
Criterion Change 2	88.89	100
Criterion Change 3	44.44	66.67
Total Average % Correct	77.78	92.59
Total % of Change from First to Final Reading =	14.81%	

Liz

Reading fluency (wcpm). Liz's baseline wcpm was 18. It took fourteen intervention sessions for Liz to complete the study. The initial criterion change was set at 27 which was a 50% increase over baseline. Liz was able to reach the criterion during the first and third sessions at this criterion. Her first session final reading was 37 wcpm and the third session final reading was 27 wcpm. During the second session, Liz became flustered during the final reading and it was lower than the second reading for that session.

Figure 4

Liz's Words Correct Per Minute



The next criterion level was set at 32 wcpm. Liz reached criterion after five sessions in the second intervention phase. On the day before the second session of this phase, Liz found out that someone in her friend's neighborhood had been shot. That morning, she told the researcher that she had a bad dream and she seemed very anxious during the session. She expressed the strong desire to continue the session despite the researcher suggesting that she not participate that day. Her first reading during that session dropped below baseline levels to 14 wcpm. During the third session, when the researcher was reviewing Liz's graph with her, she became angry that she had not met criterion during the previous day and demonstrated a lot of frustration during all three readings. During the fourth and fifth sessions at the second criterion change, Liz's third readings were at 42 wcpm.

Liz showed variability in Criterion Change 3 phase as well. Criterion was set at 38 wcpm. During the first session of this phase, she obtained a final reading of 49 wcpm. Intervention took place in another room during the next three sessions due to statewide testing. During these sessions, Liz demonstrated frustration and perseverative

commenting on one of the posters in the new room despite the researcher trying to position her so that she was not facing that area of the room. It took six sessions for Liz to reach criterion during the Criterion Change 3 phase. Her final reading during the first (49 wcpm) and last (60 wcpm) sessions were above the goal of 38.

The study was terminated with Liz after the third intervention phase because she had surpassed the 72% over baseline criterion. Liz's baseline mean was 18 wcpm thus making the final termination criterion 31 wcpm. Liz read at 37 wcpm during one session of the Criterion Change 1 phase. During the Criterion Change 2 phase, Liz's criterion was set at 32 wcpm which she reached during the fourth and fifth sessions at that level with 42 wcpm during both sessions.

Nontransfer effects. During all but one session, Liz demonstrated nontransfer effects. During Session 15, Liz's wcpm for her first reading was 21 wcpm, the second reading dropped to 17 wcpm, and the final reading was at 20 wcpm. Thus, the first reading was the fastest for that session. This session was one of the sessions in which Liz was extremely distracted by being in a different room due to statewide assessment being conducted in the building. The range of difference between Liz's first reading and the fastest reading was between -1 to 36 wcpm. The average change was 15.36 wcpm, thus demonstrating that she was able to increase her reading speed from the first reading to the subsequent readings (nontransfer effects).

Table 11.

Liz's Change in wcpm from First to Final Reading

Phase	Session Number	First Reading wcpm	Final Reading wcpm	Change in wcpm
Baseline	1	21	--	--
	2	18	--	--
	3	16	--	--
Criterion Change 1	4	17	37	20
	5	17	26	9
	6	21	27	6
Criterion Change 2	7	23	29	6
	8	15	30	15
	9	11	22	11
	10	19	42	23
	11	21	42	21
Criterion Change 3	12	18	29	11
	13	15	24	9
	14	15	32	17
	15	21	20	-1
	16	25	37	12
	17	24	60	36

Transfer effects. PND was calculated to look for transfer effects in Liz's performance on novel reading passages. Her highest wcpm during baseline was 21. During the Criterion Change 1 phase, her wcpm on first passages was 17, 17, and 21 which yielded a PND of 0%. During the Criterion Change 2 phase, PND for Liz was 20.00% since wcpm for first reading sessions was 23, 15, 11, 19, and 21. In the Criterion Change 3 phase, Liz had wcpm of 18, 15, 15, 21, 25, and 24 with a PND of 33.33%. This increasing PND indicates that there may have been slight transfer effects in Liz's performance.

Table 12.

Liz's Transfer Effects (Percent of Nonoverlapping Data)

Phase (wcpm for first readings)	Comparison Phase highest wcpm	PND (%)
Baseline (21, 18, 16)	--	NA
Criterion Change 1 (17, 17, 21)	Baseline 21 wcpm	0%
Second criterion change (23, 15, 11, 19, 21)	Criterion Change 1 21 wcpm	20.00%
Third criterion change (18, 15, 15, 21, 25, 24)	Criterion Change 2 23 wcpm	33.33%

Accuracy. Liz increased her accuracy during all intervention sessions with an average increase of 11.26% and a range of 1.96% - 21.31%.

Table 13.

Liz's Change in Percentage of Accuracy from First to Final Reading

Phase	Session Number	First Reading % Accuracy	Final Reading % Accuracy	Change in % Accuracy from first to final reading
Baseline	1	96.30	--	--
	2	88.00	--	--
	3	90.39	--	--
Criterion Change 1	4	83.05	91.53	8.48
	5	81.36	94.92	13.56
	6	84.72	90.28	5.56
Criterion Change 2	7	77.05	98.36	21.31
	8	73.08	90.85	17.77
	9	70.91	90.90	19.99
	10	83.64	100.00	16.36
	11	88.46	96.15	7.69
Criterion Change 3	12	83.33	95.24	11.91
	13	83.05	93.22	10.17
	14	95.56	100.00	4.44
	15	92.31	95.38	3.07
	16	94.12	96.08	1.96
	17	84.62	100.00	15.38

Comprehension. Liz had an average change in percentage of correct answers on comprehension questions from first to final readings of 18.63% which indicates positive nontransfer effects. Her average percentage of correct responses during first readings was 64.71% and on final readings, her average was 83.33%. Across phases, there was no consistent pattern to suggest transfer effects on comprehension as her averages of correct responses were 77.78%, 33.33%, 46.47%, and 88.89%.

