REPEATED READINGS AND SCIENCE:
FLUENCY WITH EXPOSITORY PASSAGES

A Dissertation in
Special Education
by
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ABSTRACT

The current study investigated the effects of repeated readings to a fluency criterion (RRFC) for seven students with disabilities using science text. The study employed a single subject design, specifically, two multiple probe multiple baselines across subjects, to evaluate the effects of the RRFC intervention. Results indicated that students met criterion (200 or more correct words per minute with 2 or fewer errors) on four consecutive passages. A majority of students displayed accelerations to correct words per minute and decelerations to incorrect words per minute on successive initial, intervention readings suggesting reading transfer. Students’ reading scores during post-test and maintenance out performed pre-test and baseline readings provided additional measures of reading transfer. For a relationship to comprehension, students scored higher on oral retell measures after meeting criterion as compared to initial readings. Overall, the research findings suggested that the RRFC intervention improves science reading fluency for students with disabilities, and may also indirectly benefit comprehension.
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Chapter 1

INTRODUCTION

In 1996, the National Research Council published a document entitled *National Education Science Standards* and with a sentence summarized their intent: “Science standards for all students (An Overview, ¶ 4).” The National Research Council suggested that while individuals may interact and benefit differently from their experiences with the same standard, all students regardless of background or impairment can make gains understanding science. It appears that the nation has responded as 90% of schools maintain the same science standards for students regardless of disability (U.S. Department of Education, 2006). However, the gains for students with disabilities fall well behind their non-disabled peers. In 2005, an average of 30% of students with disabilities in the 4th, 8th, and 12th grades scored at or above basic proficiency in science compared to an average of 60% of same-aged students without disabilities (Grigg, Lauko, & Brockway, 2006).

These scores should not come as a surprise as students with disabilities often do not meet with the same academic success as those without disabilities. In the case of science education, however, these scores may pose an even greater problem. Individuals with Disabilities Education Act [IDEA] (U.S. Department of Education, 2006) reports that 80% of secondary students with high incidence disabilities (e.g., specific learning disabilities, serious emotional disturbance, visual impairments, etc.) take science with two-thirds receiving instruction in a general education setting. Therefore, many students with disabilities perform well below their peers in science and receive instruction in the same setting with the same standards.
To address the issue of struggling students educated in inclusive settings, the educational system provides accommodations. In total, 65% of students with disabilities receive some form of modification in academic areas (U.S. Department of Education, 2006). Some of the modifications in science instruction include oral instead of written answers (Cawley & Parmar, 2001), changes to the instructional materials (Ormsbee & Finson, 2000), and adaptations to textbooks in the form of study guides (Horton & Lovitt, 1989) and/or graphic organizers (Bergerud, Lovitt, & Horton, 1988). Not limited to only modifications, researchers (Salend, 1998) and focus groups (NRC, 1994) suggest changing instructional styles from more traditional textbook-based to more discovery-, activity-, or inquiry-based instruction addressing students’ diverse “learning styles” (Grumbine & Alden, 2006) and meeting science reform recommendations (e.g., Rutherford & Ahlgren, 1990). On the other hand, direct instruction (McCleery & Tindal, 1999) and strategy instruction (Guastello, Beasley, & Sinatra, 2000; Smith, Dittmer, & Skinner, 2002) have also helped students with disabilities in science. Finally, some have suggested using technology or augmentative devices such as a television (Williams & Hounshell, 1998), computer (Kumar & Wilson, 1997), or a communication device (Davies, 1994).

With many of the suggested science modifications, students spend less time engaged in decoding and comprehension of text due to two factors. First, many students with disabilities display reading deficits (Lee, Grigg, & Donahue, 2007). Oftentimes, students with disabilities have the arduous task of attempting to comprehend poorly organized textbooks sometimes grade levels above their ability (Bergerud et al., 1988; Cawley & Parmar, 2001; Horton & Lovitt, 1989). Second, students with disabilities must
still have access to the general education curriculum including science. In response, researchers and educators have turned to various adaptations and accommodations to provide students with disabilities a gateway to science content while minimizing deficits (Cawley & Parmar, 2001; Grumbine & Alden, 2006; Williams & Hounshell, 1998).

While addressing, to varying degrees, the charge of providing students with disabilities access to science, minimizing reading experiences may hinder current and future opportunities. Science education changes and adaptations to scientific material provide students a limited number of experiences. However, teachers and researchers providing basic academic skill support within the context of science may have untold effects. For example, students with disabilities who improve their reading of science material may better comprehend what they read. This increase to reading productivity would benefit students both in and out of the classroom and may occur even if science education does not rely on printed text alone. Converging, rather than separating, science and reading may help students build both scientific knowledge and improve their reading fluency.

Reading fluency has ties to overall reading ability (Fuchs, Fuchs, Hosp, & Jenkins, 2001; Shinn & Good, 1992), serves as an access point to reading comprehension (Therrien, 2004), and influences content area success (Bhattacharya, 2006). While research shows a number of methods that promote reading fluency, repeated reading has emerged as one of the most effective fluency-building procedures for students with disabilities (Chard, Vaughn, & Tyler, 2002; Kuhn & Stahl, 2003; Meyer & Felton, 1999). Students who practice with the repeated reading method not only increase their ability to
read fluently, but also display reading transfer: the ability to read successive passages faster (Faulkner & Levy, 1994; Rashotte & Torgesen, 1985).

The method of repeated readings arose from the work of researchers (Chomsky, 1976; Dahl, 1974; Samuels, 1979) in the 1970s. Originally, Dahl wanted to address the skills of intermediate level readers while incorporating the theory of automaticity (LaBerge & Samuels, 1974). Repeated readings allow students to master a few select reading passages rather than limited work with many passages akin to the practice beginning musicians receive. Dahl stressed that her use of the word *master* and *mastery* “goes beyond mere accuracy in word recognition (p. 36).” Instead, she concerned herself with a student’s rate of reading and, more specifically, their ability to reach a specific fluency criterion on one passage before moving to another. Dahl proposed that once students reached automaticity they would no longer have to struggle decoding the passage, but could spend time attending to the meaning of the passage.

Different models of repeated reading grounded on a basic structure (Meyer & Felton, 1999) have surfaced through the years. However, not all models produce the same student outcomes. In his meta-analysis of repeated readings, Therrien (2004) identified critical components of repeated reading models. One, in particular, appeared primarily effective: repeated readings to a fluency criterion (e.g., Kostewicz & Kubina, in review; Staubitz, Cartledge, Yurick, & Lo, 2005; Therrien & Kubina, 2007; Yurick, Robinson, Cartledge, Lo, & Evans, 2006). Repeated readings to a fluency criterion helped students improve oral reading fluency and the ability to read new passages faster and reach successive criteria sooner.
What would happen if students improved reading fluency with science material?

Many science classrooms continue to use textbooks as the primary mode of instruction (Cawley & Parmar, 2001). Students who can read fluently may not withdraw when receiving chapter assignments totaling 24-40 pages (Williams & Hounshell, 1998). Students in activity- or inquiry-based classrooms may also improve their ability to incorporate information from text into group discussions. Additionally, fluent readers may improve their ability to fill out concept maps or graphic organizers because they can reference text material faster. Applying repeated readings to a fluency criterion in concert with science instruction may provide a powerful way to help students with disabilities.
Chapter 2

LITERATURE REVIEW

The term “science” has different meanings for different people. For example, Neufeldt (1995) defines science as “systemized knowledge derived from observation, study, etc. (p. 526).” Freeman and Taylor (2006) observe that science helps make sense of phenomena based on observations grounded in empirical methods and logic. Chiappetta, Koballa, and Collette (1998) expand on the two definitions suggesting science may depend on an individual’s viewpoint. Individuals may define science as a collection of information pertaining to science, the procedures involved with hypothesis testing, or as the method of questioning reality and truth (Chiappetta et al.). Conceptualizing science based on both broad and specific meanings entails a knowledge and understanding about nature, the ability to convey that knowledge to others, and a verification of that knowledge which results in expansion and elaboration (Chiappetta et al.). Therefore, an essential part of science hinges on the ability of those that understand science communicate that knowledge to others. One form of science communication takes place in education.

Education, at its core, prepares individuals for productive lives (Rutherford & Ahlgren, 1990). Science education holds similar goals especially considering the ever shrinking world. Concerns when viewed from a scientific perspective, such as the effects of population growth combined with decreasing natural resources, affect individuals across the world. Considering the amount and availability of information via the Internet, people worldwide should have the ability to understand, interact with, and make determinations about scientific knowledge. In other words, individuals require effective
scientific literacy (Gurganus, Janas, & Schmitt, 1995; Rutherford & Ahlgren). Here in the United States, however, Americans have displayed a lack of scientific knowledge especially when compared to other developed countries (Grigg et al., 2006; Grossen & Romance, 1994; Rutherford & Ahlgren). Science education reform has attempted to address science literacy deficits.

Science Educational Reform

The United States Government and other concerned professionals have spent considerable time and energy over the last 20 years examining ways to improve science education. In 1985, the American Association for the Advancement of Science (AAAS) started Project 2061 (AAAS, 2008) as an attempt to address scientific literacy problems in the United States. Project 2061 continues to research and produce materials with the expressed intent of improving science, math, and technology education. One of AAAS’s subsequent publications, Science for All Americans (Rutherford & Ahlgren, 1990), summarized recommendations regarding science instruction and education. These recommendations, originating from a panel of AAAS experts, focus on specific science content, concerns relating to teacher training, and overall science reform (Rutherford & Ahlgren).

Six years after Science for All Americans (Rutherford & Ahlgren, 1990), the National Research Council (1996) released the National Science Educational Standards. Among the many important suggestions for science education, the National Research Council indicated that all students regardless of differences should have the same science education standards. Another committee, the National Commission on Mathematics and Science Teaching for the 21st Century, returned a report to congress in 2000 citing
teacher development and training as a route to improve science instruction (U.S. Department of Education). Five years later, the National Science Board (NSF, 2005) associated with the National Science Foundation produced a comprehensive examination of necessary improvements to science education. The board suggested not only producing effective teachers but also an alignment and coherence of curriculum across grades for science, technology, math, and engineering subject matter. Most recently, the Carnegie Corporation of New York and the Institute for Advanced study sponsored the formation of a new panel to address science education reform (Brainard, 2007).

To summarize the many reports and their recommendations, science education in America faces problems with training and maintaining effective science teachers and delivering effective science curricula. In fact, most science education curricula failed to adequately address science (Rutherford & Ahlgren, 1990). Instead, the focus remained on memorization of facts through difficult and unorganized textbooks while sparsely covering a broad array of topics (Rutherford & Ahlgren). Therefore, science education reform has supported more inquiry- and activity-based scientific experiences (Champagne, Newell, & Goodnough, 1996; Freeman & Taylor, 2006; Le, Stecher, Lockwood, Hamilton, Robyn, Williams, Ryan, et al., 2006; Nolet & Tindal, 1994; Patton, 1995; Rutherford & Ahlgren).

Inquiry-based education moves away from traditional textbook instruction in a variety of ways. For instance, teachers actively engage students during instruction and increase opportunities to participate in group discussions and other group-orientated activities (Freeman & Taylor, 2006; Le et al., 2006). Through multiple avenues, students purportedly connect science and math with reading and writing, relate new experiences to
previous experiences, and further develop conceptual, rather than factual, scientific understanding (Champagne et al., 1996; Freeman & Taylor; Fox, Grosso, & Tashlik, 2004; McKee & Ogle, 2005). With the change in instruction, scientific assessments could evolve to include portfolio and performance measures to better represent students’ varied learning (Champagne et al.; McFarland, 1997). Inquiry-based instruction allows teachers to focus on fewer topics, but cover those topics with a greater degree of depth (Champagne et al.; Chiappetta et al., 1998; Patton, 1995; Rutherford & Ahlgren, 1990).

The current state of science instruction and education in America continues to vary regardless of reform. Some teachers embrace the reforms and suggestions employing activities- or inquiry-based instruction. Still others continue to hold to traditional textbook instruction. And a third group of teachers combine the different techniques in various ways.

Science Literacy and Special Education

Science reform considers all students, regardless of need. For example, the National Research Council (1996) specifically mentioned that all students should have science standards; just how those students interact with those standards vary. Most school districts maintain the same standards for all students and many students with high incidence disabilities receive science instruction in an inclusion setting (U.S. Department of Education, 2006). Norman, Caseau, and Stefanich (1998) found that approximately 240 of 300 elementary and secondary science teachers surveyed reported having students with learning disabilities in their room. However, those same teachers have little or no training in special education and have difficulties relating to students with special needs (Norman et al.). On the other hand, special education teachers receive little or no training
in science instruction (Doran & Sentman, 1994; Ormsbee & Finson, 2000; Patton, 
Polloway, & Cronin 1990). Therefore, students educated outside of inclusion settings 
may not receive the most current science instructional methods requiring special 
education teachers to rely on general education science textbooks (Patton et al.; Grganus 
et al., 1995). The mismatch of training and need helps explain why students with 
disabilities exhibit poor science literacy, but does not tell the full story (Cawley & 
Parmar, 2001; Grigg et al., 2006).

Science education, as mentioned previously, contains a vast amount of 
information that involves many different behaviors associated with academic success 
(Mastropieri & Scruggs, 1994a; Woodward, 1994). Content area instruction, including 
science, involves the culmination and combination of diverse academic skills such as 
applying strategies, reading, writing, listening, and speaking (Deshler, Schumaker, Lenz, 
Bulgren, Hock, Knight, et al., 2001). To make the greatest gains, students must perform 
appropriate academic behaviors efficiently and effectively. However, students with 
disabilities display deficits along some if not all of the necessary characteristics. As a 
result, Grumbine and Alden (2006) present some overall suggestions which can promote 
success in science education for students with disabilities. The suggestions include 
teaching to diverse learning styles, using explicit instruction strategies and objectives, 
matching instruction and assessment, providing consistent feedback, and providing 
opportunities for the student to create self-knowledge (Grumbine & Alden). More 
specifically, educators and researchers have examined various science curricula and 
techniques to improve science literacy for students with disabilities.
Science Curricula for Students with Special Needs

Textbook curricula. Even in the face of many science reforms, many educators continue to use text-book based instruction relying on the student to interact with large amounts of written material, recall facts and information, and listen to lecture (Cawley, Foley, & Miller, 2003; Cawley & Parmar, 2001; Scruggs & Mastropieri, 2007). Woodward (1994) suggests textbook instruction alone presents many problems, as suggested earlier by Rutherford and Ahlgren (1990), and has given way to other types of curricula for students with disabilities.

Activity-based or hands-on curricula. Compared to a text-book approach, activity-based or hands-on approaches focus less on reading and instead allow students to interact with the object(s) of study (Bay, Staver, Bryan, & Hale, 1992; Caseau, & Norman, 1997; Mastropieri & Scruggs, 1994b). Students follow four steps in learning: engagement, exploration, development, and extension (Salend, 1998). Each step extends the student’s experience with the current topic transitioning from concrete to the formation of their own examples to further examine and research (Salend). Additionally, some studies have shown students with disabilities perform better on two (i.e., hands-on assessment and short-answer test) of three science achievement measures when receiving hands-on as compared to text-book instruction (McCarthy, 2005). Even though language and reading receive less attention, Mastropieri and Scruggs (1994b) caution that students with disabilities may encounter social behavioral concerns due to the extensive group interactions.

Guided inquiry-based curricula. As an extension to activities-based or hands-on approaches, teachers can use guided inquiry-based curricula. Using guided inquiry-based
curricula and methods, the teacher acts as a facilitator that guides students as they learn, discover, and construct science knowledge (Dalton, Morroco, Tivnan, & Mead, 1997; Lynch, Taymans, Watson, Ochsendorf, Pyke, & Szesze, 2007; Sasaki & Serna, 1995). Teachers use specific guiding questions to enhance a student’s experience as they interact with particular aspects of the learning environment (Palincsar, Magnusson, Collins, & Cutter, 2001). As teachers ask directed questions, they also actively scaffold the questions based on each student’s ability and experience (Hogan & Pressley, 1997). While written print and reading play a lesser role, students with disabilities still must display effective social behaviors to interact with the class. However, research (Lynch et al.) suggests that students with disabilities gain more experience with conceptual change (i.e., a transition from minimal to more scientifically accurate understanding) as they participate in the classroom learning community.

Other curricula. Researchers have suggested and discussed additional science curricula for students with disabilities. Kataoka and Lock (1995) recommend an integrated science curriculum for students with disabilities. An integrated curriculum combines features from many disciplines (e.g., reading, research, written expression, oral expression, music, art, etc.) for each topic. Students can interact with the same topic across multiple educational avenues allowing for a more complete understanding (Kataoka & Lock).

Another method summarized by Carnine (1989) described a group of studies incorporating Direct Instruction curriculum and the use of technology (e.g., video disc and computer assisted instruction) for science (e.g., earth and life sciences) and mathematics (e.g., fractions). Instead of relying simply on teacher-based instruction,
technology presents a supportive teaching medium. Because students can receive more instruction in a given time, students with disabilities can readily decrease the achievement gap with higher performing students (Carnine).

Cawley et al. (2003) propose universal design as another science curriculum for students with disabilities. As an example, *Science for All Children* (Cawley, Miller, Sentman & Bennett, 1999) provides a framework for science curriculum. Essential features include minimized need for reading and writing, unlimited teaching and format examples, and various methods of representation and engagement all with a focus on science for grades one through six. Originally created solely for students with disabilities, Cawley et al. (2003) suggest all students can benefit from a universal design curriculum.

*Science Instruction Adaptations and Modifications*

Even though some reformist have suggested otherwise, textbooks still remain an integral part of science instruction (Cawley et al., 2003) and can account for 90% of science instruction (Woodward, 1994). Many science textbooks often have poor internal structure, organization, and oftentimes read at much higher levels than intended making it difficult for students with disabilities to improve science literacy (Bergerud et al., 1988; Mastropieri & Scruggs, 1994b). In response, special education researchers have proposed various adaptations.