Table 14.

Liz's Comprehension

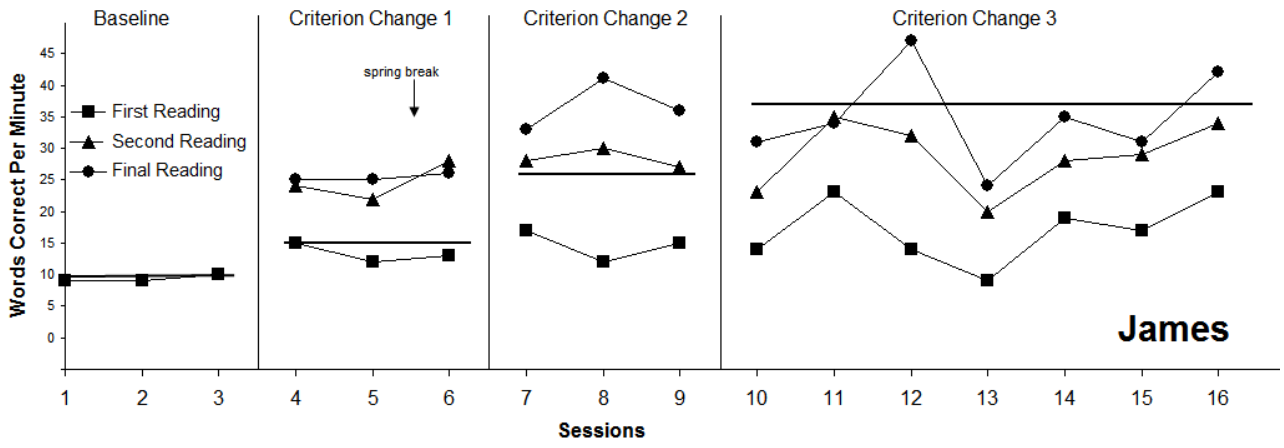
	Average % Correct on First Reading	Average % Correct on Final Reading
Baseline	77.78	--
Criterion Change 1	33.33	66.67
Criterion Change 2	46.67	80.00
Criterion Change 3	88.89	94.44
Total Average % Correct	64.71	83.33
Total % of Change from First to Final Reading =	18.63%	

James

Reading fluency (wcpm). James completed the study in 16 sessions. His baseline mean was 10 wcpm. The first criterion was set at 15 which was a 50% increase over the baseline mean. During all three of the sessions during the first intervention phase, both the second and third readings were higher than criterion of 15 wcpm. During session six, which was the third intervention session, James' second reading was slightly faster than his final reading.

Figure 5

James' Words Correct Per Minute



The second criterion change was set at 26 wcpm and James met criterion three out of three sessions with both the second and third readings being higher than the criterion of 26 wcpm. During the Criterion Change 3 phase, James showed more variability in his performance and required seven sessions before meeting criterion at this criterion change level. Criterion was set at 37 wcpm. James met criterion during the third session of this criterion level by having one final reading above 37 wcpm, but then required three more sessions before meeting the criterion of two sessions at or above criterion level when his final reading was again above 37 wcpm.

Terminal criterion for James was set at 17 wcpm which represented a 72% increase over baseline mean of 10 wcpm. The intervention was terminated with James after the Criterion Change 3 phase because he had surpassed the terminal criterion during Criterion Change 1 phase. During the Criterion Change 1 phase, James' fastest readings were at 25, 25, and 28 wcpm, thus passing the 72% terminal criterion level.

Nontransfer effects. James demonstrated positive nontransfer effects during all intervention sessions. The range of difference in wcpm from the first reading of a session to the fastest was between 10 – 33 wcpm with the mean difference being 18 wcpm.

Table 15.

James' Change in wcpm from First to Final Reading

Phase	Session Number	First Reading wcpm	Final Reading wcpm	Change in wcpm
Baseline	1	9	--	--
	2	9	--	--
	3	10	--	--
Criterion Change 1	4	15	25	10
	5	12	25	13
	6	13	26	13
Criterion Change 2	7	17	33	16
	8	12	41	29
	9	15	36	21
Criterion Change 3	10	14	31	17
	11	23	34	11
	12	14	47	33
	13	9	24	15
	14	19	35	16
	15	17	31	14
	16	23	42	19

Transfer effects. James demonstrated some positive transfer effects. His highest wcpm during baseline was 10. For the Criterion Change 1 phase, his first readings were at 15, 12, and 13 wcpm with a PND of 100%. In the Criterion Change 2 phase, 33.33% of James' readings (17, 12, 15 wcpm) were higher than the highest point in the Criterion Change 1 phase (15 wcpm). In the Criterion Change 3 phase, James had a PND of 42.86% with three out of seven readings (14, 23, 14, 9, 19, 17, 23 wcpm) being higher than the highest reading of 17 wcpm in the previous phase.

Table 16.

James' Transfer Effects (Percent of Nonoverlapping Data)

Phase (wcpm for first readings)	Comparison Phase Highest wcpm	PND (%)
Baseline (9, 9, 10)	--	NA
Criterion Change 1 (15, 12, 13)	Baseline 10 wcpm	100%
Criterion Change 2 (17, 12, 15)	Criterion Change 1 15 wcpm	33.33%
Criterion Change 3 (14, 23, 14, 9, 19, 17, 23)	Criterion Change 2 17 wcpm	42.86%

Accuracy. James demonstrated positive nontransfer effects for accuracy for all sessions. The average percent of change from the first reading to the final reading for James was 15.0% with a range of 3.85% to 40.38%.

Table 17.

James' Change in Percentage of Accuracy from First to Final Readings

Phase	Session Number	First Reading % Accuracy	Final Reading % Accuracy	Change in % Accuracy from first to final reading
Baseline	1	75.93	--	--
	2	80.00	--	--
	3	80.77	--	--
Criterion	4	84.75	98.31	13.56
Change 1	5	77.97	96.61	18.64
	6	76.67	98.33	21.66
Criterion	7	88.52	95.08	6.56
Change 2	8*	59.62	100	40.38
	9	85.45	100	14.55
Criterion	10	85.45	96.36	10.91
Change 3	11	88.46	92.31	3.85
	12	88.10	100	11.9
	13**	67.80	96.61	28.81
	14	93.33	100	6.67
	15	87.69	95.38	7.69
	16	90.20	100	9.8

* During Session 8, James skipped one entire line of text during first reading.
**During Session 13, James was distracted as described in text.

Comprehension. James showed positive nontransfer effects on comprehension. His average percentage correct on first readings was 75%. On final readings, his average correct was 92.31%. This indicates an average change from first readings to final readings of 17.31%. James' averages on first readings across phases (88.89%, 55.6%, 66.67%, 80.95%, 75.00%) did not indicate a pattern that would suggest transfer effects occurred for comprehension.

Table 18.

James' Comprehension

	Average % Correct on First Reading	Average % Correct on Final Reading
Baseline	88.89	--
Criterion Change 1	55.56	100
Criterion Change 2	66.67	100
Criterion Change 3	80.95	85.71
Total Average % Correct	75.00	92.31
Total % of Change from First to Final Reading =	17.31%	

Interobserver Reliability and Procedural Fidelity

Interobserver reliability and procedural fidelity were collected for a minimum of 33% of sessions for each participant. At least one session of baseline and at least one session per criterion change phase were selected for assessment of IOR and procedural fidelity. IOR and procedural fidelity were collected for 7 out of 17 sessions (41.18%) for Liz, 6 out of 16 sessions (37.5%) for James, 5 out of 12 sessions (41.67%) for Marcus, and 4 out of 12 sessions (33.33%) for Simon. For reading accuracy, the results indicated an interobserver agreement range of 89.93% to 100%. Mean agreement on reading accuracy by participant was 98.11% for Liz, 100% for James, 99.63% for Marcus, and 99.09% for Simon with an overall mean of 99.17%. For reading rate, agreement was 100%. Procedural fidelity was 100% in all sessions.

Social validity. A 5-point Likert-type scale with the questions as shown in Table 19 was administered at the completion of the study to assess the social validity of

procedures. Students were given a number scale with the numbers one through five along with the corresponding rating information. For example, the words, “strongly disagree” were placed under the number one, “agree” under the number two, “maybe” under the three, “agree” under the four, and “strongly agree” under the five. All items on the instrument received “agree” or “strongly agree” except for “I really like having the teacher tell me the words I miss” for which Liz indicated, “Maybe.” On the final question which asked if participants would like to continue the treatment package, two students noted “agree” and two said “strongly agree.” The student averages out of a total possible of 5 were as follows: Simon 4.5, James 5.0, Marcus 4.3, and Liz 3.9.

The average score for each of the repeated readings-related questions was 4.5. For the question asking if repeated readings helped them read faster, Marcus and James strongly agreed and Simon and Liz indicated they agreed. When asked if they liked rereading the passages, Simon and James strongly agreed while Marcus and Liz agreed. When asked about computer modeling, only James strongly agreed that it helped him read faster. The other three students said they agreed that it did. The average for that item was 4.25. As far as liking having the computer read to them, Liz agreed while the other three students strongly agreed yielding an average for that item of 4.75. This finding was not surprising because during the course of the study, the three boys all expressed a big interest in the computer and made comments such as, “This is cool!”

In terms of error correction (average score 4.25), James was the only student who strongly agreed that it helped him make fewer mistakes while the other students agreed. James and Simon strongly agreed that they liked having the researcher provide error correction. Marcus agreed that he liked it and Liz indicated a neutral response (maybe).

That item received an average of 4.25. Only James gave a score of strongly agree to the question about liking seeing the progress on the graph. The other three students agreed that they liked it. This was surprising since the three boys appeared anxious to see their graph each day. Several times, the researcher was asked if they could have a copy of their graphs to take home (which they were given at the conclusion of the study) and Simon reported his progress to his teacher every time he reentered the classroom after participating in the study for the day.

As far as the students' view of the overall treatment package, James strongly agreed and the others agreed that they made a lot of progress through the entire package with an average item score of 4.25. Two students (Simon and James) strongly agreed and two (Marcus and Liz) agreed that they would like to continue using the treatment package. This finding is not surprising because Simon and James were the most enthusiastic about participating in the study and commented numerous times to the researcher that they enjoyed it. For the question asking if students felt they could understand their reading when they read faster, Liz agreed and the other three students strongly agreed (item average of 4.75). The overall average for all items was 4.43 indicating that the students felt they were able to read faster because of the treatment package and that they enjoyed participating in the study.

Table 19.