*Textbook and curricular aides.* A number of aids appear in the literature assist students with disabilities with the complexities of science information. For instance, study guides have important questions or statements about a particular passage or chapter on a piece of paper with (Bergerud et al., 1988) or without graphics, which allow the student to effectively focus their attention either during or after reading (Horton & Lovitt,
1989; Horton, Lovitt, & Christenson, 1991). Similar to study guides, graphic organizers (Horton, Lovitt, & Bergerud, 1990) and concept maps (Guastello et al., 2000) not only include important words from the text, but arrange them a meaningful visual format.

Woodward (1994) suggests the use of completed graphic models in science instruction. For example, students can refer to an informative graphical display of air movement over the United States and within a hurricane. These models would share similar markings and provide concrete representations of the information covered (Woodward, 1994). Bulgren, Lenz, Schumaker, Deshler, and Marquis (2002) apply a comparison routine strategy. Like graphic organizers, teachers and students arrange scientific vocabulary and phrases in a meaningful diagram. However, the strategy has students compare similarities and differences between two concepts (e.g., birds and snakes, plants and animals, etc.). Once filled in, students receive instruction to summarize the information in paragraph form.

**Instructional interventions.** Researchers have implemented a variety of instructional changes and practice procedures to improve student knowledge with science concepts and vocabulary. Studies have shown mnemonic-based science interventions effective for students with disabilities (King-Sears, Mercer, & Sindelar, 1992; Mastropieri, Scruggs, McLoone, & Levin, 1985; Mastropieri, Scruggs, & Levin, 1986; Scruggs, Mastropieri, Levin, & Gaffney, 1985). Mnemonic interventions link previously unknown science terms with more familiar words that sound similar and accompanying graphics which also display the terms’ meaning. The graphic can also link multiple attributes back to the original term. For example, a teacher can link bauxite to a picture of
a box and include other graphics (e.g., the word “buns” to represent hardness level “1”) to further define bauxite (Mastropieri et al., 1986).

Students using the cover, copy, and compare strategy, another method used for learning science vocabulary, practice a self-mediated direct instruction procedure (Smith et al., 2002). Students look at an academic model (i.e., answer on a labeled blank), cover the model, write their answer, finally comparing to the original answer (Smith et al.). Because of the many polysyllabic words found in science (e.g., carbohydrate, chlorophyll, chloroplasts, etc.), another strategy for science vocabulary focuses on syllabication (i.e., saying each syllable) and meaning (Bhattacharya, 2006). During guided and independent practices, students say a word fast, explain the meaning, segment the word, then finish the strategy by saying it fast. Students can also write previously identified vocabulary words based on the definition for one minute then check their own work with a model and graph their progress (Lovitt, Rudsit, Jenkins, Pious, & Benedetti, 1986).

*Technology-assisted instruction.* Similar to the previously mentioned technology use and curriculum (Carnine, 1989), research has demonstrated that technology can assist students with disabilities improve their science literacy. For example, some suggestions indicate that students with disabilities can interact with television, videos, and computers, possibly as a motivation for following the rules (Williams & Hounshell, 1998). When used as a motivator or teaching aid for students with special needs, technology use provides a safe environment “because they know that they can relax and learn without the threat of being called on to answer a question or read aloud (Williams & Hounshell, p. 30).”
Kumar and Wilson (1997) provide a more specific use of computers as a teaching tool. They suggest that computers can individualize instruction, provide an expert tutor, and integrate science with other topics. Another study (MacAuthur & Haynes, 1995) has shown that a computer program mirroring information from a science text book could provide features such as an accessible glossary of terms and definitions, highlighted links of both main ideas and text referring to questions, and additional summaries of information. Students using these enhanced lessons out performed those using only a limited number of the computing options (e.g., access to graphics, a note page, and text on a computer screen, etc.).

Davies (1994) presents another use of technology to support science instruction for students with disabilities in the form of a facilitated communication device. Students work with a facilitator on an augmentative and alternative communication device to interact with science material. With only limited and questionable research support and considerable research to the contrary, facilitated communication prompted an unfavorable resolution from the American Psychological Association (1994). Currently, mainstream science considers facilitated communication a pseudoscience and no more than a fad (Jacobson, Foxx, & Mulick, 2005).

The Role of Reading within Science Instruction Suggestions for Students with Special Needs

Overall, reading plays a crucial role in science (Deshler et al., 2001). A student’s ability to read fluently sets the stage for their comprehension in content-areas, such as science (Bhattacharya, 2006). The ability to read competently helps continue the scientific process (e.g., communication of scientific knowledge) and allows students to
integrate science with literature enhancing scientific literacy (Freeman & Taylor, 2006; McKee & Ogle, 2005).

Students with disabilities, however, have documented difficulties with reading (U.S. Department of Education, 2006). Teachers using science textbooks or primarily student reading behaviors as instruction presuppose that students can proficiently interact with the material (Cawley et al., 2003). Science textbooks oftentimes read at a higher grade level than noted and contain information in a disorganized fashion (Ofiesh, 2007), while students with learning disabilities traditionally have difficulties with decoding and comprehension (Lynch et al., 2007). Such a combination hinders a student’s ability to improve conceptual science understanding (Cawley & Parmar, 2001; Parmar, Deluca, & Janczak, 1994; Woodward, 1994). Despite reading deficits, students with disabilities must still have the opportunity to learn and display science knowledge (Cawley & Parmar, 2001). Therefore, language-based (e.g. activity- or inquiry-based) interventions and accommodations provide a way for students with disabilities to interact with, learn, and display science knowledge minimizing the effect or assisting with reading deficits (Cawley & Parmer, 2001; Rivard, 2004).

Teachers should maximize science educational opportunities for students with disabilities. Regardless, reading still plays a role in each of the curricula and accommodations. Whether students read passages to fill out study guides or concept maps, read lab assignments or worksheets to participate in group activities, or read computer screens, students have to read scientific material. Students with disabilities may benefit from the ability to read science text fluently regardless of the method of instruction or accommodations provided.
Oral Reading Fluency and Repeated Readings

Once neglected, oral reading fluency has received much needed attention from the educational community (Allington, 1983; Kubina & Morrison, 2000; National Reading Panel, 2000; Pikulski & Chard, 2005). While fluency has garnered recognition in reading, some variations occur with the definition. Some definitions of reading fluency (Fountas & Pinnell, 1994; Hook & Jones, 2002; Schreiber, 1980) include the ability to read quickly, accurately, and with expression while other definitions (Archer, Gleason, & Vachon, 2003) center on the speed and accuracy of reading. Focusing only on reading speed and accuracy (i.e., decoding fluency) provides a simple, observable measure for educators and researchers (Archer et al.). While reading research offers slight differences in the definition of fluency, uniform agreement surrounds the benefit of reading fluency. Notably, a student’s ability to read fluently provides a quality measure of overall reading ability (Fuchs et al., 2001).

The National Reading Panel (2000) categorized fluency as an essential component when reviewing reading. Based on available research, the panel found that students improve oral reading fluency more through systematic, guided practice, rather than sustained silent reading or additional access to reading. In addition, students across grade levels participating in guided fluency practice improved both word recognition and comprehension (National Reading Panel, 2000). Many researchers and teachers have used repeated readings as one systematic, guided fluency practice to help students develop oral reading fluency.
Repeated readings originated from the work of Dahl (1974), Chomsky (1976), and Samuels (1979). Rather than focusing on beginning readers, Dahl hypothesized ways to improve intermediate level readers; students who could decode printed text, but read slowly. During repeated readings, students practiced reading a single grade-level passage repeatedly until reaching a criterion (i.e., 100 words per minute). Once reached, the student repeated the process with additional grade-level passages. Dahl surmised that student’s needed to increase their focus on small amounts of reading, rather than touch on many different passages. Her results indicated that as students increased their reading rate, they improved their reading accuracy. She conjectured that this intense practice would afford the student another outcome: the ability to decode fluently would motivate students to comprehend to the passage’s meaning based on the theory of automaticity (LaBerge & Samuels, 1974).

Theory of automaticity. Part of the process of reading involves decoding printed words. Samuels’ (1987) assertion provides a starting point for the theory of automaticity. Revolving around the notion of attention, LeBerge and Samuels (1974) suggest that individuals have only so much attention to spend while reading. Do individuals have to attend to decoding a passage or can they decode so effortlessly and error-free that they can use their attention elsewhere? Samuels (1987) suggests that as students increase their decoding fluency, they can spend more time understanding what they read. Students unable to read fluently constantly shift their attention from decoding to understanding, hindering both. Samuels (1987) defines skillful readers as those who can decode and understand simultaneously. While reading fluently sets the stage for comprehension
(Allington, 1983; Pikulski & Chard, 2005; Samuels, 1987), students must first demonstrate decoding fluency before moving to other levels of reading (Samuels, 1987). Thus the focus of repeated reading: improve a student’s decoding fluency.

Different Models of Repeated Readings

The basic structure for repeated readings follows the original model posed by Dahl (1974) and Samuels (1979). Students read a grade-level passage until reaching a predetermined criterion or number of readings. Once reached, the student reads a different yet grade equivalent passage to the same criterion or number of readings (Meyer & Felton, 1999). This process can continue with incrementally more difficult text or stop as the student displays fluency criteria on new passages. Over time, different models to the basic repeated reading structure have surfaced in the literature. Students can read to an adult until reaching a criterion (e.g., Samuels, 1979), read along with a peer or adult (e.g. Kuhn, 2005), or reread the passage without assistance (e.g., Compan, Iamsupasit, & Samuels, 2001). Other models (e.g., Young, Bowers, MacKinnon, 1996) have focused on the student reading with prosody or have provided various types of error correction in response to each rereading (e.g., Martens, Eckert, Begeny, Lewandowski, DiGennaro, Montarello et al., 2007). Still other models matched (e.g., Valleley & Shriver, 2003) or not matched (e.g., Begeny & Silber, 2006) reading practice and test timings.

Repeated reading efficacy. Considering the different models, literature reviews (Chard et al., 2002; Kuhn & Stahl, 2003; Meyer & Felton, 1999) have found repeated reading an effective method for building oral reading fluency for all students. Noting that students in early grades (e.g., 1st-2nd) benefit from fluency instruction, Kuhn and Stahl indicate that students with reading problems benefit from repeated reading practice.
Additionally, Kavale (2005) reported a .76 effect size (ES) gain for students with specific learning disabilities. Performing a meta-analysis of the effects of repeated readings on fluency and comprehension gains, Therrien (2004) established specific characteristics of the various models of repeated readings had significant effects on student outcomes. Three important components emerged confirming the conclusions drawn by Chard et al.

First, students should reread the passage three or four times (ES = .85-.95). Second, the researcher or teacher should provide error correction (ES = 1.37). Third, the student should continue reading until reaching a fluency criterion (ES = 1.74).

Repeated Readings with Science Material

Research (Chard et al., 2002; Kuhn & Stahl, 2003; Meyer & Felton, 1999) has shown repeated readings benefits with narrative text, but rarely examined the effect of repeated readings in science which consists mostly of expository text. The two types of text contain differences. Expository text often contains more difficult vocabulary, a straightforward presentation of information, and concepts and content that students may not readily relate (Carnine, Silbert, Kame’enui, & Tarver, 2004).

Specifically, two studies (Ellis & Graves, 1990; Heibert, 2005) used a repeated reading method with science text. Ellis and Graves compared repeated readings to a paraphrasing strategy to locate the main idea within a science passage rather than focusing on building reading fluency. Students able to decode at roughly 100 words per minute found more main ideas with the paraphrasing strategy as compared to repeated readings and a combination of both.

Heibert (2005) did use repeated readings to examine reading fluency across literature text, content (i.e., science) text, and a control group. Students received
modeling, opportunities to reread passages with a partner, choral readings led by the teacher, and comprehension activities. Students across groups did not receive similar amounts of opportunities to reread, reading instruction, and error correction. Average reading rates for students reading science passages improved from 33 to 66 words per minute, the largest increase of the three groups. On average, the content group had the least amount of reading instruction and opportunities to reread, but read the highest amount of text repeatedly and received comparable amounts of error correction.

Given the importance of oral reading fluency for content area success and the paucity of reading fluency research conducted with science text, a subset of the repeated reading literature base may provide an initial direction. Although many models of repeated readings occur in the literature, models that contain one component differentiate themselves (Therrien, 2004): repeated readings to a fluency criterion.

Repeated Readings to a Fluency Criterion Studies

Researchers using repeated readings to a fixed fluency criterion have employed different criteria in 21 articles with 23 individual studies. Some researchers (Dahl, 1974; Dowhower, 1987; Herman, 1985; Samuels, 1979) have chosen criteria based on early repeated reading studies (e.g. Dahl; Samuels). Other researchers (Anderson & Alber, 2003; Martens et al., 2007; Polk & Miller, 1994; Spence, 2002; Tam, Heward, & Heng, 2006) have used student-specific criteria based classroom teacher, student, and/or researcher decisions. Still other researchers (Carroll, McCormick, & Cooper, 1991; Mercer, Campbell, Miller, Mercer, & Lane, 2000; Staubitz et al., 2005; Therrien & Kubina, 2007; Therrien, Wickstrom, & Jones, 2006; Weinstein & Cooke, 1992; Yurick et al., 2006) have chosen to have students read to grade-level or reading rate norms. A final
group of researchers (Kostewicz, & Kubina, in review; Kubina, Amato, Schwilk & Therrien, in press; McDowell, McIntyre, Owen & Keenan, 1998; Sweeney, Ring, Malanga & Lambert, 2003; Teigen, Malanga & Sweeney, 2001) have used fluency criteria originating from the Precision Teaching and behavioral fluency literature.

*Early repeated reading fluency criteria.* The seminal studies by Dahl (1974) and Samuels (1979), previously discussed, plus two additional studies used criteria of 85-100 words per minute (WPM) (Dahl; Dowhower, 1987; Herman, 1985; Samuels, 1979). The original criterion of 100 WPM (Dahl, 1974) appeared to originate from study inclusion curriculum-based criterion rates (i.e., 35-50 WPM). Other than citing Dahl or Samuels (1979), remaining studies (Dowhower; Herman) provided no other insight to their criterion choice. Students did not have to read accurately to reach WPM criteria, only faster. Dahl suggested that errors decrease as a student reads more quickly and considered measuring word recognition errors unnecessary. Samuels (1979) added that over emphasizing accuracy, impedes reading speed. Each study reported either accuracy (Dahl; Dowhower; Herman) or number of word recognition errors (Samuels, 1979) but did not incorporate either into the fluency criterion.

Students in all four studies read below grade level, demonstrated an ability to decode, and, more specifically, read study materials between 35-50 WPM as inclusion criteria (Dahl, 1974; Herman, 1985; Dowhower, 1987). Each study reported using similar repeated reading procedures aside from fluency criterion rates. Students listened to a reading model prior to reading via tape or fluent reader (Dowhower), did not receive formal error correction or performance feedback, and each repeated reading consisted of
approximately 10 minutes of reading at their seat (Dahl; Dowhower; Herman; Samuels, 1979).

Students improved their oral reading fluency in each of the studies, but the highest reading rates remained near criterion rates. The number of readings or practice sessions to criterion varied from 4 one-minute readings (Dowhower, 1987) to 77 minutes of reading (i.e., seven 10-minute sessions of reading practice plus seven 1-minute test readings) (Herman, 1985). Looking at specific study outcomes, Samuels (1979) displayed one student’s data which showed an improvement to initial WPM scores on successive passages. The student also decreased the number of readings to reach criterion on successive passages (Samuels, 1979). Herman (1985) and Dahl (1974) demonstrated student increases in WPM and decreases in errors. While starting on third grade-level passages, students finished the study reading passages between fourth and thirteenth grade-level (Dahl). Dowhower (1987) noted student increases to WPM but found little difference between assisted and unassisted repeated readings.

Researcher, teacher, or school determined fluency criteria. Researchers (Martens et al., 2007; Tam et al., 2006) and teachers (Anderson & Alber, 2003; Polk & Miller, 1994) created student-specific rates or used one rate school-wide regardless of the reader (Spence, 2002) for five studies. Oral reading fluency criteria ranged from 75 (Tam et al.) to 200 (Polk & Miller) correct words per minute (CWPM); a change from the previous criteria using WPM. Additionally, two studies (Anderson & Alber; Polk & Miller) incorporated a maximum number of errors per minute (i.e., five) into their fluency criteria. Therefore, students had to not only meet the CWPM criterion, but also read the
passage with no more than five errors. By adding an error rate into the criterion, students had to not only read the passage quickly, but also display accuracy.

Students included in these studies either received special education services (Anderson & Alber, 2003; Polk & Miller, 1994), English as a Second Language services (Tam et al., 2006), read well below (i.e., average of 3.8 years) grade level (Spence, 1992) or demonstrated low achievement and/or received special education services (Martens et al., 2007). Standardized scores (Spence; Tam et al.) or standardized and curriculum-based scores (Martens et al.) established student reading level. Actual repeated reading procedures varied. Students read the same passage for one minute each day until reaching criterion (Spence) to three times each day (Martens et al., Tam et al.). Researchers provided students no error correction (Spence), immediate error correction on every reading (Anderson & Alber; Martens et al.), delayed error correction one session (Polk & Miller) or one instance of error correction per passage (Tam et al.). Error correction included phase drill (Martens et al.), model-lead-test (Anderson & Alber; Martens et al.; Tam et al.) or a review of errors on flash cards (Polk & Miller). Researchers from all studies provided performance feedback following student readings and others also provided a model reading (Martens et al.; Spence) or performance-based rewards (Martens et al.).

Students demonstrated fluency gains in all five studies. The amount of readings or the amount of reading time necessary for students to meet criterion varied widely. One student met criterion a few times during initial one-minute readings (Spence, 1992) while another student met criterion after 169 minutes of reading which included 15 sessions of 10-minute peer-mediated practice (Anderson & Alber, 2003). The majority of
studies (Anderson & Alber; Polk & Miller, 1994; Tam et al., 2006) targeted improving students’ oral reading fluency. Martens et al. (2007) not only focused on improving fluency, but also displayed students’ 2-day fluency retention rates. Spence compared two types of instruction on fluency building suggesting fluency with phonic sheets, rather than sight word vocabulary fluency, had greater effects on oral reading fluency.