Social Validity Questionnaire

Social Validity Item	Simon	Marcus	Liz	James	ITEM AVERAGE
Reading a passage several times made me read a lot faster.	4	5	4	5	4.5
I really like rereading the passages.	5	4	4	5	4.5
Watching and listening to the computer really helps me read faster.	4	4	4	5	4.25
I really like having the computer read to me.	5	5	4	5	4.75
Having the teacher tell me the words I missed helps me read with fewer mistakes.	4	4	4	5	4.25
I really liked having the teacher tell me the words I missed.	5	4	3	5	4.25
I really liked seeing the progress I was making on the graph.	4	4	4	5	4.25
I really made progress by rereading passages, having the computer read to me, and hearing the words I missed.	4	4	4	5	4.25
When I read faster, I can understand everything I read.	5	5	4	5	4.75
I would really like to keep rereading passages, having the computer read to me, hearing the words I missed, and seeing my work on a graph.	5	4	4	5	4.5
STUDENT AVERAGE	4.5	4.3	3.9	5	Overall Average 4.43

Discussion

Because students with physical disabilities often have reading difficulties, it is important to examine reading instruction methods that are effective with this population. One reading skill with which students with physical disabilities often have trouble is reading fluency. There is very little research available which looks at reading instruction for students with physical disabilities. Literature on reading fluency with this population

is extremely sparse. Therefore, the purpose of this study was to examine the effects of a treatment package consisting of methods that have been shown to be effective with other populations, on reading fluency and comprehension of students with physical disabilities. The treatment package consisted of repeated readings with computer modeling, error correction, and performance feedback. This study addressed four research questions. They were:

1. To what extent is a treatment package using repeated readings with computer modeling, error correction, and performance feedback effective in increasing the nontransfer effects of oral reading fluency for students with physical disabilities?
2. To what extent is a treatment package using repeated readings with computer modeling, error correction, and performance feedback effective in increasing the transfer effects of oral reading fluency of students with physical disabilities?
3. To what extent is a treatment package using repeated readings with computer modeling, error correction, and performance feedback effective in decreasing the number of errors from the first reading to the last reading of a session (nontransfer effects)?
4. What is the effect of a treatment package using repeated readings with computer modeling, error correction, and performance feedback on the reading comprehension of students with physical disabilities for both nontransfer and transfer effects?

The data from this study support the use of the treatment package for students who have physical disabilities. Students in this study made gains in reading fluency and accuracy

during individual reading sessions (nontransfer effects) and some students made slight gains in reading fluency (transfer effects).

Moreover, this study added to the literature base in physical disabilities by being the first to use such a treatment package to address reading fluency with students who have physical disabilities. There is only one known study addressing reading fluency and only a few known studies addressing the use of computer modeling for students with physical disabilities. The participants in this study had intellectual or academic functioning which was lower than in many other reading fluency studies given that two students had IQs documented in the mild range of mental retardation and all students had achievement scores that were considerably below average for their age. The participants also had reading fluency rates that were significantly lower than rates in many other reading fluency studies. The results of this study are encouraging when considering these participant factors. Because the students in this study made gains in reading fluency when exposed to the treatment package, further research with students who have similar cognitive and physical disabilities is warranted. One other addition to the literature offered by this study is the inclusion of comprehension questions. Many reading fluency studies do not measure comprehension. Since comprehension is often stated as being important to reading fluency, this study adds to the literature that examines increased comprehension in light of increased reading fluency. Student results for each of the research questions will now be discussed.

Nontransfer Effects

Nontransfer effects are the increases (positive) or decreases (negative) in reading fluency across repeated readings of the same passage during an individual reading

session. Positive nontransfer effects are important because they demonstrate the student's ability to improve reading speed, accuracy, and comprehension with practice (Therrien, 2004). The most important issue with nontransfer effects is comprehension. According to LaBerge and Samuels (1974), increased reading speed clears working memory and allows for greater comprehension. In this study, all students demonstrated positive nontransfer effects for reading rate, reading accuracy, and overall wcpm (rate plus accuracy). This is consistent with findings by the National Reading Panel (National Institute of Child Health and Human Development, 2000) and with a meta-analysis by Therrien (2004) which both found over numerous studies that repeated readings led to large nontransfer effects on fluency and comprehension for students with and without learning disabilities.

Because the calculated wcpm reflects the rate and the accuracy, it is possible for a student to improve only one skill and still show an increase in wcpm. For example, if the student increased only in reading speed, but the number of reading errors remained the same or slightly decreased, the wcpm could still reflect improved performance. For the purposes of identifying the specific skills which increased, it is important to look at accuracy and rate in addition to wcpm. Since the benefit of increased fluency is increased comprehension, it is also important to examine how the positive nontransfer effects on fluency affect reading comprehension.

Nontransfer effects on wcpm. The measure used as the final determinate of reading fluency in this study was words correct per minute (wcpm). This measure demonstrates effects of the treatment package on the overall fluency rate. In terms of nontransfer effects in wcpm, all students showed increases in reading fluency from first

to final readings. Average increases for each student indicate that positive nontransfer effects were present. The average increase from the first reading to the final reading was 15.89 wcpm across all students. James and Simon had the highest increases in wcpm (17.46 wcpm for James, 17.44 wcpm for Simon) as compared to Marcus (15.11 wcpm) and Liz (13.93 wcpm). This may be attributed to the fact that James and Simon started with the lowest wcpm so therefore had the most room for improvement.

Only one student (Liz) had one session where wcpm did not increase from the first reading to the final reading. During Session 15, Liz's wcpm decreased from 21 to 20 which resulted in an increase in accuracy of two more words correct but a decrease in time by 17 seconds. This possibly was due to Liz being extremely distracted. This was one of the intervention sessions conducted in the orchestra room due to state-wide testing. During this session, Liz kept commenting on a poster that was in the room and singing a song about the colors on the poster. Positive nontransfer effects were present for all other sessions; however, in two sessions (sessions 5 and 13), Liz read faster during the second reading than the final. Two components of wcpm are accuracy and reading rate which will now be further examined.

With the exception of Liz, graphic analysis of the data indicate a pattern with the most improvement between the first and second readings. Between the first and second readings, students were able to read along with the computer model. Thus, the second oral reading was the students' third exposure to the text. Because this treatment package had oral as well as silent reading with a model, it cannot be determined what role the number of readings played or what amount of gain was attributable to the modeling.

Further research is needed to tease out the effects of these elements in the treatment package.

Nontransfer effects on accuracy. All students showed positive nontransfer effects on accuracy. The range of number of words increased was from one to 21 words with the average being 8.69 across students (which was a 15.71% increase).

Liz showed the least amount of improvement in accuracy with a low of one word and a high of 13 words. However, it is notable that during the sessions where her improvement was low, there was not a lot of room for improvement. During the session where she only increased by one word, she only made three errors in the first reading and then made two errors in the final reading. During three sessions, Liz had a final reading accuracy of 100%. Overall she demonstrated positive nontransfer effects with her average improvement being 6.07 words.

The other three students showed greater improvements than Liz in accuracy within each session. This indicated the treatment package was effective on increasing accuracy. The average nontransfer number of correct words read were 8.31 words for James (range 2 -21), 9.67 words for Marcus (range 4-16), and 12.33 words for Simon (range 6-20). James had five sessions in which his final reading accuracy was 100% which included the session with the largest number of words incorrect during the first reading (21). Marcus also showed marked nontransfer improvements in reading accuracy. On his final readings, he had one session with five errors, one session with four, and all other sessions had two or fewer errors. Thus, Marcus' accuracy was greatly improved from first to final readings. Simon had the highest average number of words improved. His error rate during initial readings was higher than the other students' initial reading

error rates. Simon improved accuracy in all sessions by at least six words. On final readings, he had five sessions with two or fewer errors.

Overall, the data reveal that the treatment package was effective in increasing nontransfer effects in reading accuracy for all students. In particular, having the teacher go over the words that were missed was felt to be useful to the students. On the social validity questionnaire, students agreed that having the teacher tell them the words they missed helped them to read with fewer mistakes (mean 4.25 out of a 5 point likert scale with a range of 4 to 5). When asked if they liked having the teacher tell them the words they missed, there was a positive mean score of 4.25 with all scores being 4 or 5 except for Liz who selected a score of 3.

Nontransfer effects on reading rate. Although the overall wcpm increased and accuracy increased, questions remain if the increase in fluency was due solely to an increase in accuracy alone, or if the reading rate actually increased. Calculations were done for each student to determine if there was an increase in reading rate (wpm), regardless of the accuracy. In terms of reading rate alone, each student was able to improve from the first to the final reading. All students showed an increase, with an overall mean increase of 14.13 wpm. Student's average increases in wpcm were Simon 14.37, Marcus 13.24, Liz 13.43, and James 15.48. These numbers demonstrate that the treatment package was effective in increasing the rate at which students were able to read when comparing their first reading to the final reading, in addition to increasing accuracy. In two sessions, Liz's reading rate decreased. As previously mentioned, in session 15, her wcpm went from 21 to 20. During that session, her accuracy increased by two words, but her rate decreased by 2.09 wpm. In session 7, Liz's wcpm increased from 23 wcpm to 29

wcpm; however, this increase was due to an increase in accuracy of 13 more correct words because her reading rate in this session decreased by .73 words per minute. The decrease in rate was possibly attributable to her increase effort to read more accurately after error correction was provided for that session.

Students also had a positive response to the treatment package increasing reading rate. On the social validity scale, students reported that they felt that reading the passages several times made them read a lot faster (overall mean 4.5 on Likert scale). They also indicated that they liked rereading the passage (overall mean of 4.5). This indicates that the repeated readings portion of the treatment package was viewed as helpful and enjoyable to the students.

Nontransfer effects on comprehension. An increase in reading rate and accuracy has been attributed to an increase in comprehension (National Institute of Child Health and Human Development, 2000). The comprehension results of this study demonstrated an increase for all students, showing similar findings as the The National Reading Panel (NICHHD, 2000) in which repeated readings led to positive nontransfer effects in the area of comprehension. However, the National Reading Panel stated that the results in comprehension were not as high as the results for word recognition or fluency. The results of this study are inconsistent with the findings of the National Reading Panel in that the average percentage of change in comprehension was 16.16% as compared to a 15.71% average change in accuracy and an average change of 15.89% in wcpm. Students' average correct percentage of comprehension questions on first readings was 73.12% and the average correct percentage of comprehension questions for final readings was 89.28%. Although this study cannot conclusively determine why that may have been

the case, students with physical disabilities often have less experience with print which can affect comprehension. This is the case with these participants given their age and only reading at the preprimer level.

Marcus had slightly higher percentages of comprehension both on initial readings and final readings. His initial reading comprehension was 77.78% compared to Simon's (75.00%), Liz's (64.71%), and James' (75.00%). His average on comprehension following final readings was 92.59% as compared to Simon (88.89%), Liz (83.33%), and James (92.31%). This may have been due to his being a grade level ahead of the other students, having the highest reading score, and hence possibly having more exposure to print.

Liz had the lowest comprehension on initial and final readings even though she had the highest average wcpm for both. Even though Liz has the least significant physical effects of cerebral palsy, she has diagnoses of Periventricular Leukomalacia, and Seizure Disorder. Additionally, she had the lowest documented IQ of the four participants with a score of 67 on the Differential Abilities Scale. These diagnoses indicate damage to wider areas of the brain beyond the primary motor cortex which may play a part in explaining why Liz demonstrates inconsistencies in her reading performance and behaviors.