Fluency criteria based on grade-level or reading rate norms. Researchers used fluency criterion rates based on grade-level (Mercer et al., 2005; Weinstein & Cooke, 1992; Staubitz et al., 2005.; Yurick et al., 2006), student reading rate norms (Therrien & Kubina, 2007; Therrien et al., 2006), and reading rates of a proficient reader (Carroll et al., 1991). The CWPM and WPM criterion rates varied considerably (i.e., 30-180) depending on grade-level or reading age of students and originated in previous publications (e.g., Carnine, & Silbert, 1979; Hasbrouck & Tindal, 1992; Koorland, Keel, & Ueberhorst, 1990). Two studies (Staubitz et al.; Yurick et al.) reporting a WPM criteria and one additional study (Carroll et al.) incorporated errors into fluency criteria.

Students met inclusion criteria based on standardized reading test scores (except Therrien et al, 2006) rather than criterion-based tests, read below grade level, or by having or at-risk for special needs such as learning disabilities or emotional and behavioral disorders. Students practiced and tested for the same one-minute interval (except Staubitz et al., 2005; Yurick et al., 2006), received some type of error correction (except Weinstein & Cooke, 1992), and read test readings to a researcher, teacher, or paraprofessional. Weinstein and Cooke chose to exclude error correction as students in their study could decode accurately and listened to an error-free tape recording of the passage. Additionally, researchers provided performance feedback for student readings
(Carroll et al., 1991; Mercer et al., 2005; Weinstein & Cooke; Staubitz et al.; Yurick et al.) and, in one case (Yurick et al.), performance-based rewards.

Students demonstrated improvements to reading fluency. As with previous findings, students met criterion following a wide range of reading time. Therrien and Kubina (2006) found students in intervention met criterion after an average of 1.8 one-minute trials, while Staubitz et al. noted one student required approximately five hours of reading (i.e., 23 ten-minute peer-mediated reading practice sessions, 20 sessions of 3 one-minute test readings, and 3 sessions of 3 twenty-second test readings) to meet criterion on one passage. Researchers demonstrated effective use of repeated readings to build oral reading fluency when combined with sight words, used in peer-mediated formats (Staubitz et al; Yurick et al.), and when implemented by paraprofessionals (Mercer et al., 2000). Students also demonstrated greater levels of oral reading fluency with words in-rather than out-of-context (Therrien & Kubina) and when asked to generate questions based on their readings (Therrien et al., 2006). Finally comparing two types of criteria (i.e., fixed vs. set number of fluency improvements), student reading results favored fixed fluency criteria (Weinstein & Cooke, 1992).

*Precision Teaching fluency criteria.* Criteria from five studies (Kostewicz, & Kubina, in review; Kubina et al., in press; McDowell et al., 1998; Sweeney et al., 2003; Teigen et al., 2001) reported using high oral reading fluency criteria originating from the behavioral fluency (Binder, 1996) and Precision Teaching literature bases (Freeman & Haughton, 1993; Kubina & Starlin, 2003). These fluency criteria had very little variance ranging from 180 to 210 CWPM (Sweeny et al.; Teigen et al). Researchers tallied student reading errors in four of the studies (Kostewicz & Kubina; McDowell et al.; Sweeney et
al.; Teigen et al.), but only Kostewicz and Kubina incorporated number of errors (i.e., 2 or less) into the criterion.

All students within the five studies had special needs, received Title 1 services, or read below grade level. These five repeated reading procedures included immediate error correction (e.g., model-lead-test) and feedback. Additional error correction and reading techniques involved prompting (i.e., student provided phonetic prompts for difficult words), taking turns reading sentences, reading at the same time, and having the student read a part of a phrase fluently then chaining it to the next part (Teigen et al., 2001). Sweeney et al. (2001) incorporated pre-correction and daily goal setting with a static overall fluency criterion and McDowell et al. (1998) played an error-free recording for the student to read along with before taking the daily test reading. Other than McDowell et al., one-minute practice readings matched with one-minute test readings (Kostewicz & Kubina, in review; Kubina et al., in press; Sweeney et al.; Teigen et al.). In addition to matched practice-to-test timings, Kostewicz and Kubina used interval sprinting (i.e., repeated 10-second reading sprints across parts of the passage) before having students test for one minute.

As with previous studies, students demonstrated fluency gains. Excluding incomplete and non-disaggregated data, students reached criterion on a passage within a range of 25 minutes (Kostewicz & Kubina, in review) to 58 minutes (Kubina et al.) of reading. McDowell et al. (1998) demonstrated students could reach high CWPM criteria with difficult passages. Other studies showed oral reading fluency gains for an individual student (Tiegen et al., 2001) to many students receiving intervention from pre-service teachers (Sweeney et al., 2003). The other two studies (Kostewicz & Kubina, in review;
Kubina et al., in press) reported various comparisons. Retention scores for students reading to different criteria (i.e., 200 v. 123 CWPM) decreased at a similar rate over time (i.e., 3 ½ months). However, students reading passages to 200 CWPM read faster consistently. Kostewicz and Kubina compared traditional repeated readings to a fluency criterion and interval sprinting and found similar one-minute test scores and number of trials to criterion.

**Oral reading fluency criterion summary.** Researchers employed a wide range of oral reading fluency criteria (30 to 210+ CWPM) within these 21 articles for a variety of reasons (e.g., student reading norms, precision teaching rates, researcher/teacher decisions, etc.). Some criteria included students making no more than 2-10 errors. Students demonstrated fluency gains as a result of all the studies, however, students rarely read faster or more accurately than the criterion used. Students reached fluency criteria across a wide range of reading times, without one group distinguishing itself.

**Conclusions and Research Questions**

Science education in America has undergone various, yet consistent, reform over the last 20 years (e.g., AAAS, 2008, NRC, 1996). Due to its complicated subject matter, reformers suggest the science instruction rely more on doing and experiencing rather than reading and memorization (Rutherford & Ahlgren, 1990). Not always placed in the highest quality science education settings, students with disabilities continue to perform poorly in science (Grigg et al., 2006). Researchers have responded by implementing varying levels of intervention with many suggesting overall reform approaches: minimize scientific reading and increase interactions with science (Cawley & Parmer, 2001). However, the ability to read science material fluently still plays a crucial role
(Bhattacharya, 2006). Researchers have used repeated reading, more specifically repeated readings to a fluency criterion, to build the reading fluency of students with disabilities (Chard et al., 2002). Therefore, the overall purpose of this study asks the question: How does the method of repeated readings to a fluency criterion affect reading fluency with science text (i.e., expository text)? Also, what effect will reaching fluency on one passage have on initial, unpracticed readings of successive passages? What effect will reaching fluency on one passage have on the number of sessions necessary to reach fluency criterion on successive passages? What effect will reaching criterion on passages from one chapter have on initial, unpracticed readings from another chapter? And, what effect will reaching fluency on a passage have on a participant’s ability to retell what they read in that passage?
Chapter 3

METHODOLOGY

Participants and Setting

Seven middle school students attending a learning support classroom participated in this study. All seven attended one of two middle schools within a school district serving approximately 7,000 students across all grade levels in a medium-sized, suburban city in the northeast United States. The learning support teacher nominated all participating students based on needing help with reading science material. Six of the students had a learning disability and one an emotional and behavioral disability. Additionally, all students had reading goals on their respective Individualized Education Plans and attended science class in an inclusion setting. After receiving IRB approval (see Appendix A) and school board approval to conduct the study, parents of each student provided consent (see Appendix B) and each student provided either written (see Appendix C) or verbal assent (see Appendix D) before participating. Table 1 displays detailed information for each student. An eighth student started the study, but voluntarily removed herself from the study for unknown reasons.

Students attended a learning support classroom that served a variety of functions (e.g., Direct Instruction reading and language instruction, essay writing, poem writing, organization skills, etc.). The students received no content instruction in science while attending this class. They did, however, have experience with timed readings, but not with systematic repeated readings.
Table 1

Student Demographic Data

<table>
<thead>
<tr>
<th>Student</th>
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<th>Gender</th>
<th>Grade</th>
<th>LS Class Period</th>
<th>Special Need Classification</th>
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<td>F</td>
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<tr>
<td>Ned</td>
<td>12</td>
<td>M</td>
<td>7</td>
<td>7th</td>
<td>SLD</td>
</tr>
</tbody>
</table>

Note. F = Female; M = Male; LS = Learning support; SLD = Specific learning disability; SED = Serious emotional disturbance; ADD = Attention deficit disorder.

All interventions took place in a one-on-one format with the experimenter or trained data collectors and each student in the hallway outside of the classroom. The experimenter made every attempt to minimize distractions and sometimes had to halt reading when classes changed. Under these conditions, the experimenter gave the student the option of returning to the classroom until completion of the change. If the student accepted, the student resumed reading at the conclusion of the class change.

Materials

All readings used in this study originated from the science textbook *From Bacteria to Plants* (Padilla, Miaoulis, & Cyr, 2007). The textbook makes up one part of the Prentice Hall Science Explorer series and had a seventh grade readability score according to Fry readability procedures (Fry, 1989).

The experimenter chose two separate chapters, chapter one and chapter four, and typed approximately the first 2,400 words verbatim. These words encompassed the first two sections of each chapter. Chapter one, “Living Things”, focused on life, the characteristics and classification living things. Chapter four, “Introduction to Plants”,
provided in-depth information about plants, characteristics of plants, and plant processes. Transcribed text included only the main body of the text, including headings and subheadings with any bolding or italics removed. The typed copy did not include pronunciations, text from figures, figure captions, insert assessments, insert activities, reviews, study guides, standardized test prep questions, reading previews, discover activities, chapter projects, and lab zones.

Once copied verbatim, the experimenter divided each chapter into 12 smaller passages. Each passage had at minimum 200 words; however each passage had to finish at the conclusion of a sentence. Passages ranged in total words from 200-215 and received an order number consistent with passage’s occurrence within the text. Passage 1 for both chapters comprised the first 200+ words; passage 2 the second 200+ words, and so on until reaching passage 12. This resulted in the development of 24 passages; 12 for chapter one and 12 for chapter four. Three additional passages from chapter one required for an extended baseline for one student raised the total to 27 passages.

The experimenter conducted two forms of analysis on each group of passages: passage readability and word overlap. The experimenter used the Microsoft Word tool feature to determine Flesch-Kincaid readability and Flesch reading ease scores for each of the 27 passages. Although Flesch-Kincaid readability refers to the grade level of a passage, Flesch reading ease scores translate to different difficulty levels: 0-29 very difficult, 30-49 difficult, 50-59 fairly difficult, 60-69 standard, 70-79 fairly easy, 80-89 easy, 90-100 very easy (Flesch, n.d.). These readability scores compared evenly to Fry readability (Fry, 1989) scores on a small sample of passages. Chapter one passages had an average grade level readability of 9.6 and a reading ease of 49.2. Chapter four
Table 2

Per Passage Readability for Chapter One and Four Readings

<table>
<thead>
<tr>
<th>Chapter 1 Readings</th>
<th>Flesch-Kincaid Readability</th>
<th>Flesch Reading Ease</th>
<th>Chapter 4 Readings</th>
<th>Flesch-Kincaid Readability</th>
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<td></td>
</tr>
<tr>
<td>Average</td>
<td>9.6</td>
<td>49.2</td>
<td>Average</td>
<td>8.4</td>
<td>57.1</td>
</tr>
</tbody>
</table>

Individual passage readability and reading ease appear on Table 2.

The second analysis involved calculating word overlap between passages for each chapter. This process involved three steps. First, the experimenter entered every word of each passage into a spreadsheet. Second, by comparing each pair of passages the experimenter calculated number of identical words and number of times those words overlapped. For example, ‘of’ could appear 10 times in one passage and 11 times in another passage. Therefore, ‘of’ would overlap 10 times between those passages. Finally, the experimenter divided number of overlapping words by lower number of total words for each pair of passages resulting in percentage of word overlap. Chapter one had an average word overlap between passages of 27.74% and chapter four had an average word
Table 3

Chapter One between Passage Word Overlap

<table>
<thead>
<tr>
<th>Reading Total</th>
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<th>3</th>
<th>4</th>
<th>5</th>
<th>6</th>
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<th>9</th>
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<td>212</td>
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<td>211</td>
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<td>205</td>
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<td></td>
</tr>
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<td>S1R3</td>
<td>S1R4</td>
<td>S1R5</td>
<td>S1R6</td>
<td>S1R7</td>
<td>S1R8</td>
<td>S2R1</td>
<td>S2R2</td>
<td>S2R3</td>
<td>S2R4</td>
<td>S3R1</td>
<td>S3R2</td>
<td>S3R3</td>
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<td>-----</td>
</tr>
<tr>
<td>S1R1</td>
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<td>29%</td>
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<td>26%</td>
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</tr>
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</tr>
<tr>
<td>S1R3</td>
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</tr>
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</tr>
<tr>
<td>S1R5</td>
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<td>23%</td>
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</tr>
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</tbody>
</table>

Note. S = Section; R = Reading; x = Comparison of a passage with itself.
## Table 4

*Chapter Four between Passage Word Overlap*

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<tr>
<th>Reading</th>
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<td>S1R6</td>
<td>S1R7</td>
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<td></td>
<td></td>
</tr>
<tr>
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<td>22%</td>
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<td></td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

*Note. S = Section, R = Reading, x = Comparison of a passage to itself.*
Table 5

Passage Designation and Presentation Order per Chapter

<table>
<thead>
<tr>
<th>Chapter 1</th>
<th>Baseline Passages</th>
<th>Repeated Reading to a Fluency Criterion Passages</th>
<th>Final Initial, Unpracticed Reading</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>3*, 9*, 6*, 12, 5, 8, 2, 13**, 14**, 15**</td>
<td>4*, 1*, 11*, 7*</td>
<td>10*</td>
</tr>
<tr>
<td>Chapter 4</td>
<td>12*, 3*, 7*, 2, 6, 5, 10</td>
<td>4*, 1*, 9*, 11*</td>
<td>8*</td>
</tr>
</tbody>
</table>

Note. * = All students assigned to the chapter read these passages; ** = Additional passages used for single student not showing stable or decelerating baseline.

overlap of 28.19%. Tables 3 and 4 displays detailed passage overlap for individual passage pairs for chapters one and four, respectively.

Following passage analysis and numbering, the experimenter randomly designated each passage within each group as a baseline or repeated reading passage and randomized presentation order. Table 5 shows passage designation and order of presentation for both chapters.

Additional materials included copies of each passage for the experimenter and participants, a count down timer, No. 2 pencils, and a video recorder (i.e., JVC Everio hard disk camcorder), tripod, and age-appropriate participation prizes (e.g., pencils, pens, folders, erasers). Passage copies for the experimenter had a running total of words at the end of each row and a table to score oral retells. Passage copies for participants had no word count or numbered table. Appendix E provides an example of an experimenter and corresponding student copy of a passage.

Dependent Variables

Measurement of one main dependent variable and one generalization variable determined intervention effects: reading (i.e., decoding fluency) and oral retell fluency,
respectively. Decoding fluency comprised words read correctly and incorrectly per minute. Correct words included words pronounced correctly within three seconds in their proper place in the text (Shinn, 1989). Self-corrections also counted as correct. Incorrect words included omissions, substitutions, mispronunciations, and words not read within three seconds (Shinn, 1989). Inserting words into text also counted as incorrect. If participants skipped entire lines of text, those words did not count as correct or incorrect. Measurement of correctly and incorrectly read words occurred during one-minute timings. Calculation of corrects involved subtracting incorrects from total words read in one-minute with any insertion errors added to the incorrect total only.

Oral retell fluency consisted of number of words correctly recalled pertaining to a particular reading in one minute. Each of the words had to refer back to the original reading. The experimenter based oral retell scoring procedures on those found in the 6th edition Dynamic Indicators of Basic Early Literacy Skills™ (Good & Kaminski, 2007). Correct words included the number of words spoken by a student that showed an understanding of the passage. Contractions counted as single correct word. If the experimenter determined that any minor repetitions, redundancies, irrelevancies, and inaccuracies still show the student fundamentally on track with their retell, these counted as correct words. If the experimenter determined the student off track with their retell, these words did not count. When a student repeated a retell, the repetition did not count. Exclamations (e.g., sounds, “uhhhs”, “like” etc.), singing songs, recitations (e.g., saying the alphabet), also did not count. The scorer determined the number of words correct and incorrect and reported the number of correct words as the retell score. Oral retell tests have an alternate form reliability of .68-.72 and a criterion-based validity of .73-.81.
(Whalen, 2006). The experimenter administered an oral retell test after each initial, unpracticed reading of a repeated reading passage, and immediately after each student met fluency criterion on that passage. The experimenter transcribed each retell verbatim from video recordings and then scored the retell per scoring procedures.

**Independent Variable**

*Repeated readings to a fluency criterion condition.* In the repeated readings to a fluency criterion (RRFC) condition, the student read one of the RRFC passages for one minute, three times each session. The experimenter provided the student with an unmarked copy of the passage and told the student that they would read the passage three times for one minute each as fast as possible and to return to the start of the passage if reaching the end. Timed for 60 seconds, the student started reading from the first word of the passage. As the student read, the experimenter maintained a count of any incorrects on the experimenter’s copy of the passage. After 60 seconds, the timer beeped and the experimenter prompted the student to stop reading and provided the student feedback in the form of number of correct and incorrect words. Additionally, error correction consisted of a model-lead-test error correction procedure for all incorrects (Carnine et al., 2004). Every word mispronounced, omitted, substituted, skipped, or hesitated on for longer than three seconds received error correction. The student had to pronounce each word properly after hearing a model. To error correct insertions, students listened to the pronunciation of the words occurring just before and after the inserted word. After hearing these words, the student had to pronounce both words properly. Students received identical error correction procedures for the remaining two readings.
Experimental Design

To show repeated readings to a fluency criterion effects on science textbook passages, the experimenter employed two multiple-probe multiple baselines across each group of students (Horner & Baer, 1978; Kennedy, 2005). One advantage of this design allows the comparison of celerations of initial, unpracticed readings for each student from baseline to intervention and a comparison of celerations for each RRFC passage for each student. Another advantage of this design allows a comparison of celerations between multiple students. As some students remained in baseline for an extended period, multiple probes of readings, rather than daily readings, minimized reading practice effects while still showing the celeration.