After final readings, many students increased to 100% accuracy on answering comprehension questions. Simon had six out of nine (66.67%) intervention sessions where he had 100% accuracy on comprehension questions after the final reading. Marcus had 100% accuracy on comprehension after the final reading for seven out of nine (77.78%) intervention sessions. Liz and James had 9 out of 14 sessions (64.28%) and 11 out of 13 (84.62%) sessions at 100% after final readings respectively.

In this study, the treatment package was effective in yielding positive nontransfer effects in overall reading fluency (rate plus accuracy), reading accuracy and reading rate for all students. The participants in the study all had baseline reading fluency under the 10th percentile for their grade levels. The treatment package provided the students with practice reading the same passage multiple times as well as a model of fluent reading. Although reading fluency rates for the final readings did not exceed the 10th percentile, all students were able to increase their reading fluency on final readings by more than 72% as compared to baseline. This provided the students with the opportunity to practice reading at a much more fluent rate.

One of the advantages of reading faster and more accurately on subsequent readings of the same passage (positive nontransfer effects) is increased comprehension. In this study, once the treatment package was implemented, students increased reading fluency and accuracy from first to final readings and also increased comprehension. This supports the LaBerge and Samuels theory of automaticity in reading (Samuels, 2004) that proposed that repeated practice which allows students to read more fluently rather than concentrating on decoding frees up cognitive reserves so the reader can focus on comprehension. Students also supported a positive outcome by reporting on the social validity scale that they felt when they read faster, they can understand everything read (overall mean 4.75 on 5 point Likert scale).

Transfer Effects

Transfer effects on fluency. Transfer effects for reading fluency are the changes in fluency rates over time on reading novel passages. These effects represent an overall growth in reading fluency rate (Therrien, 2004). In this study, no clear transfer effects

results were found. This is not surprising given the limited studies in the literature which found transfer effects (Therrien, 2004). In this study, three students (Simon, Liz, and James) showed some improvements in fluency of reading novel passages; however, the fourth student's (Marcus) initial readings actually decreased.

Given the length of the study, it is not surprising that larger transfer effects were not present. The number of intervention sessions ranged from 9 – 14. More stringent criteria in the changing criterion design may have resulted in a longer study. A lengthier course of intervention may have promoted generalization of increased reading fluency to novel passages. Additionally, criterion levels were based on the fastest reading per session rather than on novel readings. Setting criteria for novel passages may promote transfer effects.

James showed the most transfer effects of all four students. He demonstrated transfer effects with his PND being 100%, 33.33%, and 42.86%. Although it is not conclusive as to the reason, James had the most room for improvement in his reading because he was the youngest student and had the slowest reading fluency. He also had the most significant physical disability. The researcher also anecdotally noted that James was the most motivated of the students and he had the highest ratings on the social validity scale of all the participants. According to anecdotal notes on his data sheet, his final PND might have been even higher (57.14%) except for session 13 which was conducted in his prone stander and resulted in fatigue and a high rate of errors.

Two other students showed some transfer effects. Simon had the next highest transfer effects (0%, 66.67%, and 33.33%). Liz was next with 0%, 20.0%, and 33.33%. Liz started with the highest reading fluency rate. It is possible, especially considering that

she made the least improvement in nontransfer effects, that she was reading closer to her potential rate at the onset of the study and had less room for improvement. Additionally, her variable performance, possibly due to behavioral factors, impacted her initial reading performance and, thus, her PND.

The fourth student (Marcus) demonstrated negative transfer effects. Marcus' PND was 0% on all intervention phases and he actually demonstrated a decrease of average wcpm on initial readings across phase changes. One factor that may have influenced his performance is having over five absences over the course of the study which was a 41.67% absence rate. The absences were spread across the length of the study so no pattern can be seen which coincides with his negative transfer effects. The exact reasons Marcus had negative transfer effects cannot be definitively determined.

Transfer effects on accuracy and comprehension. No transfer effects were seen in the area of accuracy or comprehension for any participant. Since there was not a significant increase in fluency on novel passages, it would not be expected that there would be an increase in accuracy or comprehension. This is in line with the literature (Therrien, 2004) where studies have shown positive nontransfer effects in fluency, accuracy, and comprehension but have not shown positive transfer effects for these three areas. Further research is needed on the impact of comprehension when positive transfer effects are present.

Computer Modeling

One of the unique aspects of this study was the use of computer modeling. Computer modeling has the advantage of providing increased opportunities for students to practice skills without relying on a human model; thus decreasing the amount of 1:1

teacher instruction needed. Although it does not have prosody as a human voice would, it does provide a model with controllable speed. In addition, some software, such as the type used in this program, has the advantage of visual tracking of text while it is being read which provides additional student support.

The use of a computer model, as with any type of reading model, makes it difficult to know what to attribute the results to, especially in the area of comprehension. Although there was a definite increase in comprehension upon implementation of the treatment package, it is uncertain if the increase in comprehension is because of an increase in reading fluency or if hearing the computer read the passage resulted in an increase in comprehension due to listening comprehension. Students in this study exhibited behaviors that indicated they were reading along silently with the computer model (e.g., moving their lips along with the words, eyes appeared to be tracking as computer highlighted words). However, there is no definitive measure to determine if they were reading silently with the computer or merely listening to the passage. Although other studies without computer models resulted in increases in fluency and comprehension, indicating that an increase in comprehension can occur due to rereading passages without a model, it is not possible to know what to attribute the increase in comprehension to in this study. Future research is necessary to single out the role of computer modeling in increasing fluency, accuracy, and comprehension. The potential benefits for classroom instruction of computer modeling being able to free up teacher time while providing students with increased opportunities to respond warrants further exploration of the benefits of this method.