Procedures

Assessment/Pretest reading. To start the study, students read one 200+ word passage taken from chapter three, consisting of 221 words, and had 9.4 readability and a 56.4 reading ease score. The passage also had an average word overlap of 27.95% with chapter one passages and an average word overlap of 28.01% with chapter four readings.

Individually, each student read the passage for one minute. Students reading between 50 and 150 fell within an instructional reading range (Kubina & Starlin, 2003) and met inclusion criteria. Any student reading less than 50 or greater than 150 correct words, fell within a frustration or fluent reading range, respectively, and did not meet inclusion criteria. All seven students read between 50 and 150 correct words per minute.

Based on assessment scores, the experimenter formed two four-student groups by matching students with similar assessment scores and placing them in opposite groups. Based on random assignment, each group received either chapter one or four readings.
Table 6

*Group Assignment and Assessment/Pretest Scores*

<table>
<thead>
<tr>
<th>Student</th>
<th>Score (C/I)</th>
<th>Student</th>
<th>Score (C/I)</th>
</tr>
</thead>
<tbody>
<tr>
<td>Nancy</td>
<td>76/11</td>
<td>Ned</td>
<td>79/7</td>
</tr>
<tr>
<td>Jason</td>
<td>100/15</td>
<td>Elizabeth</td>
<td>98/16</td>
</tr>
<tr>
<td>Denise</td>
<td>91/11</td>
<td>Kevin</td>
<td>92/3</td>
</tr>
<tr>
<td>Joseph</td>
<td>64/8</td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

*Note.* C = Correct; I = Incorrects

Although assigned to different chapters, both groups experienced identical procedures for the remainder of the study. Table 6 shows the two groups of students, their assessment reading scores, and the chapter assigned to each group.

*Baseline.* During the first baseline session, each student read the first baseline passage from their respective chapter for one-minute. During the second session, each student read the second baseline passage and the third session, the third baseline passage. Feedback but no error correction followed each of the baseline passages.

The student from each group displaying a decelerating or stable baseline for correct words per minute over the first three readings entered intervention with the first RRFC passage for each chapter. The remaining five students, two from one group and three from the other group, remained in baseline and continued receiving successive reading probes at the rate of every three sessions using the format of feedback with no error correction. No student read the same baseline passage more than once. Following the first probe, the student with a decelerating or stable baseline for correct words per minute started the initial RRFC passage for their chapter. In the case that no student per group displayed a decelerating or stable baseline, the experimenter continued to provide
additional baseline passages each session until a student displayed a decelerating or stable baseline signaling the start of intervention the next session with the first RRFC passage. This process continued until all students started the RRFC condition with the first passage from their chapter.

The final student in Group A did not demonstrate a decelerating or stable baseline after reading seven baseline passages failing to meet intervention starting criteria. Because this exhausted the number of assigned unique baseline passages for chapter one, the experimenter compiled three readings from the beginning of chapter one, section three and used these as additional baseline passages. Combining the final three reading scores with the previous two reading scores, the student demonstrated a decelerating trend for correct words per minute and started the first RRFC passage.

Starting with the first baseline session and continuing for the remainder of the study, students received an age-appropriate prize (e.g., pencils, erasers) or a sticker to save for larger prizes (e.g., lead pencils, large erasers, pens) based solely on participation (e.g., LeBlanc, Coates, Daneshvar, Charlop-Christy, Morris, & Lancaster, 2003; Kostewicz & Kubina, submitted). At no time did receiving a prize or sticker depend on a student’s reading performance.

*Initial RRFC condition sessions.* For each initial RRFC reading, students read the passage for one minute as fast as possible followed by feedback only. The experimenter then conducted an oral retell test on the passage using the administration procedures found in Good and Kaminski (2007) for each student. At the conclusion of both measures, the student returned to the classroom. The experimenter conducted identical
initial sessions for each student for each new RRFC passage (e.g., RRFC readings 1, 2, 3, and 4).

**Successive RRFC condition sessions.** Each successive session following the initial session, student completed the series of three repeated readings with feedback and error correction followed by the testing procedures outlined below. Each student continued to read the same RRFC passage until reaching a fluency criterion of 200 or more correct words with 2 or less incorrects during the test reading (Freeman & Haughton, 1993; Kubina & Starlin, 2003). Students received notification of the fluency criterion during the first successive RRFC condition and reminders during other sessions.

**Tests.** After each RRFC condition, other than the initial RRFC session, each student completed a test reading on the current passage reading for one-minute from the start of the current passage. The experimenter recorded incorrects and total words read and prompted the student to stop reading at the beep of the timer (i.e., 60 seconds). At the conclusion of the test reading, each student received feedback without error correction.

If the student reached criterion (i.e., 200 or more correct words with 2 or less incorrects) during the test reading, the student completed an oral retell fluency test without feedback and notification that they would start a new passage during the next session.

**Additional initial, unpracticed reading.** Once reaching criterion on the fourth RRFC passage, students read a new passage for one minute following baseline procedures and received feedback only.

**Posttest reading.** During the next session following the additional initial, unpracticed reading, students read the posttest passage. All students regardless of group
read this passage. The passage came from the fifth chapter, consisted of 201 words and had a 7.2 readability score and a 65.6 reading ease score. The posttest passage had a word overlap of 29.8% with the pretest passage and an average word overlap of 25.25% with passages from chapter one and 28.99% overlap with passages from chapter four. Each student read this passage for one-minute using baseline procedures followed by feedback only.

*Maintenance/Transfer readings.* For four sessions, following the posttest reading, each student read each of the RRFC passages from the other chapter for one minute. Meaning, students in Group A read the four RRFC passages for Group B and vice versa at the rate of one reading per session. These additional readings followed baseline procedures. After the final maintenance/transfer reading, students concluded their participation in the study.

*Training Data Collectors*

The experimenter instructed two data collectors to implement this study. Data collectors scored video of student’s reading and practiced scoring transcripts of oral retell fluency tests based on retell scoring procedures. Additionally, they practiced the methods of study implementation and acquainted themselves with how to operate the timer and video camera. After meeting 90% total reliability, data collectors individually observed a live session with all seven students and scored all readings also meeting 90% reliability. Following these training procedures, both data collectors served to implement this study and collect data in the absence of the experimenter during one session.
Accuracy and Inter-Observer Agreement

Because each session had a paired video recording (i.e., permanent product), the experimenter examined each video to determine accuracy, or “the extent to which observed values approximate the true state of nature (p. 363)” of each student’s reading (Johnson & Pennypacker, 1993). The experimenter used these accuracy scores as each student’s reading score. Test readings had an accuracy score of 100% for all students.

For oral retell tests, the experimenter used the video recordings to transcribe the oral retell test verbatim then scored the test using aforementioned scoring procedures. To verify oral retell scores, a data collector verified 20% of the oral retell test transcriptions from video, and then scored those retells based on the transcripts. To calculate retell scoring agreement, the experimenter used a total agreement approach (Kennedy, 2005). To calculate total agreement per observation, the experimenter divided the larger number of correct words by the smaller amount of correct words. Average total agreement for oral retells equaled 90%.

Procedural Integrity

The same data collector, who calculated oral retell agreement, performed procedural integrity on 20% of the sessions. To calculate procedural integrity, the observer reviewed each identified session and completed experimenter-created checklists verifying the specific steps of the procedure (see Appendix F for checklists). Percent of steps completed correctly equaled 99%.

Social Validity

To measure social validity, the experimenter used three distinct measures. First, students and teachers completed a questionnaire at the conclusion of the study targeting
their involvement in the study. While taped, students verbally responded to three questions: 1) Did you enjoy participating in this study? Why or why not, 2) Do you feel this procedure helped you with your science text? and 3) Do you feel you understood what you read better? The teacher responded with written answers to four questions: 1) Did you feel that your students benefited from their participation? 2) Did you notice anything different about your students as a group as they progressed through the study? If yes, could you elaborate briefly? 3) Did you notice anything notable about any particular student(s)? 4) If possible, would you try this procedure with students? Second, the students also completed a 5-point Likert scale for 10 questions (see Appendix G). The student responded to these questions anonymously after returning to the classroom to minimize any observer effects. The classroom teacher answered any questions students had with regards to the questionnaire. Third, any unprompted feedback received during the course of the study from any student or the teacher relating to the study added to social validity.
Chapter 4

RESULTS

In the results section, computer generated Standard Celeration Charts (SCC) display all data. Filled dots represent corrects, open dots represent correct initial reading frequencies following criterion readings, and X’s represent incorrects. The SCC has the vertical axis scaled logarithmically, while the horizontal axis represents consecutive days with corresponding dates at the top of each chart. The dotted, horizontal line along the vertical axis count of 1 refers to the counting time meaning that that each student read or presented an oral retell for one minute and solid vertical lines represent phase changes (e.g., new passages during intervention). When displayed, celeration lines lie on specific data paths and can represent acceleration (x) or deceleration (÷). Celerations or “the frequency of responding for a particular time unit divided by unit time (Kennedy, 2005, p. 90)” provide a quantification of the change in behavior frequency. For example, a behavior that has a x2.00 celeration means that the behavior has doubled in a week. Any adjustments or additional information to the previously mentioned conventions occur during the description of each individual figure.

Group and Individual Pre- and Post-Test Reading Scores

Figure 1 displays the pre- and post-test scores for all students. The first dot and X for each student represents the pre-test score and the second dot and X signify the post-test score. Students’ mean correct words per minute (CWPM) increased from 85.7 to 93.8 and mean incorrect words per minute (IWPM) decreased from 10.1 to 6.8. Student reading accuracy improved from 90.0% to 93.2% on average. Referring to Table 7 which


Table 7

*Pre- and Post-Test Readings*

<table>
<thead>
<tr>
<th>Student</th>
<th>Pre-Test</th>
<th></th>
<th>Post-Test</th>
<th></th>
<th></th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>Corrects</td>
<td>Errors</td>
<td>Accuracy</td>
<td>Corrects</td>
<td>Errors</td>
</tr>
<tr>
<td>Group A</td>
<td>100</td>
<td>15</td>
<td>87%</td>
<td>101</td>
<td>11</td>
</tr>
<tr>
<td>Jason</td>
<td>64</td>
<td>8</td>
<td>89%</td>
<td>68</td>
<td>4</td>
</tr>
<tr>
<td>Joseph</td>
<td>91</td>
<td>11</td>
<td>89%</td>
<td>113</td>
<td>8</td>
</tr>
<tr>
<td>Denise</td>
<td>76</td>
<td>11</td>
<td>87%</td>
<td>92</td>
<td>5</td>
</tr>
<tr>
<td>Nancy</td>
<td>82.8</td>
<td>11.3</td>
<td>88%</td>
<td>93.5</td>
<td>7</td>
</tr>
<tr>
<td>Group Average</td>
<td></td>
<td></td>
<td></td>
<td>93.5</td>
<td>7</td>
</tr>
<tr>
<td>Group B</td>
<td>79</td>
<td>7</td>
<td>92%</td>
<td>77</td>
<td>4</td>
</tr>
<tr>
<td>Ned</td>
<td>92</td>
<td>3</td>
<td>97%</td>
<td>97</td>
<td>3</td>
</tr>
<tr>
<td>Kevin</td>
<td>98</td>
<td>16</td>
<td>86%</td>
<td>108</td>
<td>13</td>
</tr>
<tr>
<td>Elizabeth</td>
<td>89.7</td>
<td>8.7</td>
<td>92%</td>
<td>94.0</td>
<td>6.7</td>
</tr>
<tr>
<td>Group Average</td>
<td></td>
<td></td>
<td></td>
<td>93.8</td>
<td>6.8</td>
</tr>
<tr>
<td>Overall Average</td>
<td>85.7</td>
<td>10.1</td>
<td>89.6%</td>
<td>93.8</td>
<td>6.8</td>
</tr>
</tbody>
</table>

Presents summary and individual scores, six of seven students improved the number of corrects and all students made the same or fewer numbers of incorrects. Six students improved reading accuracy and the remaining student read with the same accuracy. Group A students improved reading accuracy more than Group B from pre- to post-test, while Group B displayed a higher mean accuracy score.

*Within Group Reading Scores*

Figures 2 and 3 illustrate reading scores for students reading chapter one (Group A) and chapter four passages (Group B) respectively. Each SCC per page presents individual student’s data and arrangement of these pages follows multiple baseline display rules. In addition, open dots refer to initial readings following intervention. The six phase labels refer to baseline (BL), repeated reading 1-4 (RR1-RR4), the extra reading (EX), and maintenance/transfer readings (M/T) and names refer to specific students. All scores, except M/T readings, occur on the day noted. Although all four
occurred after the EX reading and in the order noted, M/T readings may have taken place over more than four days but grouped together for display purposes.

Both figures show that with the introduction of the repeated reading intervention (RRFC) student’s oral reading fluency improved. Two particular aspects of each student’s reading scores highlight effects of the intervention. The first aspect of each group’s results comprises each student’s initial readings. Each student had four celeration lines; correct and incorrect celerations for both pre- and post-intervention readings created using the quarter intersect method (Pennypacker, Gutierrez, & Lindsley, 2003). Pre-intervention readings include all baseline reading scores. Post-intervention readings combined the initial reading scores from intervention passages with the final, extra reading score.

The second aspect of each group’s results centers on within student celeration comparisons. Group A consisted of four students who started intervention in the following order: Jason, Joseph, Denise, and Nancy (Figure 2). Three students in Group B began intervention in the following order: Ned, Kevin, and Elizabeth (Figure 3).

*Group A: Pre- and post-intervention celerations.* Figures 4, 5, 6, and 7 show the reading scores for Jason, Joseph, Denise, and Nancy, respectively. Standard Celeration Charts show the data using previously mentioned scaling and labeling. Each figure shows the reading scores used to create pre- (i.e., baseline reading scores) and post-intervention (i.e., initial reading scores from intervention and the extra, initial reading score; corrects marked as open dots) celerations for corrects and incorrects.

Prior to intervention, three students had decelerating corrects with one student showing acceleration. Jason (Figure 4), Joseph (Figure 5), and Denise (Figure 6) had
decelerations of ÷1.32, ÷1.43, and ÷1.10 while Nancy (Figure 7) exhibited an acceleration of x1.28. For incorrects, Jason, ÷1.58, Joseph, ÷1.15, and Denise, ÷1.05, produced decelerating incorrects and Nancy showed an acceleration, x1.10. After intervention, all four students had accelerations for corrects on post-intervention initial readings. Consequently, Jason, Joseph, Denise, and Nancy had accelerations of x1.03, x1.10, x1.05, and x1.09. Joseph, ÷1.18, and Denise, ÷1.15, registered decelerations for incorrects. Jason and Nancy showed accelerations of x1.00 and x1.10.

The celeration change equation (Pennypacker et al., 2003) permits the calculation of celeration comparisons. Celeration change quantifies the behavior change as a result of intervention. For example, a student’s corrects may decelerate into intervention and then begin to accelerate. The change from deceleration to acceleration shows the celeration change.

The celeration equation has two possible operations which depend on the sign of the celerations. The first operation divides the larger celeration by the smaller celeration then attaches the sign of change in the event both celerations share the same sign (Pennypacker et al., 2003). For example, a x2.00 acceleration followed by a x4.00 acceleration would produce a x2.00 celeration change (4 ÷ 2 = 2, as x4.00 after a x2.00 suggest a further acceleration resulting in a x2.00 celeration change). Reversing the order of the two celerations would result in a ÷2.00 celeration change (4 ÷ 2 = 2, x2.00 follows a x4 suggests a deceleration resulting in a ÷2.00 celeration change). For situations where two celerations have different signs, the second operation multiples the two celerations then attaches the sign of change (Pennypacker et al., 2003). A x2.00 acceleration
followed by a $\div 2.00$ deceleration would result in a $\div 4.00$ celeration change ($2 \times 2 = 4$, $\div 2.00$ follows a $x 2.00$ showing a decelerating resulting in a $\div 4.00$ celeration change).

Joseph and Denise had improving celeration changes for both corrects, $x 1.57$ and $x 1.16$, and incorrects, $\div 1.03$ and $\div 1.10$. Improved celeration changes for corrects would result in an acceleration and for incorrects, a deceleration. Jason had an improving celeration change for corrects, $x 1.36$ and Nancy’s incorrect celeration change of $x 1.00$ means the celerations remained the same. Jason and Nancy had either worsening celeration changes for incorrects (Jason, $x 1.58$) or corrects (Nancy, $\div 1.17$).

**Group B: Pre- and post-intervention celerations.** Figures 8, 9, and 10 show reading scores on SCC for Ned, Kevin, and Elizabeth using the aforementioned conventions. Ned (Figure 8) and Kevin (Figure 9) had pre-intervention decelerations of, respectively, $\div 1.35$ and $\div 1.05$, for corrects and accelerations for incorrects, $x 1.28$ and $x 1.38$. Elizabeth (Figure 10) had accelerations for corrects, $x 1.00$, and incorrects, $x 1.12$. Ned, Kevin, and Elizabeth had decelerations of, $\div 1.08$, $\div 1.02$, and $\div 1.08$, for corrects post-intervention. For incorrects post-intervention, Kevin and Elizabeth had accelerations of $x 1.10$ and $x 1.00$ and Ned had a deceleration of $\div 1.15$.

Ned and Kevin had improving celeration changes for both corrects, $x 1.25$ and $x 1.03$, and incorrects, $\div 1.47$ and $\div 1.25$, from pre- to post-intervention. Elizabeth, while showing improving celeration changes for incorrects, $\div 1.12$, had a worsening correct celeration change, $\div 1.08$.