Students also supported the use of the computer. In their social validity questionnaire, students agreed that they really liked having the computer read to them (overall mean 4.25 out of 5 point Likert scale, with a range of 4 to 5). In addition, they felt that watching and listening to the computer helped them read faster (overall mean score of 4.25 out of 5 point Likert scale, with a range of 4 to 5).

Physical Disabilities and Fluency

Several other factors from this study are notable. One such factor is the impact of physical disabilities on reading performance and on research. Students with physical disabilities tend to have higher absence rates than other students. Marcus had frequent absences and demonstrated negative transfer effects. It is not able to be determined if there is any relationship although the impact of absences on academic performance is well documented in the literature (Heller, Forney, Alberto, Best, & Schwartzman, in press). Regarding the effect of absences on research, this is one of the problems in conducting research with students who have physical disabilities. It is not clear what impact Marcus' absences had on the outcomes of the study. When choosing participants who have physical disabilities, researchers must keep in mind that frequent medical appointments and a higher susceptibility to illnesses can result in high absence rates that may impact the study.

Of the four participants, James has the most significant physical disability. His movement patterns were slower and less controlled than the other students. James' speech was slightly dysarthric but was intelligible to the researcher. He demonstrated poor breath support and talked somewhat softly and slowly. His teacher noted that his posture and speech had decreased since the insertion of a Baclofen pump one year before

the study. Physical disabilities can result in restricted access to typical early literacy experiences and students with dysarthric speech may speak more slowly to increase their intelligibility. James' posture appeared to impact his reading performance by limiting his access to materials (lack of the ability to finger point for tracking text in this case) as well as resulting in poor breath support which required him to occasionally pause during reading to breathe. These factors may have been the reason that James had the lowest reading fluency rate.

Students with physical disabilities tend to develop good adult interaction skills because they are around more adults (e.g., therapists, doctors, orthotists) than children without physical disabilities. In this study both Marcus and James had to be reminded not to stop while reading to engage in other conversation. Marcus was especially easily distracted and occasionally commented on words that appeared in the text or engaged in self-talk in the middle of reading such as, "Oh, I think I missed that word." Each day before the session began, the researcher reminded him to concentrate on reading and not to "chit-chat" until they were completely finished for the day. This does not really explain his decreasing fluency rate on novel passages because he engaged in these behaviors less frequently as the study progressed. James did not engage in these behaviors as frequently as Marcus, but the researcher provided the same reminder to him at the beginning of each session.

Behavioral factors definitely had an impact on reading performance for Liz during this study. Of the four participants, Liz has the least significant physical disability. However, she has several concomitant disabilities that require her to take medications. It is unknown what factors may have contributed to her inappropriate behaviors during

some sessions. Interestingly, Simon, who met eligibility for the behavioral disorders program and was living in a foster situation seemed to have the least impact of behaviors during this study. Simon's teacher reported that in the classroom, he demonstrated inappropriate laughing, talking, or teasing classmates during class instruction. He also demonstrated problems with anger management and when upset or frustrated would exhibit self-injurious behavior. Simon had a behavior plan in place and attended regular sessions with the school counselor. One day when the researcher arrived, Simon was crying and talking to the counselor in the classroom after having had a difficult morning so he did not participate in the intervention that day. However, no inappropriate behaviors were noted when Simon was with the researcher. During all baseline and intervention sessions, Simon was enthusiastic and cooperative. He did not appear to be easily frustrated and would attempt difficult words with a very positive attitude.

Limitations and Future Directions

There are several limitations of this study. First, the fact that there were only four participants all of whom had cerebral palsy limits generalization of the findings across the population of students with physical disabilities as a whole. More research is needed to assess reading interventions with this population as well as with other populations of students. Another limitation is the length of the study. This study may not have been sufficient in length to demonstrate full transfer effects for all students. A final limitation is that because the independent variable was a treatment package, it is not clear which elements yielded the students' increased reading fluency. Further research needs to be conducted to examine the effects of each element of the treatment package on reading fluency for students who have physical disabilities.

Further research is needed examining text difficulty. Kuhn and Stahl (2004) noted that several studies did not find effects for text difficulty on reading fluency. They found effects to be strongest for interventions where readers were between a late preprimer level and a late 2nd grade level. Kuhn and Stahl stated that the most successful approaches were found to be in studies where children were reading instructional-level texts or even text at the frustration level with strong support. In this study, the participants were all at the preprimer level. The materials used were the lowest level stories from Reading Recovery book room materials which contained connected text. On these materials, many times students initial readings were below 90% accuracy indicating that the materials were not at the independent level. While all students demonstrated positive nontransfer effects in this study, further research is needed to determine if reading level would have made a difference in transfer effects. Perhaps if materials had been at the independent level, stronger positive transfer effects would have been present.

Further research is needed on the use of computer modeling. Computer modeling has an advantage over auditory-only modeling in that the words can be highlighted on the screen while they are being read. Limited research has been done to compare these two forms of modeling. However, children are often motivated by the computer. In this study, all of the students appeared to be interested in the computer and were generally attentive to the computer models. Although prompted to read along silently with the computer, Liz often read aloud while the computer read or at least moved her lips in silent reading. Simon and James did not read aloud with the computer, but the researcher observed both boys following intently along with their eyes during most of the computer readings. Occasionally, Marcus had to be prompted to follow along with the computer. This was

not a frequent occurrence, but it could have impacted his performance as far as transfer effects were concerned. This element of the treatment package needs a lot further examination to see if (a) highlighting while reading makes a difference, (b) student attentiveness correlates with the effects of computer modeling, and (c) computer modeling is more or less motivating than other forms of reading fluency instruction. An additional factor to consider in computer modeling is the lack of prosody. Because the speech is synthesized rather than digitized, the voice in Kurzweil 3000 is choppy and robotic. The program does have some elements of prosody programmed such as raising of the tone of the voice at the end of a question.