**Within passage celerations.** Table 8 lists students’ celerations for each passage and Figures 11 (Jason), 12 (Joseph), 13 (Denise), 14 (Nancy), 15 (Ned), 16 (Kevin),
Figure 9

Kevin's Pre-/Post- Intervention Celeration Changes
Figure 11

Jason's Within-Passage Celerations

SUCCESSIVE CALENDAR DAYS

COUNT PER MINUTE

CALENDAR WEEKS

0 7 14 21 28 35 42 49 56 63 70 77 84 91 98 105 112 119 126 133 140

PERFORMER

CHARTER

METER

MANAGER

ADVISER

SUPERVISOR

DEPOSITOR

13 M.

LABEL

COUNTED

AGE

Jason

Doug

Doug

Doug

Doug

Doug

Doug

Doug

Doug

Doug

Author
Figure 17

CALENDAR WEEKS

SUCCESSIVE CALENDAR DAYS

COUNT PER MINUTE

RR1 \times 1.25
RR2 \times 1.29
RR3 \div 10.0
RR4 \times 1.22

\frac{1}{1.20} \times 1.12
\frac{1}{1.78}

Elizabeth’s Within Passage Celebrations

<table>
<thead>
<tr>
<th>Rick</th>
<th>Rick</th>
<th>Doug</th>
<th>Doug</th>
<th>Elizabeth</th>
<th>13 F</th>
<th>Wpm (C&amp;I)</th>
</tr>
</thead>
<tbody>
<tr>
<td>SUPERVISOR</td>
<td>ADVISER</td>
<td>MANAGER</td>
<td>DEPOSITOR</td>
<td>PERFORMER</td>
<td>AGE</td>
<td>LABEL</td>
</tr>
<tr>
<td>PSU</td>
<td>AGENCY</td>
<td>TIMER</td>
<td>COUNTER</td>
<td>CHARTER</td>
<td></td>
<td></td>
</tr>
</tbody>
</table>
### Table 8

*Student Correct and Incorrect Celerations per Passage*

<table>
<thead>
<tr>
<th>Group</th>
<th>RR1</th>
<th>RR2</th>
<th>RR3</th>
<th>RR4</th>
</tr>
</thead>
<tbody>
<tr>
<td>Jason</td>
<td>C</td>
<td>x1.40</td>
<td>x1.51</td>
<td>x1.50</td>
</tr>
<tr>
<td></td>
<td>I</td>
<td>x1.00</td>
<td>÷2.70</td>
<td>x1.00</td>
</tr>
<tr>
<td>Joseph</td>
<td>C</td>
<td>x1.23</td>
<td>x1.48</td>
<td>x1.37</td>
</tr>
<tr>
<td></td>
<td>I</td>
<td>÷1.21</td>
<td>÷1.80</td>
<td>÷4.30</td>
</tr>
<tr>
<td>Denise</td>
<td>C</td>
<td>x1.60</td>
<td>x1.43</td>
<td>x1.38</td>
</tr>
<tr>
<td></td>
<td>I</td>
<td>x1.00</td>
<td>÷3.50</td>
<td>÷3.30</td>
</tr>
<tr>
<td>Nancy</td>
<td>C</td>
<td>x1.87</td>
<td>x12.00</td>
<td>x1.55</td>
</tr>
<tr>
<td></td>
<td>I</td>
<td>x1.00</td>
<td>÷300.00</td>
<td>÷9.50</td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th>Group</th>
<th>RR1</th>
<th>RR2</th>
<th>RR3</th>
<th>RR4</th>
</tr>
</thead>
<tbody>
<tr>
<td>Ned</td>
<td>C</td>
<td>x1.70</td>
<td>x1.65</td>
<td>x1.82</td>
</tr>
<tr>
<td></td>
<td>I</td>
<td>x1.00</td>
<td>÷10.00</td>
<td>x1.00</td>
</tr>
<tr>
<td>Kevin</td>
<td>C</td>
<td>x1.15</td>
<td>x1.15</td>
<td>x2.40</td>
</tr>
<tr>
<td></td>
<td>I</td>
<td>÷2.25</td>
<td>x1.60</td>
<td>÷20.00</td>
</tr>
<tr>
<td>Elizabeth</td>
<td>C</td>
<td>x1.25</td>
<td>x1.29</td>
<td>x1.60</td>
</tr>
<tr>
<td></td>
<td>I</td>
<td>x1.20</td>
<td>÷1.12</td>
<td>÷18.00</td>
</tr>
</tbody>
</table>

*Note.* C = Corrects, I = Incorrects, RR = Repeated reading passage

All students reached criterion on four within chapter passages and demonstrated variable accelerations for corrects. No student showed correct or incorrect celerations that improved from passage to passage. Some students, such as Jason, Nancy, and Ned, had multiple instances of x1.00 celerations for incorrects meaning that the students did not make many reading errors during testing of the specific passages. Denise had decelerations of x3.30 or higher for the final three passages demonstrating a significant drop in errors from initial to criterion readings.

### Group Average Reading Scores

Table 9 lists Group A’s and B’s reading score averages for CWPM and IWPM during baseline, initial, and criterion readings. Table 9 also shows the average number...
### Table 9

**Average Reading and Summary Scores**

<table>
<thead>
<tr>
<th></th>
<th>Group A</th>
<th>Group B</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>Baseline</strong></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Average # of Baseline Passages per Student</td>
<td>6</td>
<td>4.3</td>
</tr>
<tr>
<td>Baseline Score (Ave. C/I)</td>
<td>81.9 / 6.8</td>
<td>87.7 / 7.8</td>
</tr>
<tr>
<td>Average Readability (Ave. Reading Ease)</td>
<td>9.4 (50.7)</td>
<td>8.6 (55.9)</td>
</tr>
<tr>
<td><strong>Repeated Reading Passage 1</strong></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Initial Reading (Ave. C/I)</td>
<td>92.3 / 9</td>
<td>105.3 / 5.7</td>
</tr>
<tr>
<td>Criterion Reading (Ave. C/I)</td>
<td>209.8 / 1.5</td>
<td>205.7 / 1.3</td>
</tr>
<tr>
<td>Ave. Sessions to Criterion (Reading Trials)</td>
<td>7.4 (29)</td>
<td>9.3 (37.3)</td>
</tr>
<tr>
<td>Readability (Reading Ease)</td>
<td>9.9 (51.3)</td>
<td>8.4 (61.4)</td>
</tr>
<tr>
<td><strong>Repeated Reading Passage 2</strong></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Initial Reading (Ave. C/I)</td>
<td>66.3 / 7</td>
<td>106.3 / 6</td>
</tr>
<tr>
<td>Criterion Reading (Ave. C/I)</td>
<td>213.8 / 1.3</td>
<td>201 / 0.7</td>
</tr>
<tr>
<td>Ave. Sessions to Criterion (Reading Trials)</td>
<td>7.4 (29)</td>
<td>8 (32)</td>
</tr>
<tr>
<td>Readability (Reading Ease)</td>
<td>9.4 (52.5)</td>
<td>7.7 (61.4)</td>
</tr>
<tr>
<td><strong>Repeated Reading Passage 3</strong></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Initial Reading (Ave. C/I)</td>
<td>75.5 / 8.5</td>
<td>71.7 / 9</td>
</tr>
<tr>
<td>Criterion Reading (Ave. C/I)</td>
<td>204.5 / 0.8</td>
<td>203 / 2</td>
</tr>
<tr>
<td>Ave. Sessions to Criterion (Reading Trials)</td>
<td>8.5 (34)</td>
<td>4.3 (17.3)</td>
</tr>
<tr>
<td>Readability (Reading Ease)</td>
<td>10.7 (42.9)</td>
<td>7.4 (66.8)</td>
</tr>
<tr>
<td><strong>Repeated Reading Passage 4</strong></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Initial Reading (Ave. C/I)</td>
<td>93.8 / 6.8</td>
<td>82.7 / 4.3</td>
</tr>
<tr>
<td>Criterion Reading (Ave. C/I)</td>
<td>205.8 / 1</td>
<td>203.0 / 0.0</td>
</tr>
<tr>
<td>Ave. Sessions to Criterion (Reading Trials)</td>
<td>6.6 (26.5)</td>
<td>10 (40.0)</td>
</tr>
<tr>
<td>Readability (Reading Ease)</td>
<td>9.5 (52.3)</td>
<td>8.9 (55.2)</td>
</tr>
<tr>
<td><strong>Extra Initial Reading</strong></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Initial Reading (Ave. C/I)</td>
<td>101.8 / 6.0</td>
<td>81.0 / 5.7</td>
</tr>
<tr>
<td>Readability (Reading Ease)</td>
<td>11.6 (35.4)</td>
<td>8.6 (50.8)</td>
</tr>
</tbody>
</table>

*Note. C = Corrects, I = Incorrects.*

sessions and readings (i.e., four per session) each group required reach criterion. For reference, Table 9 displays the readability and reading ease of each passage.

Group A showed an increase to initial readings following the introduction of RRFC. Group A students read an average of 66.3, 75.5, 93.8, and 101.8 CWPM on passages 2, 3, 4, and the extra reading. The initial reading average of 101.8 CWPM, the highest average for Group A, occurred in the passage with the highest grade level (11.6)
Table 10

Retell Scores (Correct Words per Minute)

<table>
<thead>
<tr>
<th>Student Group A</th>
<th>Repeated Reading 1</th>
<th>Repeated Reading 2</th>
<th>Repeated Reading 3</th>
<th>Repeated Reading 4</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>Pre</td>
<td>Post</td>
<td>Pre</td>
<td>Post</td>
</tr>
<tr>
<td>Jason</td>
<td>37</td>
<td>49</td>
<td>31</td>
<td>41</td>
</tr>
<tr>
<td>Joseph</td>
<td>16</td>
<td>66</td>
<td>12</td>
<td>60</td>
</tr>
<tr>
<td>Denise</td>
<td>0</td>
<td>48</td>
<td>22</td>
<td>11</td>
</tr>
<tr>
<td>Nancy</td>
<td>27</td>
<td>48</td>
<td>24</td>
<td>67</td>
</tr>
<tr>
<td>Average</td>
<td>20.0</td>
<td>52.8</td>
<td>22.3</td>
<td>44.8</td>
</tr>
</tbody>
</table>

| Group B         |                   |                   |                   |                   |
| Ned             | 27     | 60     | 6      | 74     | 0      | 59     | 8      | 37     |
| Kevin           | 44     | 61     | 40     | 75     | 23     | 93     | 17     | 43     |
| Elizabeth       | 27     | 60     | 39     | 46     | 31     | 67     | 38     | 49     |
| Average         | 32.7   | 60.3   | 28.3   | 65.0   | 18.0   | 73.0   | 21.0   | 43.0   |
| Overall Ave.    | 26.3   | 56.6   | 25.3   | 54.9   | 11.9   | 73.4   | 21.2   | 53.3   |

and lowest readability (35.4). Average IWPM decreased between three of the four passages. Group A required as many or more average sessions of reading to reach criterion in all but one passage.

Conversely, average reading scores for Group B did not increase from passage to passage. Average initial CWPM and IWPM varied from reading to reading across the passages. Group B showed an initial decline in the average number of session for passages two (8) and three (4.3) but more than doubling in number (10) for passage four.

Retells

Table 10 lists the retell scores in CWPM for both Group A and B. All students had eight oral retell opportunities (Appendix I presents transcripts for all oral retells). The retell tests occurred after the initial reading of each of the four repeated reading passages (i.e., pre-test) and at the conclusion of the session each student met criterion on each of the repeated reading passages (i.e., post-test).
Group A students averaged 17 CWPM during pre-test retells and 58 CWPM during post-test retells, an average increase of 41 CWPM. Nancy had the only instance, across all students, of improvements across all four passages (21, 43, 55, and 82 CWPM). Jason showed the smallest average increase from pre- to post-test retells in Group A with an average of 20 CWPM (range 12-31). However Jason, initially only gaining 12 and 10 CWPM during the first 2 pre-/post-test retell opportunities, improved by 31 and 27 CWPM during the second 2. Joseph increased by an approximate average of 61 CWPM (range 34-113) from pre- to post-tests, showing a high retell score of 125 CWPM during passage 3. Denise produced three improvements from pre-/post-tests retells (48, 73, and 26 CWPM) but also provided the only example of a decrease from pre- to post-test scores (-11 CWPM) across both groups.

Group B also averaged an increase from pre- to post-test retells. Averaging 25 CWPM during pre-tests and 60 during post-tests, Group B averaged 35 more CWPM during post-tests. Ned had the highest average increase (47 CWPM, range 29-68) and Elizabeth the lowest (22 CWPM, range 7-36). No student in Group B made increasingly higher scores on each successive retell opportunity. However, Kevin showed increasing retell improvement scores for the first 3 passages (17, 35, and 70 CWPM), before showing a smaller increase in the final passages (26 CWPM). Factoring both groups together, average scores from pre- to post-tests improved by 38.8 CWPM with a range of 29.6 to 61.5 CWPM.

Three correlations help explicate the relationship of reading fluency, amount of reading, and oral retell measures. The first association correlates retell scores and number of times the student read a particular passage before providing the retell. For example,
students had one opportunity to read a baseline line passage before providing a retell. At criterion readings, the number of readings varied. The correlation \((r=0.63)\) between number of readings and retell scores showed a moderate relationship.

The second and third correlations compared each retell score with the CWPM and IWPM each student made just prior to performing each retell. CWPM and IWPM varied during baseline and initial readings, however at minimum, students read 200 CWPM and 2 or less IWPM during criteria readings. The positive correlation between retell score and CWPM \((r=0.74)\) showed a strong relationship and the negative correlation between retell score and IWPM \((r=-0.59)\) showed a moderate relationship. While all comparisons had moderate to strong relationships, reading CWPM explained 55\% \((0.74^2)\) of retell variation while number of readings and IWPM explained only 40\% \((0.63^2)\) and 35\% \((-0.59^2)\) of retell variation, respectively.

**Maintenance/Transfer Measures**

The final four readings by each student provided a measure of maintenance/transfer. Students that received intervention using passages from one chapter, read the intervention passages (RR1-4) from the other chapter for one-minute. Exemplifying maintenance, students read the additional four passages after the removal of the RRFC intervention (Cooper, Heron, & Heward, 2007). Reading scores on the four additional readings also demonstrated reading transfer which refers to increases in successive reading scores after reaching criterion on previous readings (Faulkner & Levy, 1994). Specifically, Group A students read the four intervention passages from chapter four (passage numbers 4, 1, 9, and 11), and Group B students read the four intervention passages from chapter one (passage numbers 4, 1, 11, and 7).
Table 11

*Group A Maintenance/Transfer Readings*

<table>
<thead>
<tr>
<th>Student</th>
<th>MT 1</th>
<th>MT 2</th>
<th>MT 3</th>
<th>MT 4</th>
<th>MT A</th>
<th>Chapter 1 BL A</th>
</tr>
</thead>
<tbody>
<tr>
<td>Jason</td>
<td>119</td>
<td>8</td>
<td>112</td>
<td>7</td>
<td>70</td>
<td>12</td>
</tr>
<tr>
<td>Joseph</td>
<td>76</td>
<td>3</td>
<td>97</td>
<td>3</td>
<td>56</td>
<td>5</td>
</tr>
<tr>
<td>Denise</td>
<td>109</td>
<td>6</td>
<td>115</td>
<td>3</td>
<td>77</td>
<td>8</td>
</tr>
<tr>
<td>Nancy</td>
<td>84</td>
<td>9</td>
<td>114</td>
<td>6</td>
<td>82</td>
<td>8</td>
</tr>
<tr>
<td>Ave.</td>
<td>97</td>
<td>7</td>
<td>110</td>
<td>5</td>
<td>71</td>
<td>8</td>
</tr>
</tbody>
</table>

*Note.* MT = Maintenance/Transfer reading, BL = Baseline readings, A = Average

Table 12

*Group B Maintenance/Transfer Readings*

<table>
<thead>
<tr>
<th>Student</th>
<th>MT 1</th>
<th>MT 2</th>
<th>MT 3</th>
<th>MT 4</th>
<th>MT A</th>
<th>Chapter 4 BL A</th>
</tr>
</thead>
<tbody>
<tr>
<td>Ned</td>
<td>91</td>
<td>2</td>
<td>84</td>
<td>3</td>
<td>63</td>
<td>7</td>
</tr>
<tr>
<td>Kevin</td>
<td>104</td>
<td>2</td>
<td>90</td>
<td>3</td>
<td>103</td>
<td>6</td>
</tr>
<tr>
<td>Elizabeth</td>
<td>108</td>
<td>13</td>
<td>95</td>
<td>11</td>
<td>92</td>
<td>10</td>
</tr>
<tr>
<td>Ave.</td>
<td>101</td>
<td>6</td>
<td>90</td>
<td>6</td>
<td>86</td>
<td>8</td>
</tr>
</tbody>
</table>

*Note.* MT = Maintenance/Transfer reading, BL = Baseline readings, A = Average

Table 11 and 12 list the maintenance/transfer scores for Group A and B, respectively. Each table also includes individual maintenance/transfer reading score averages, per maintenance/transfer passage averages, and overall maintenance/transfer averages. The addition of individual and group averages from baseline readings provides added comparisons.

Group A students (Table 11) read more CWPM (+8, range 4-20) and made less IWPM (-1, range -1+2) on average during maintenance/transfer readings compared to baseline readings. Nancy reading an average of 94 (range 82-114) CWPM with 7 (range 3-9) showed the largest average increase (20 CWPM) from intervention to
maintenance/transfer and improved from 90% to 93% average reading accuracy. Making smaller gains, Denise and Joseph improved average reading accuracy (94% to 96% and 95% to 96%), CWPM (101 to 105 and 70 to 74), and IWPM (6 to 5 and 4 to 3) from baseline to maintenance/transfer readings. Joseph, while reading more CWPM (93 to 99) during maintenance/transfer readings, did make more IWPM (8 to 10) decreasing his average reading accuracy score from 91% to 90%.

Group B students (Table 12) also improved from baseline to maintenance/transfer readings by reading an average of 8 (range 1-13) more CWPM and 2 (range 1-4) fewer IWPM which increased average reading accuracy from 92% to 95%. Elizabeth made the greatest average gain of CWPM (+13) reading an average of 103 (range 92-115) CWPM during maintenance/transfer readings compared an average baseline CWPM score of 90 (range 78-106). Additionally, Elizabeth decreased IWPM from 10 (5-14) to 9 (1-13) improving her reading accuracy from 90% to 92%. Ned improved average reading accuracy from 94% to 95% by increasing average CWPM from 72 (61-81) to 83 (63-95) and decreasing IWPM from 5 (4-6) to 4 (2-7). Kevin made the smallest gains to average CWPM from 96 (79-106) to 97 (90-104) but displayed the largest jump in average reading accuracy (93% to 97%) due to the largest drop in average IWPM (7 to 3).

Examining all students together, students averaged the highest number of CWPM (93.5) and the lowest IWPM (5.5) during maintenance/transfer readings. Additionally, students improved average reading accuracy from 92% during baseline readings to 94% during maintenance/transfer readings.
## Table 13

**Student Responses to the 5-point Likert Scale Questionnaire**

<table>
<thead>
<tr>
<th>Statement</th>
<th>1</th>
<th>2</th>
<th>3</th>
<th>4</th>
<th>5</th>
<th>6</th>
<th>7</th>
<th>Ave</th>
</tr>
</thead>
<tbody>
<tr>
<td>1. This reading practice helped me a lot in school.</td>
<td>5</td>
<td>4</td>
<td>4</td>
<td>5</td>
<td>5</td>
<td>3</td>
<td>3</td>
<td>4.1</td>
</tr>
<tr>
<td>2. This reading practice helped me in my science class.</td>
<td>4</td>
<td>3</td>
<td>4</td>
<td>4</td>
<td>5</td>
<td>4</td>
<td>3</td>
<td>3.9</td>
</tr>
<tr>
<td>3. If asked, I would read more passages.</td>
<td>5</td>
<td>5</td>
<td>4</td>
<td>5</td>
<td>5</td>
<td>5</td>
<td>4</td>
<td>4.7</td>
</tr>
<tr>
<td>4. I did not like to read fast.</td>
<td>1</td>
<td>2</td>
<td>1</td>
<td>1</td>
<td>1</td>
<td>1</td>
<td>2</td>
<td>1.3</td>
</tr>
<tr>
<td>5. I did not have fun reading with Doug.</td>
<td>1</td>
<td>3</td>
<td>1</td>
<td>1</td>
<td>1</td>
<td>1</td>
<td>1</td>
<td>1.3</td>
</tr>
<tr>
<td>6. I liked reading the same passage four times each day.</td>
<td>5</td>
<td>3</td>
<td>3</td>
<td>3</td>
<td>5</td>
<td>4</td>
<td>4</td>
<td>3.9</td>
</tr>
<tr>
<td>7. I am happy to know I can read fast.</td>
<td>5</td>
<td>4</td>
<td>4</td>
<td>5</td>
<td>5</td>
<td>4</td>
<td>5</td>
<td>4.6</td>
</tr>
<tr>
<td>8. By reading fast, I was able to remember more about what I read.</td>
<td>5</td>
<td>4</td>
<td>3</td>
<td>5</td>
<td>4</td>
<td>4</td>
<td>3</td>
<td>4.0</td>
</tr>
<tr>
<td>9. I did not like having to leave my class to read.</td>
<td>1</td>
<td>1</td>
<td>2</td>
<td>1</td>
<td>1</td>
<td>3</td>
<td>2</td>
<td>1.6</td>
</tr>
<tr>
<td>10. If my teacher had me read like Doug did, I would like that.</td>
<td>1</td>
<td>4</td>
<td>3</td>
<td>5</td>
<td>5</td>
<td>5</td>
<td>3</td>
<td>3.7</td>
</tr>
</tbody>
</table>

### Social Validity

The experimenter used four measures to examine social validity data: a 5-point Likert scale questionnaire, student interview responses, a teacher questionnaire, and any other anecdotal observations and unprompted feedback collected during the course of the study. Average student responses from the questionnaire appear on Table 11. Students agreed most strongly with the statements, “If asked, I would read more passages” and “I am happy to know I can read fast.” Students disagree most with the statements “I did not like to read fast” and “I did not like reading with Doug [the experimenter].” The statement “If my teacher had me read like Doug [the experimenter] did, I would like that” drew the most neutral responses.

All students agreed to answer the three exit interview questions after the final session. Students reported enjoying their participating in the study and shared their
reasons. Some of the students explained that they had fun reading fluently and reading things that they never read before. Other students reported that they felt they learned new words and how not to skip over words. In addition to reading fast, one student reported that he liked to leave class and another liked to earn participation prizes. All but one student reported feeling that participating helped them with their science text. One student elaborated upon a situation with her and a friend, not part of the study, talked about one of the passages outside of class. Finally, referring back to practiced passages, all students reported that they felt they better understood what they read.

The learning support teacher reported that all participating students benefited from the intervention. She noticed the student’s excitement for their turn to read, reaching and announcing daily high scores, and earning participation prizes. During class, she said she noticed “a positive change in student attitudes towards reading” and recognized that students started “reading more automatically displaying an upward trend in reading fluency.” She specifically noted that a parent had contacted her voicing approval for her child’s oral reading improvement. The teacher reported, if possible, to “definitely” wanting to try this procedure in her classroom. The teacher received a demonstration and training of the study’s procedures at the conclusion of the study.

Outside of the structured measures, the teacher and students provided unprompted feedback during the course of the study. The teacher mentioned once that she felt the intervention helped the students with more than reading fluency. During one of the pre-test retells, a student said, “I don’t know. I didn’t read the words fast enough” in response to the retell test. Another student got frustrated that his finger could not move as fast as he read.
Chapter 5

DISCUSSION

The main purpose of this study addressed the effects of repeated readings to a fluency criterion (RRFC) on oral reading fluency with science text. Questions that guided the experiment attempted to investigate: What effect will reaching fluency on one passage have on initial, unpracticed readings of successive passages? What effect will reaching fluency on one passage have on the number of sessions necessary to reach fluency criterion on successive passages? What effect will reaching criterion on passages from one chapter have on initial, unpracticed readings from another chapter? And, what effect will reaching fluency on a passage have on a participant’s ability to retell what they read in that passage?

Primary Purpose

Results from this study contribute to and extend the RRFC literature base. As with previous RRFC studies employing Precision Teaching criteria (e.g., Kostewicz & Kubina, in review; Kubina et al., in press; Sweeny et al., 2003; Teigen et al., 2001), students improved their oral reading fluency. Implementation of the RRFC intervention in the present experiment showed a functional relationship between the introduction of the RRFC methods and students’ oral reading fluency improvements based on visual inspection of the two multiple baseline graphs (Kennedy, 2005). All seven students reached a fluency criterion of 200 correct words per minute (CWPM) with 2 or less incorrects per minute (IWPM) on four science passages. Four of seven students improved initial reading score celerations from baseline to intervention for both CWPM and IWPM and two other students either had improving celerations for CWPM, Jason, or IWPM,
Elizabeth. Additionally, students demonstrated higher reading scores on maintenance/transfer passages and improved from pre- to post-test oral retell measures in almost every case. Finally, six of seven students had higher CWPM, fewer IWPM, and greater reading accuracy from overall pre- to post-test scores.

The current study demonstrated that students with disabilities, through the use of reading practice to a high fluency aim, can improve oral reading fluency with expository text (i.e., science text). Students with disabilities often display early and consistent reading problems that eventually lead to negative outcomes with textbook-based reading consisting mainly of expository text (Ciborowski, 1995). As textbook-based instruction still remains pervasive within science education (Cawley et al., 2003), having effective fluency-building procedures becomes paramount considering the important role of content reading fluency (Bhattacharya, 2006).

Science textbooks traditionally have reading levels well beyond their intended use (Bergerud et al., 1988; Mastropieri & Scruggs, 1994b) and the textbook used in the present experiment, From Bacteria to Plants (Padilla et al., 2007), shared some of the same characteristics. Although initially intended for seventh graders, selected passages had readability scores from sixth to eleventh grade and “difficult” reading ease scores. Regardless, students showed oral reading fluency improvements both within and between passages.
Question One: What effect will reaching fluency on one passage have on initial, unpracticed readings of successive passages?

Aside from pre- to post-test improvements, two related parts of initial student reading scores combine to address question one: Correct words per minute and incorrect words per minute.

Correct words per minute. The present study used celerations, rather than frequency improvements (e.g., Samuels, 1979), to compare improving CWPM scores. Samuels initially suggested that once students reach criterion on one passage, students will score higher on successive passages. Student reading scores from the present study support Samuels’ findings but used a different metric called celeration. Frequency score improvements show only performance, while celerations provide a picture of learning (Pennypacker et al., 2003).

All students from Group A demonstrated accelerating CWPM celerations following intervention. Jason, Joseph, Denise, and Nancy all had accelerations ranging from x1.03 to x1.10. Students from Group B did not demonstrate accelerations to initial reading scores during intervention. Unlike Samuels (1979), the current study had baseline initial reading scores which allow additional comparisons in the form of celeration changes.

Placed in context, improving celerations changes from baseline to intervention may provide clearer analyses of RRFC intervention effects. Jason, Joseph, and Denise, while showing slight accelerations during intervention, had larger CWPM celeration changes, x1.36, x1.57, and x1.16, respectively. In each case, the students’ CWPM celerations turned from deceleration into acceleration. Group B, as mentioned previously,
had no students display accelerations to CWPM following baseline. Ned and Kevin, however, showed improving celeration changes, x1.25 and x1.03, respectively. Therefore, the RRFC intervention helped slow each student’s decelerating CWPM.

Samuels (1979) and others (Faulkner & Levy, 1995; Rashotte & Torgeson, 1985) refer to increasing initial reading scores as reading transfer. The five of seven students in the current study displayed reading transfer both during intervention and in comparison to baseline initial reading celerations. In fact, students displayed reading transfer with passages that contained word overlap that averaged approximately 28%. In previous studies, students showed reading transfer with 30% (Kostewicz & Kubina, in review), 50% (Rashotte & Torgeson) and 72% (Faulkner & Levy) overlapping words and, in the case of Faulkner and Levy, content overlap. Similar to the 28% word overlap found in the current study, Kostewicz and Kubina reported student reading transfer as a result of two fluency-building procedures, interval sprinting and RRFC, both with the same fluency criterion used during the current study.

Incorrect words per minute. Reading errors play a role in reading transfer and affect comprehension (Daane, Campbell, Grigg, Goodman, & Oranje, 2005). Samuels (1979) suggested errors decrease as students reach criteria on successive passages with students’ reading scores in the current study showing similar changes. Unlike CWPM, IWPM celerations did not figure into intervention decision making. Students could display accelerating, Nancy, Ned, Kevin, and Elizabeth, or decelerating, Jason, Joseph, and Denise, IWPM during baseline. Following intervention, five students displayed improving IWPM celeration changes ranging from ÷1.03, Joseph, to ÷1.47, Ned. Two students, Joseph and Denise, showed further decelerating IWPM decelerations and two
other students, Kevin and Elizabeth, demonstrated slowing IWPM accelerations showing the effectiveness of the RRFC intervention.

Relatively few studies (e.g., Anderson & Alber, 2003; Carroll et al., 1991; Kostewicz & Kubina, in review; Polk & Miller, 1994) graphically displayed students’ reading errors. Dahl (1979) initially suggested recording errors unnecessary because errors decrease during reading practice. IWPM celerations in the current study did not decelerate for every student. For example, Jason’s initial reading errors accelerated to x1.00 in intervention from ÷1.58 in baseline. Also, some students, Elizabeth, Ned, Nancy, and Kevin, displayed accelerating IWPM celerations within passages.

By not graphing errors, researchers may have difficulty evaluating student progress or may miss instances where reading errors do not decrease with intervention requiring procedural adjustments (e.g., Kostewicz & Kubina, in review). In within passage cases, students could not move onto the next passage until meeting aforementioned error criterion of two or fewer errors. Students not required to meet a specific error criterion may progress to another passage while still making high rates of errors (e.g., McDowell et al., 1998) potentially affecting future error rates.

Question Two: What effect will reaching fluency on one passage have on the number of sessions necessary to reach fluency criterion on successive passages?

Samuels (1979) proposed that students not only increase reading score on successive passages, but also decrease amount of sessions necessary to reach criterion. Researchers (Dowhower, 1987; McDowell et al., 1998; Samuels, 1979) have reported situations where students require fewer sessions to criterion after reaching fluency criteria on previous passages. Other researchers (e.g., Polk & Miller, 1994; Spence, 2002;
Wienstein & Cooke, 1992) have shown students require varying numbers of sessions to reach criterion on successive passages. Still other researchers (Staubitz et al., 2006; Yurick et al., 2005) have displayed some students meeting criteria sooner and some students requiring additional sessions to meet criteria. Students in the current study displayed a varying number of trials to criterion.

Two students from Group B, Ned and Elizabeth, reached criterion on intervention passage 1 in 10 sessions. Elizabeth required 9 then 5 sessions to reach criterion on passages 2 and 3 with Ned needing only 6 sessions on both passages. However, both students increased the number of sessions necessary during the fourth passages. On the whole, Group B decreased average number of trials to criterion for the first three passages then required more sessions to reach criterion on the fourth passage.

Group A students produced more varied sessions to criterion. Jason remained the same for the first three passages, 11, decreasing to 10 during the final passage. Denise, 8, 9, then 10, and Nancy, 4, 5, then 7, increased the number of sessions necessary for the first three passages before decreasing to 7 and 5, respectively, during the final passage. Changing passage readability may explain variability found with number of sessions to criterion.

Two studies (Spence, 2002; Yurick et al., 2005) have reported some students needing more sessions to meet successive criteria as passage difficulty increased. The basic model of repeated readings involves using passages of equal difficulty, rather than varying or increasing difficulty (Meyer & Felton, 1999). As previously mentioned, science textbooks have varying difficulty and passages used in the current study varied accordingly. Elizabeth and Ned decreased number of sessions to criterion over the first
three passages as passage readability decreased, 8.4, 7.7, to 7.4. When readability increased to 8.9, both students needed more sessions to meet criterion. Students from Group A demonstrated similar results although with more difficult passage readability.

Students in Group A initially reached criterion on a passage with 9.9 readability. Other than Joseph, all students required more or as many sessions to reach criterion over the next two passages with readabilities of 9.4 and 10.7. However, all four students required the fewest number of sessions during the fourth passage, even though the passage had a high readability, 9.5. The eventual improvements suggest that over time RRFC may not only improve reading fluency, but also affect amount of time students reach criterion on passages with higher readability (e.g., Staubitz et al., 2005).

Question Three: What effect will reaching criterion on passages from one chapter have on initial, unpracticed readings from another chapter?

A student’s ability to display improvement after removal of intervention demonstrates maintenance of intervention effects (Cooper et al., 2007) and in the case of repeated reading interventions, reading transfer (Faulkner & Levy, 1987). Individually, all students outperformed average CWPM baseline reading scores during maintenance. Additionally, all students except Jason, increased average reading accuracy and decreased average IWPM during maintenance. Considering that Lovitt, Horton, and Bergerud (1987) suggest students must read 135 CWPM to effectively respond to science content, students maintaining and making further gains after four intervention passages suggests that continued use of the RRFC intervention may allow students to improve to a degree that they can functionally and fluently read science content.
Group B’s reading improvements during maintenance provide additional insight into the RRFC effects. Group B practiced with passages from chapter four during the course of the study. Chapter four passages read with a slightly lower average readability as compared to chapter one passages. Yet, all three students displayed higher reading scores during maintenance. Ned and Elizabeth increased an average of 11 and 13 CWPM, respectively, while Kevin improved average reading accuracy from 93% to 97%. The findings further support the ability of the RRFC intervention to affect improvements with more difficult material moving students toward higher reading rates.

**Question Four: What effect will reaching fluency on a passage have on a participant’s ability to recall what they read in that passage?**

Gleason, Krauss and Tindal (n. d.) evaluated oral retell measures across three measures (i.e., holistic scoring, number of ideas, and number of words). Results indicated strong correlations between both holistic scores and number ideas and retells with the highest number of words suggesting a relationship between quality and quantity. Therefore, the importance of students in the current study improving, on average, 40 CWPM on oral retell tests after reaching fluency criteria suggests an additional benefit of RRFC. For example, Joseph showed some of the largest gains from pre- to post-tests increasing by 113 CWPM during the third passage and by over 40 on the other three passages. Nancy, over the final two passages, improved from 0 to 55 and 82 CWPM. The student making the lowest gains, Elizabeth, still displayed an average improvement of 22 CWPM. While current research (e.g., Staubitz et al., 2005; Therrien et al., 2006; Yurick et al, 2006) shows various comprehension outcomes as a result of RRFC interventions,
oral retells may provide a better estimate of reading comprehension as a result of fluency interventions (Roberts, Good, & Corcoran, 2005).

Roberts et al. (2005) offer four reasons for supporting the use of oral retells with reading fluency interventions. First, students can provide an oral retell without completing an entire passage. During study pre-tests and baseline readings, students read less than 50% of passage, yet provided oral retells. Second, students can complete oral retells in a time efficient manner. RRFC intervention sessions with retells accounted for no more than a minute increase to session length. Third, students can generate many comprehension-like behaviors in a short amount of time. As compared to adding five words to a passage via cloze procedures (e.g., Staubitz et al., 2005), students commonly responded during oral retells with approximately 30 words pertaining to each passage. Fourth, oral retells quickly identify students whose reading fluency and comprehension do not relate. After reaching fluency criteria, students commonly responded with much higher oral retell rates in post-test situations demonstrating the relationship between reading comprehension and reading fluency.

Comprehension and decoding skills combine to produce competent reading (Gough & Tunmer, 1988). Therefore, a relationship occurs between fluent reading and reading comprehension (Therrien, 2004). Skilled readers tend to understand more of what they read (Roberts et al., 2005). For example, the National Center for Education Statistics [NCES] completed a study in 2002 examining fourth graders’ oral reading fluency and found a positive correlation between overall reading assessment scores, as a measure of comprehension, and words read per minute (Daane et al., 2005). Supportive of NCES’s relationship, students in the current study demonstrated a moderately strong positive
correlation between oral retells and CWPM. Only Denise, after reaching fluency
criterion, had a lower oral retell score on one passage. In every other case, students read
200 or more CWPM and improved on retell scores.

Daane et al. (2005) also reported that fourth grade students making the fewest
errors when reading aloud also scored the highest on overall reading assessments. During
reading, students can make various types of errors that do or do not change text meaning
(Daane et al.). However, Daane et al. found that making errors, regardless of type,
negatively correlated with reading comprehension. During the current study, the number
of student incorrects and retell scores displayed a moderately strong negative correlation.
Again, students did not perform a post-test retell until meeting the second part of the
fluency criterion, 2 or fewer errors, during which students displayed aforementioned oral
retell improvements. Considering pre-test scores, Kevin made only 4 IWPM on passage 1
and 2 initial readings, yet displayed 44 and 40 CWPM on oral retell pre-tests before
improving to 61 and 75 CWPM during post-tests. Findings support data presented by
Daane et al. and suggest importance of incorporating error rates into fluency criteria.