Summary

This study demonstrated that a treatment package consisting of repeated readings, computer modeling, error correction, and performance feedback was effective in increasing reading fluency in students who have physical disabilities. All four students with physical disabilities in this study demonstrated positive nontransfer effects in reading fluency, accuracy, and comprehension with implementation of the treatment package. While transfer effects were minimal in this study, the fact that some transfer effects were present suggests that, under different conditions or perhaps with lengthier intervention, more transfer effects may be made. The results of this study are encouraging and contribute to the literature in several ways.

First, this study demonstrated that a treatment package was effective in producing positive nontransfer effects on reading fluency, accuracy, and comprehension. This is consistent with other studies that used repeated readings and adds to the literature base demonstrating the effectiveness of this procedure. Secondly, there is very limited

research demonstrating the effects of academic interventions with students who have physical disabilities. In this study, all participants were able to benefit from fluency instruction using a treatment package which was composed of reading interventions previously used with other students (e.g., students without disabilities, with learning disabilities, with vision impairments). This research adds to the literature base in the field of physical disabilities to show that these students are able to be instructed using methods that research has demonstrated effective with other populations, despite problems inherent to this population of students (e.g., high absentee rate, limited motor movement, impact of breath support on oral reading). Further research is needed to find best practices for teaching fluency skills to this population of students.

This study also demonstrated that a treatment package that included computer modeling was beneficial in increasing reading fluency, accuracy, and comprehension across readings of a passage. Because computer modeling was part of a treatment package in this study, no inferences can be drawn on what affect this part of the package played. Computer modeling has great benefits as far as reducing 1:1 teacher instruction time and providing motivation for students. For students with physical disabilities, computer-assisted instruction opens many possibilities for access that are otherwise unavailable. The computer-assisted instruction used in this study was computer modeling. The technology in this study provided a verbal model paired with visual tracking of text. Few studies have assessed the benefits of this type of technology on reading fluency, accuracy, and comprehension. Software that visually tracks as the text is read onscreen may be especially beneficial in increasing fluency for students who frequently lose their place in a text but lack the ability to physically finger point to each word. More research

is needed to examine computer modeling and, particularly, computer modeling with students who have physical disabilities.

In conclusion, this study shows that students with physical disabilities were able to increase their reading fluency, accuracy, and comprehension with the implementation of a treatment package consisting of repeated readings, computer modeling, error correction, and performance feedback. This was especially evident with nontransfer effects, which is consistent with the literature. Although transfer effects were minimal, further research may show that a treatment package such as the one used in this study would result in overall improvements in reading fluency if used for a lengthier period of time. Overall, this study demonstrates that students with physical disabilities can benefit from a treatment package consisting of research-based fluency interventions and the use of computer modeling can have a positive impact on fluency and comprehension.

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APPENDIXES

APPENDIX A: EXAMPLE DATA SHEET

15 Everyday Math
Benchmark Education Company C3

Student _____ Session _____ Kurzweil Speed _____

Errors		Not counted as errors	
Mispronunciation or substitution	Lions prefer large prey	Self-corrections	Lions prefer large prey
Transpositions (2 errors)	Lions prefer large prey	Errors due to speech differences (dialect or motor speech impairment) - not marked	
Hesitations (word supplied after 3 sec)	Lions prefer large prey	Repetitions	Lions prefer large prey
Omissions	Lions prefer large prey		
Dropped ending	Lions prefer large prey	Insertions	Lions prefer large prey
Repeated errors – if student repeats error, each occurrence is marked and counted as a separate			

1. Review Purpose
2. Review graph/progress and set criterion if needed
3. Remind to read as fast as possible but understand
4. Remind to try each word but if struggle will provide and then move on.
5. Cue to get ready
6. Start reading and start timing.

My grandma and I got some seeds. On Monday, we went to the garden. We put some seeds in the dirt. On Tuesday, we put water on the seeds. On Wednesday, we looked for the seeds. On Thursday, we saw the sun. On Friday, the sun did not come out. On Saturday, we did not go to the garden. On Sunday, the seeds came up.

7. Comprehension ?s
    a. Who got the seeds and went to the garden with the child in the story? (Grandma)
    b. On what day did they plant the seeds in the dirt? (Monday)
    c. Why do you think they planted seeds?

8. Error correction
9. Start 1st computer model – remind to watch and read along silently
10. Cue to get ready for second reading
11. Start 2nd reading and start timing

My grandma and I got some seeds. On Monday, we went to the garden. We put some seeds in the dirt. On Tuesday, we put water on the seeds. On Wednesday, we looked for the seeds. On Thursday, we saw the sun. On Friday, the sun did not come out. On Saturday, we did not go to the garden. On Sunday, the seeds came up.

12. Error correction
13. Start 2nd computer model – remind to watch and read along silently
14. Cue to get ready for third reading

My grandma and I got some seeds. On Monday, we went to the garden. We put some seeds in the dirt. On Tuesday, we put water on the seeds. On Wednesday, we looked for the seeds. On Thursday, we saw the sun. On Friday, the sun did not come out. On Saturday, we did not go to the garden. On Sunday, the seeds came up.

15. Start 3rd reading and start timing
16. Comprehension ?s
    a. Who got the seeds and went to the garden with the child in the story? (Grandma)
    b. On what day did they plant the seeds in the dirt? (Monday)
    c. Why do you think they planted seeds?
17. Error correction
18. Provide verbal feedback and encouragement