Another measure, reading accuracy or the combination of corrects and incorrects,
contributes to reading comprehension. Students met aims of, at minimum, 99% before
moving onto new passages. Daane et al. (2005) reported that students scored in or did not
score significantly different from a basic range when reading with 90% and 97%
accuracy. Haughton (1982) suggested that for students to perform at basic levels students
must practice at higher levels. Considering the previous relationships corrects and errors
have on reading comprehension, students should read to fluency criteria that include both
to the highest accuracy measure possible.
Samuels (1979) cautioned against concentrating on reading accuracy at the cost of reading speed. However, Pikulski and Chard (2005) asserted that students must display both high levels of fluency and comprehension. By including an error criterion of two or less incorrects, student reading results suggest the RRFC intervention attended to reading accuracy without slowing reading speed. Students such as Joseph, Jason, and Denise initially read some passages with only 82%-89% accuracy, under 100 CWPM, 9 or more IWPM, and stated only 9-37 CWPM during retells. Each student met criteria by reading more than 200 CWPM and 2 or fewer errors displaying 99% reading accuracy and improved to 49-82 CWPM during post-test retells. Fluency criteria that account for high numbers of CWPM, 200, and low numbers of IWPM, 2 or fewer, attend to reading accuracy, reading speed, and retell gains simultaneously. Based on students’ performance, it would appear RRFC with science text provides an additional benefit beyond increasing decoding fluency: increasing retells of science content.

**Limitations**

While students with disabilities demonstrated reading fluency gains practicing science readings to fluency criteria, this study does contain limitations. First, a fourth passage reading test for criterion may have unnecessarily increased the number of reading trails. On four occasions during the study, students met criterion during one of the first three readings without meeting criterion during the fourth reading. In each case, however, students met the criterion during the next session adding only four one-minute readings per passage.

A second limitation of the test reading as the criterion reading, students started to read passages differently as the study progressed. Students received prompting to read as
fast as they could throughout the study. However, both reading scores and student comments suggest that some students started to “save” their fastest reading for the fourth reading in order to meet criterion. Therefore, the current RRFC methods while effective in building science reading fluency may not have promoted the most efficient use of reading time.

A third limitation regarding one student, Nancy, involved the introduction of intervention. Nancy remained in baseline until her CWPM reading scores stabilized, x1.00, or decelerated. After seven readings, Nancy’s reading scores had not stabilized and she remained in baseline for an additional three readings. Combined with the previous two reading scores and because Nancy’s CWPM showed a deceleration over the final five readings, Nancy started intervention. However, Nancy maintained an overall acceleration, x1.28, during baseline. The addition of more baseline readings, rather than only three, may have allowed Nancy’s overall CWPM acceleration to stabilize.

A fourth limitation may present hesitancy when interpreting some of the social validity results. Some of the student interview questions may have inadvertently prompted certain answers. For example, the question “Did you enjoy participating in the study?” may have presented a focus on “enjoy” rather than how they “felt” about participating. A change in phrasing from close to open ended may also have allowed students to further expound on their answers. However, the inclusion of the anonymous questionnaire with varying wordings soften the possible biased interview questions and suggest positive students experiences with the study.
Implications for Practitioners

The method of repeated readings to a fluency criterion (RRFC) holds promise for practitioners responsible for improving science literacy. This study took approximately five minutes a day for each student. Results show that the intervention had positive effects. Logistically, teachers might have lower achieving students take turns daily reading to an aide, paraprofessional, or another student able to provide effective error correction, feedback, and data collection/presentation. Teachers attempting to incorporate peer-mediated RRFC formats should understand that students responsible for implementing RRFC procedures would require procedural training and close adult supervision during application considering the difficult science vocabulary (Staubitz et al., 2005). While students in this study read the passage four times, teachers can have students read three times daily (Therrien, 2004). As a practical adjustment, students could meet criterion on any of the readings rather than only during the final reading.

Decisions regarding specific science readings would depend heavily on the type of instruction. Teachers primarily using science text-books can identify pertinent passages across topics or target a series of passages used over the course of the school year. Teachers who provide supportive text-book interventions such as study guides (e.g., Bergerud et al., 1988), graphic organizers (e.g., Horton et al., 1990) or concept maps (e.g., Guastello et al., 2000) can match passages targeted for RRFC practice and accompanying oral retell fluency measures with upcoming specific modification. For example, students may have an upcoming test on classifying living things that will require them to complete a graphic organizer. Earlier in the week, the teacher can use the RRFC practice with a passage about classifying living things in addition to normal
instruction. Teachers can then probe students’ comprehension of the passage via oral retell measures and compare results to graphic organizer completeness. Combining methods and results may increase the effectiveness of each modification and inform future instructional modifications and changes.

Compared to text-book based instruction, teachers using inquiry- or activity-based instruction tend to employ less science text with their lessons (e.g., Caseau, & Norman, 1997, Lynch et al., 2007). Teachers responsible for covering specific topics for discussion and inquiry can identify various 200 word passages for student RRFC practice containing content overlap with the current topics for investigation. Students receiving RRFC practice could quickly generate reading fluency with scientific terms that may assist them during discussion and experimentation. Teachers who wish to incorporate literature to enhance science literacy (e.g., Freeman & Taylor, 2006; McKee & Ogle, 2005) can also use RRFC practice procedures, as RRFC methods have previously shown the ability to improve oral reading fluency with narrative text (Chard et al., 2002; Therrien, 2004).

The methods of RRFC can also connect science and special education. For students spending parts of their day in general education science and learning support settings, a cooperative approach may help students with disabilities improve their science reading fluency. Science teachers can identify a series of important science passages that students can practice using RRFC procedures in the learning support classroom. Additionally, special education teachers fully responsible for a students’ science instruction can consult with science teachers during passage identification. Joint approaches to science education may better support students with disabilities.
Teachers should note that some science text does not lend itself to RRFC practice. For example, pages of scientific formulas or worksheets with only questions would require instruction rather than fluency practice. Selected passages that work best have connected science text with more than 200 words.

*Future Directions for Researchers*

As an initial example of repeated readings to a fluency criterion (RRFC) with science text many avenues of research remain open. Primarily, researchers can systemically replicate the RRFC procedures with different science text, different aged students both with and without special needs, and ordering, rather than randomizing, passages. Researchers can reduce the number of readings from four to three and/or allow students to meet criteria on any reading rather than the final reading only. Additional modifications to the RRFC procedures may include various error correction procedures, such as phrase drill (e.g., Martens et al., 2007), as a possible way to further decelerate errors. Examination of oral retells may benefit from both quantity and quality measures (e.g., Gleason et al., n.d.). Future research can also investigate the use of a writing exercise after reaching criteria. In addition, researchers can examine if the RRFC results replicate in peer-mediated formats (e.g., Staubitz et al., 2005; Yurick et al., 2006) or if the difficulty of the material requires an adult mediator. Based on these possible modifications to the procedures, research can further solidify both the effectiveness and the efficiency of the RRFC procedures.

Aside from procedural modification, examinations of RRFC should include applying RRFC interventions particularly in science settings. Investigators working in concert with science and classroom teachers can determine appropriate science passages
and evaluate effects of RRFC on specific science outcomes (i.e., quiz scores, chapter test scores, lab scores, etc.). As a multi-layered intervention, experimental questions can address how students complete study guides (e.g., Bergerud et al., 1988) or graphic organizers (e.g., Horton et al., 1990) after receiving the RRFC intervention and then measure quiz or test scores. In activity- or inquiry-based classrooms, effects of building science reading fluency with RRFC may produce more tangential student outcomes such as increasing the amount of participation in group discussions or the number of science questions generated.

Conclusions

For the past 20 years, education reform has made the goal of promoting science literacy for all students a priority. However, students with disabilities continue to perform poorly in science due in part to reading difficulties. In response, science and special education researchers have suggested various curricula and modifications to promote and support students with disabilities. One method, repeated readings to a fluency criterion, has the ability to improve students’ oral reading fluency. Students not only showed oral reading fluency improvements within passages, but also improved their scores on novel science passages both within and between chapters. As a result of building passages to a criterion of 200 words per minute with 2 or less errors, students also demonstrated improvements to oral retell measures. Based on these initial results, repeated readings to a fluency criterion may hold untold benefits for students with disabilities struggling to read science text fluently.
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Appendix A

Research Approval Letter from The Pennsylvania State University

Social Science Institutional Review Board
Date: September 24, 2007

From: XXXXXX X XXXXXX, IRB Administrator

To: Douglas E. Kostewicz

Subject: Results of Review of Proposal - Expedited (IRB #26473)

Approval Expiration Date: September 16, 2008

“Repeated Readings and Science: Fluency with Expository Passages”

The Social Science Institutional Review Board (IRB) has reviewed and approved your proposal for use of human participants in your research. By accepting this decision, you agree to obtain prior approval from the IRB for any changes to your study. Unanticipated participant events that are encountered during the conduct of this research must be reported in a timely fashion.

Enclosed is/are the dated, IRB-approved informed consent(s) to be used when recruiting participants for this research. Participants must receive a copy of the approved informed consent form to keep for their records.

If signed consent is obtained, the principal investigator is expected to maintain the original signed consent forms along with the IRB research records for this research at least three (3) years after termination of IRB approval. For projects that involve protected health information (PHI) and are regulated by HIPAA, records are to be maintained for six (6) years. The principal investigator must determine and adhere to additional requirements established by the FDA and any outside sponsors.

If this study will extend beyond the above noted approval expiration date, the principal investigator must submit a completed Continuing Progress Report to the Office for Research Protections (ORP) to request renewed approval for this research.

On behalf of the IRB and the University, thank you for your efforts to conduct your research in compliance with the federal regulations that have been established for the protection of human participants.

Please Note: The ORP encourages you to subscribe to the ORP listserv for protocol and research-related information. Send a blank email to: L-ORP-Research-L-subscribe-request@lists.psu.edu

XXX/XX

Enclosure

cc: Richard M. Kubina, Jr.
Appendix B

Parental Consent Form
Title of Project: Repeated Readings and Science: Fluency with Expository Passages

Principal Investigator: Douglas E. Kostewicz, M.A., BCBA
123 CEDAR Building
University Park, PA 16802
(814) 863-2477; dek184@psu.edu

Advisor: Richard Kubina, Ph.D., BCBA
209 CEDAR Building
University Park, PA 16802
(814) 863-2400; rmk11@psu.edu

1. **Purpose of the Study:** The purpose of this research is to examine repeat readings of science passages on a student’s ability to read those passages quickly and accurately.

2. **Procedures to be followed:** Students will be asked to read passages from their science textbook for either 1 minute probes or 4 minutes per session (3 repeated one minute readings and 1 one minute probe) and sometimes be asked to recall facts from a passage. After each repeated reading, your child will be provided feedback and error correction. Each session will be video recorded and last approximately 5-10 minutes.
   This study will last about 40 sessions for an approximate total of 325 minutes over an 8 to 10 week period.

3. **Discomforts and Risks:** There are no risks to your child participating in this research beyond those experienced in everyday life. You child will experience no more discomfort reading then they normally would in a classroom.

4. **Benefits:** The benefits to your child include working one-on-one increasing the speed and accuracy of their reading ability of science text. This research may provide additional reading techniques for teachers to use with their students in science class.

5. **Statement of Confidentiality:** You and your child’s participation in this research are confidential. The data and video recordings will be stored and secured at 123 CEDAR building on Penn State’s campus in a locked file. Only Mr. Kostewicz and Dr. Kubina will have access to the data. The following may review and copy records related to this research: The Office of Human Research Protections in the U.S. Department of Health and Human Services, the Social Science Institutional Review Board and the PSU Office for Research Protections. In the event of a publication or presentation resulting from the research, no personally identifiable information will be shared.

**Please place your initial in front of the statement(s) for which you provide permission(s):**

_____  I do not give permission for my child’s recordings to be archived for educational and training purposes. The recordings will be destroyed 3 years from study completion.
I give permission for my child’s recordings to be archived for educational and training purposes.

6. **Right to Ask Questions:** You can ask questions about this research. Contact Douglas Kostewicz at (814) 863-2477 or Dr. Richard Kubina at (814) 863-2400 with questions, complaints or concerns about the research. You can also call this number if you have concerns about this research, or if you feel that you or your child has been harmed by this study. If you or your child has questions about your rights as a research participant, or you or your child have concerns or general questions about the research, contact Penn State University’s Office for Research Protections at (814) 865-1775. Call this number if you cannot reach the research team or wish to talk to someone else.

7. **Payment for participation:** Your child will receive age-appropriate prizes (for example, stickers or school supplies) following each session they participate.

8. **Voluntary Participation:** Your decision and your child’s decision to be in this research are voluntary. You can stop your child’s participation at any time. Additionally, your child can stop their participation at any time. You or you child do not have to answer any questions you do not want to answer. You or your child’s refusal to take part in or withdrawing from this study will involve no penalty or loss of benefits you or your child would receive otherwise.

You must be 18 years of age or older and the parent or guardian of this child to consent for this child to take part in this research study. If you agree that your child can take part in this research study and the information outlined above, please sign your name and indicate the date below. Note: Even if you provide consent, your child will also have the opportunity to provide assent for their participation. This means that he/she has the final option to participate or not. Your child will not have the opportunity to provide assent if you have chosen not to provide consent.

I give permission for my child, ________________________ __________________, to participate in this research project.

__________________________  ____________________
Signature of Parent or Guardian     Date

__________________________
Contact Number, if providing consent

__________________________  ____________________
Person Obtaining Consent     Date

**NOTE:** Please return the *one copy* of the consent form the enclosed self-addressed stamped envelope by *(DATE – one week from when the packet is sent home)* and keep the *other copy* of the consent form for your own records.
Appendix C

Written Assent Form for Students Ages 13-17
Child Assent Form (13-17 years of age)
The Pennsylvania State University

Title: Repeated Readings and Science: Fluency with Expository Passages

Principal Investigator: Douglas E. Kostewicz, M.A., BCBA
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Advisor: Richard Kubina, Ph.D., BCBA
209 CEDAR Building
University Park, PA 16802
(814) 863-2400; rmk11@psu.edu

Why are you doing this study?
We would like to learn more information about helping students read science passages quickly. The information we collect will be used to understand ways to help students read science material.

What will I be asked to do?
Your parent(s) have provided permission for you to participate if you are less than 18 years of age. If you are agreeable to help, you will be asked to participate in roughly 40 sessions, lasting roughly 5-10 minutes each. You will be asked to either read a passage for one minute or four minutes and randomly answer some questions about what you read.

How long will the study take?
The amount of time needed to help is no more than 325 minutes over 8-10 weeks.

What will be gained from doing this?
By helping with this research, you personally will have the opportunity to increase your ability to read science material faster. The results of this study may also help other teachers help the other students with reading science material fast.

What else should I know?
This study involves no risk to your physical and mental health.

Will anyone know that I am in the study?
If this research is presented/published, the information will not be linked to your name or other potentially identifying information. A secret code will be used. Only the researchers will be able to match names with the code numbers, and this list will be stored in a secure location that only the researchers will know about.
Do I have to do this?
You do not have to take part in this research. If you agree, you have the right to stop at any time. If you decide not to participate or if you decide to stop taking part in the research at a later date, there will be no penalty or loss of benefits to which you are entitled. You are free to decline answering any questions. As each session is video taped, please place your initial in front of the statement(s) for which you provide permission(s):

_____ I do not give permission for my recordings to be archived for educational and training purposes.  
    The tapes will be destroyed on (3 years from the study’s completion, date added when start time determined).

_____ I give permission my recordings to be used for educational and training purposes.

What if I have questions?
Any question with respect to the research and the investigation being performed can be directed to the researchers listed at the top of the page. Please call the Office for Research Protections if you have questions regarding your rights as a participant (814-865-1775).

You will receive a copy of this document for your records.

_________________________________________  ____________________________  _____________
Signature of Minor          Printed Name          Date

_______________________________     _____________
Person Obtaining Consent          Date
Appendix D

Verbal Assent Script for Students Ages 8-12
Verbal Assent Script for Students 8-12 years of age for Repeated Readings and Science: Fluency with Expository Passages

(Read to student)

Hello, my name is Douglas Kostewicz. Your parents said it was okay for you to help with this study. If you are interested in helping me, I will ask you to read sections of your science book, fast and sometimes answer questions.

You do not have to help if you don’t want to.

Even if you start, you can stop at any time. And, you do not have to answer any questions I ask.

Do you have any questions for me?

Would you like to help?

[If parents previously provided consent for use of video recordings, then read]

If you would like to help, do you mind if I use these video recordings to teach others? Your parents said this was ok with them.
Appendix E

Example Experimenter and Corresponding

Student Copy of a Passage
One adaptation that helps a plant reduce water loss is a waxy, waterproof layer called a cuticle that covers the leaves of most plants.

Transporting Materials

A plant needs to transport water, minerals, food, and other materials from one part of its body to another. In general, water and minerals are taken up by the bottom part of the plant, while food is made in the top part. But all of the plant’s cells need water, minerals, and food.

In small plants, materials can simply move from one cell to the next. But larger plants need a more efficient way to transport materials farther, from one part of the plant to another. These plants have transporting tissue called vascular tissue. Vascular tissue is a system of tubelike structures inside a plant through which water, minerals, and food move.

Support

A plant on land must support its own body. It’s easier for small, low growing plants to support themselves. But for larger plants to survive, the plant’s food making parts must be exposed to as much sunlight as possible. Rigid cell walls and vascular tissue strengthen and support the large bodies of these plants.

Reproduction

All plants undergo sexual reproduction that involves fertilization.
One adaptation that helps a plant reduce water loss is a waxy, waterproof layer called a cuticle that covers the leaves of most plants.

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Reproduction
All plants undergo sexual reproduction that involves fertilization.
Appendix F

Procedural Integrity Checklists
Checklist for pre-test, baseline, initial reading, post-test, and maintenance/transfer reading sessions

___ Greeting/starting prompt
___ Prompted the 1 minute probe and timed for 60 seconds only.
___ Told the student how many words they read correctly and incorrectly
___ If retell conducted: Student prompted to tell everything they know about the passage
___ If student pauses longer than 5 seconds, prompt “Can you remember anything else?” (N/A if student never pauses)
___ If student pauses again, stop (N/A Possible)
___ Stop at timer (N/A if already stopped)

Checklist for repeated reading to a fluency criterion practice sessions

___ Greeting/starting prompt
___ Prompted the first 1 minute reading and timed for 60 seconds only.
___ Told the student how many words they read correctly and incorrectly
___ Corrected errors (if errors were present, N/A if no errors)
___ Students states correct words (if errors were present, N/A if no errors)
___ Prompted the second 1 minute reading and timed for 60 seconds only.
___ Told the student how many words they read correctly and incorrectly
___ Corrected errors (if errors were present, N/A if no errors)
___ Students states correct words (if errors were present, N/A if no errors)
___ Prompted the third 1 minute reading and timed for 60 seconds only.
___ Told the student how many words they read correctly and incorrectly
___ Corrected errors (if errors were present, N/A if no errors)
___ Students states correct words (if errors were present, N/A if no errors)
___ Prompted the fourth 1 minute reading and timed for 60 seconds only.
___ Told the student how many words they read correctly and incorrectly
___ Corrected errors (if errors were present, N/A if no errors)
___ Students states correct words (if errors were present, N/A if no errors)
___ If student reads 200+ words correctly and 2 or fewer errors on fourth reading:
   ___ Prompted to tell everything they know about the passage
___ If student pauses longer than 5 seconds, prompt “Can you remember anything else?” (N/A if student never pauses)
___ If student pauses again, stop (N/A Possible)
___ Stop at timer (N/A if already stopped)
Appendix G

Student Social Validity Questionnaire
Circle the number that best represents how you feel about each question.

1. This reading practice helped me a lot in school.
   1     2  3  4  5
   Strongly Disagree Disagree Neutral Agree Strongly Agree

2. This reading practice helped me in my science class.
   1     2  3  4  5
   Strongly Disagree Disagree Neutral Agree Strongly Agree

3. If asked, I would read more passages.
   1     2  3  4  5
   Strongly Disagree Disagree Neutral Agree Strongly Agree

4. I did not like to read fast.
   1     2  3  4  5
   Strongly Disagree Disagree Neutral Agree Strongly Agree

5. I did not have fun reading with Doug.
   1     2  3  4  5
   Strongly Disagree Disagree Neutral Agree Strongly Agree

6. I liked reading the same passage four times each day.
   1     2  3  4  5
   Strongly Disagree Disagree Neutral Agree Strongly Agree

7. I am happy to know I can read fast.
   1     2  3  4  5
   Strongly Disagree Disagree Neutral Agree Strongly Agree

8. By reading fast, I was able to remember more about what I read.
   1     2  3  4  5
   Strongly Disagree Disagree Neutral Agree Strongly Agree

9. I did not like having to leave my class to read.
   1     2  3  4  5
   Strongly Disagree Disagree Neutral Agree Strongly Agree

10. If my teacher had me read like Doug did, I would like that.
    1     2  3  4  5
    Strongly Disagree Disagree Neutral Agree Strongly Agree
Appendix H

Student Retell Transcripts
Group A
Jason

Passage 1 – Pre-test:
Umm I remember you need heat energy to make an organism cell thingy ummm they were talking about development and growth and how a sun made me spill water if you jump up how sudden it is like you gotta react to it that would be actions they were talking about umm [prompt] no [stop]

Passage 1 – Post-test:
Alright They talk about organisms umm they talk about it reacts how you react to a stimulus if you spill water or something how it reacts explains why that happens umm they umm talk about how moths flying out of the weeds or anything like that is reproduction um that robins lay eggs that closely resemble their parents’ reproduction or production or whatever umm [Prompt] [Stop]

Passage 2 – Pre-test:
Umm they were talking about how ummm there were like weird blob-like thingys umm and they were scaring homeowners or whatever and scientists were saying that its really not that bad and to calm people down ummm that’s all I can remember [prompt] Naw [Stop]

Passage 2 – Post-test:
Um What they are talking about how organisms and stuff um they’re talking they are saying talking about how people are terrified of the slime molds that oozed across the laws and stuff umm talking about biologists scientists who told people that’s okay um talking about like chemical reactions and stuff like that basically all I can remember [prompt] not really [stop]

Passage 3 – Pre-test:
[Video recording error. No transcript available]

Passage 3 – Post-test:
Um they were talking about uh how organisms can reproduce and produce offspring they talk about levels they talk about levels of classification um talk about how a organisms have the same names um they talk about how um what they talk about what they are known for like um its appearance um that’s about it [prompt] [Stop]

Passage 4 – Pre-test:
Well I remember the one thing they said water makes half ninety percent of your blood um some water can be vital to living things um ah that’s all I can remember [prompt] [Stop]

Passage 4 – Post-test:
Um chemicals I mean your body’s cells uh dissolves more chemicals than any substance on earth um an organism must find shelter and water and stuff and shelter to live um
water can only live for a few days without water and food um heterotrophs and autotrophs consume the sun for energy but in an indirect way um

**Joseph**

**Passage 1 – Pre-test:**
Umm the de…umm umm development d..uhhh d development’s like the process of like growth is I don’t know theeeeee something about umm getting bigger then oh yeah the you get startled if some if like something happens you get startled [Stop]

**Passage 1 – Post-test:**
Alright. Ahhhhh an organism reacts to a stimulus with a response an action or a change in behavior if somebody knocks over a umm glass of water you jump Am I allowed to repeat it? [Prompt] an action change in behavior if somebody ahh life comes from life whenever a robin lays an egg it grows into a young robin and it closer young robin resembles the parent and apples seeds make new trees and mildew keeps growing if you don’t umm clean it off ahh [Stop]

**Passage 2 – Pre-test:**
Bright blobs started to appear on a summer day in Dallas Texas [prompt] no cause I didn’t read that much [stop]

**Passage 2 – Post-test:**
Umm The slime molds oozed across the uhh people’s porches and lawns and people thought that they were from a different plan.. life forms from a different planet and living all living things us.. have cellular organization um respond to their surroundings use energy dev grow and develop um um moss and the slime molds are oozing across the lawns and uh mildew on bathroom tiles are moving things uh [prompt] [stop]

**Passage 3 – Pre-test:**
Umm a species gets named flight characteristics or features of and um the binomicure its like bi its called the bi nomicure whatever I cant pronounce it uhhh [prompt] no [stop]

**Passage 3 – Post-test:**
The first word in a scientific name often describes a distinctive feature of an organism, such as where it lives or its appearance. Together, the two words indicate a unique species. A species is a group of similar organisms that can mate with each other and produce offspring that can also mate and reproduce. Uh the scientific name contains is written in italics um only the first word in a scientific name the first letter in the first word in a scientific name is capitalized uh scientific names contain Latin words Linnaeus used Latin words in his naming system because Latin was the language that scientists used during that time. Using different names for the same organism can get very confusing. For instance look at the the well [Time]

**Passage 4 – Pre-test:**
Ahhhhhh…. Alright uhh. Alright alright uh. Heterotrophs eat autotrophs some heterotrophs eat heterotrophs and uh that eat uhh heterotrophs eat heterotrophs that eat
autotrophs so they get sunlight from an indirect way and uh uh uh [prompt] water we need water we can only survive a few days without water we need it to like for us to move obtain chemicals grow and develop [time]

Passage 4 – Post-test:
Some heterotrophs eat autotrophs and use the energy in the autotroph’s stored food. Some heterotrophs consume heterotrophs that eat autotrophs. Therefore, a heterotroph’s energy source is also the sun – but indirect way. Water all thing all living things need water to survive. In fact most organisms can live for only a few days without water. Uh um the um the most important most vital thing that water has is the ability to dissolve more chemicals than any substance on earth ahh oh yeah um water makes organisms I don’t know ahhh ummm [prompt] I think [stop]

Denise
Passage 1 – Pre-test:
Umm Ahh The thingy with the [prompt] [Stop]

Passage 1 – Post-test:
The spilling that they made at the table it caused her the person at the table to jump because the sudden spilling of the organism caused the startled response um apple trees develop into young I mean into apple I mean seeds develop into apple trees and robins lay eggs that develop into young robins and [prompt] there’s a lot that I can remember just that I can’t get it out [stop]

Passage 2 – Pre-test:
I remember the blobs climbing all over the porches and stuff I remember people were scared out of their minds and scientists study living things blobs [prompt] [Stop]

Passage 2 – Post-test:
Slime molds oozing across lawns um and the um all organisms have organisms are in living things and [prompt] umm [stop]

Passage 3 – Pre-test:
I remember that the scientific name is Latin words some names out that [prompt] [stop]

Passage 3 – Post-test:
That Linnaeus used Latin words in his naming system because that was the language that scientists used during that time and that um the second word in a scientific name is often described as a distinctive feature of an organism such as where it lives or its appearance um together the two words indicate a unique species a species is a group the species is a group of similar names that contain groups that produce offspring that can also mate and reproduce um a complete scientific name is a wait um that’s it [prompt] no [stop]

Passage 4 – Pre-test:
Um that water I mean no that heterotrophs can eat heteroptrophs and [prompt] that heterotrophs can use the autotrophs ah food the stored [stop]
Passage 4 – Post-test:
Some heterotrophs eat autotrophs and use the energy in the autotroph’s stored food. Therefore, a heterotroph’s energy source is also the sun but in an indirect way. Some animals, mushrooms, and slime molds are examples of heterotrophs. Um autotrophs need water to survive um that’s all [prompt] [stop]

Nancy
Passage 1 – Pre-test:
Okay ummm organism growth it um look at figure four to figure out the whatsamacallisit thing um sunflower seed development and um when somebody spills a glass of water you react in a startle reaction and stuff like that and that’s all I remember [prompt] no [stop]

Passage 1 – Post-test:
There are moths in closets and cracks in the sidewalk from weeds umm robins lay eggs that turn into young robins which closely resemble their parents umm development is the process of changing er no it more complex organisms and that’s all I oh apples produce seeds which make apple trees which in turn make more apple seeds and that’s all I remember [prompt] no [Stop]

Passage 2 – Pre-test:
There were slime things in Dallas Texas and they shot from the sky and people thought they were from outer space from another planet [prompt] [Stop]

Passage 2 – Post-test:
What is life It was an unusually damp summer when bright flowing blobs began to appear everywhere they were slime molds and biologists people scientists who study living things put peoples minds at ease and told them that they were slime molds and they oozed across the lawn and over people’s yards and porches umm all organisms are the same they have use energy use the same chemicals and that and umm that’s all I can remember [prompt] no [stop]

Passage 3 – Pre-test:
I can’t remember anything [stop]

Passage 3 – Post-test:
The levels of classification are based on the contributions of Linnaeus um binomial nomenclature makes it easier for scientists to communicate about an organism because everyone uses the same scientific name and using different names for the same organism is very confusing and that the scientific name for woodchuck, groundhog, or whistle pig is um Marmota Monax and that’s all I can remember [prompt] yes [stop]

Passage 4 – Pre-test:
I have no idea I read it too slow [Stop]
Passage 4 – Post-test:
Some heterotrophs eat autotrophs and use the energy in the autotroph’s stored food for energy. Um heterotroph’s energy source is also the sun but in an indirect way um water dissolves more chemicals than any other substance on earth it makes up about ninety percent of the liquid part of your blood um heterotrophs eat heterotrophs that yeah eat autotrophs um heterotrophs examples of heterotrophs are animals slime molds and mushrooms um there is limited amount of space on earth so some organisms have to compete for space and yeah that’s it.

Group B
Ned
Passage 1 – Pre-test:
The cell ummm it suck themselves the way they transport and everything and what it needs to transport and the things that it can get umm material out of the earth and that’s all I remember

Passage 1 – Post-test:
Umm that there’s a waxy waterproof layer called a cuticle that covers a lot of leaves and ahhh materials move can simply move from one cell to the next by that and by vascular tissue strengthen and can help a plant support its own body and stuff and it’s easier for small low growing plants to survive on land and vascular tissue and something is us..no strengthen and support the plant reproduction

Passage 2 – Pre-test:
I don’t know

Passage 2 – Post-test:
So in the beginning its talking about the plant kingdom and different plants and how some is umm getting animals and others can smell like rotting meat and others that bloom once every thirty years and there you don’t usually see those kinds of plants but you do see plants when you run across a lawn see moss on a tree trunk or pick ripe tomatoes from a garden and plants are autotrophs that that’s all I remember

Passage 3 – Pre-test:
[Stop]

Passage 3 – Post-test:
It’s a photosynthesis is the nature of light and when the sun hits you and it warms your skin then um you feel it and you can see it on objects around you and its called white light when white light passes through a prism then yeah a prism then it will change into the colors of the rainbow like red orange blue violet and green that’s all I remember

Passage 4 – Pre-test:
There’s colors like green and yellow and pigments

Passage 4 – Post-test:

Passage 4 – Post-test:
Um The passage explains what why plants are usually green and there are pigments called accessory pigments and are there’s stuff like orange and yellow pigments that absorb different colors of light and light is masked by chlorophyll and ah [prompt] no [stop]

Kevin
Passage 1 – Pre-test:
Alright, the vascular tissue it um transports the minerals but that umm other minerals don’t get to it so it has to ahhh like boost up the transport and cells I mean minerals and food and water go up through the bottom of the tree that feed the leaves a lot and uhhh [prompt] no [stop]

Passage 1 – Post-test:
Alright. All the plants water and um minerals are taken up by the bottom part of the plant while food is made in the top part all plants re I mean reproduction sexual reproduction and um all plants need water minerals and food and its easier for small low growing plants to support themselves on land by the minerals food and water and its much harder for bigger plants on land to support themselves and that’s it [prompt] [stop]

Passage 2 – Pre-test:
Umm there are plants that trap animals and plants that bloom every thirty years and umm plants that ummm bloom other flowers that smell like rotten meat [prompt] we encounter plants when we look at mossy tree trunks and run through the lawn we encounter them everyday.

Passage 2 – Post-test:
Plants I mean autotrophs are organisms that produce their own food and um photosynthesis is uhh basically is sun powered food making factory for the plant and um ahhh [prompt] when you run across I mean you can see plants whenever moss is on a tree trunk run across a lawn or pick ripe tomatoes from a garden and um there um very unusual plants and some plants bloom only once every thirty years and plants with rotting meat I mean a flower that smells like rotting meat and um ahhhh [time]

Passage 3 – Pre-test:
Alright a German scientist named Engelmann I think um proved that photosynthesis happens during sun I mean when the sun’s out or any kind of light but mainly sun and um [prompt] no [stop]

Passage 3 – Post-test:
The year was 1883. T. W. Engelmann, a German biologist, was at work in his laboratory. He peered into the microscope at some algae on a slide. The microscope had a prism located I mean The microscope had a prism located between the light source and the algae and he did not know it at the time but the photosynthesis needs the s… energy of
the sun to perform and when white light passes through a spectrum it scientists refer the colors to I mean it when white light passes through a prism it’s the colors of the [Time]

Passage 4 – Pre-test:
Ummm When sunlight hits a plant’s leaf it sends a process known as photosynthesis [prompt] No [Stop]

Passage 4 – Post-test:
Alright when sunlight strikes a plant’s leaves it sets into motion the process known as photosynthesis in phtosyn…I mean [prompt] chlorophyll is not masked I mean it can’t be seen in plants because its masked by the chlorophyll I mean the chloroplasts in um chlorophyll has different colors of um different colors than chloroplasts I think and that’s all [stop]

Elizabeth
Passage 1 – Pre-test:
Ummm The plants like they have this certain tissue that transports all like the nutrients and food that they need and [prompt] umm not other than it travels through two..tissues to get all the nutrients [stop]

Passage 1 – Post-test:
Um the cell like there’s a waxy covering over a plant that helps it keep like all its stuff together and there’s vascular tissues that help transport materials and everything like food through the plant and with taller growing plants its like they need their um like their I forget what’s it called but they need to be shown to the like sun as much as possible and its easier low growing plants to grow that’s about it [prompt] no [stop]

Passage 2 – Pre-test:
Um there are some familiar plants and unfamiliar plants some that trap animals some that um like don’t bloom for like thirty years um there’s like you would think of like a plant whenever its like either you run over it or like moss growing on a tree or something like that that’s it [prompt] [stop]

Passage 2 – Post-test:
Plants are like you see them anywhere and they’re pretty much around you surround you everywhere and um and they go through a process called photosynthesis um all plants are eukaryotes um ah they are multicellular so you can see them like with a like you like you don’t have to have a microscope or anything and [prompt] nope [stop]

Passage 3 – Pre-test:
Some guy uhhh had uhh a piece of something underneath a microscope and like gas bubbles formed around it gave him a clue that something air um like something happened to the air made something else that’s it [prompt] [stop]
**Passage 3 – Post-test:**
Um there was a German biologist and he was like had algae in with like mixed with light and they saw it like gas bubbles started to form around it and at the time he was help like he was his experiment like explained photosynthesis and then like they explained how light is like the sun’s natural light was like some figure seven like you can see that it changes like colors like red blue and stuff like that that’s it [prompt] [stop]

**Passage 4 – Pre-test:**
Um something about like pigments and that whatever the pigments are they show up in like leaves and that’s why its green and um this has something to do with photosynthesis how photosynthesis takes like the light and does something with the pigments that’s all I know [prompt] [stop]

**Passage 4 – Post-test:**
Umm they were they compared um photosyn… the photosynthesis process to the gasoline like car needs gasoline to um runs off gasoline for power and photosynthesis goes off sunlight I think it is and um like it needs certain things like you need flour and stuff to make cookies and um there’s chloroplasts and pigments and its like green yellow like green orange or orange and yellow pigments whatever and like that’s all I know [prompt] [stop].
Vita
Douglas E. Kostewicz

**Education**

PhD 2008  Pennsylvania State University, University Park, PA  Special Education

MA 1997  Ohio State University, Columbus, OH  Special Education

BS 1996  Allegheny College, Meadville, PA  Psychology

**Academic Positions**

Fall 2008  Assistant Professor of Instruction and Learning
University of Pittsburgh, Pittsburgh, PA

2007  Instructor, The Pennsylvania State University
Mathematics Instruction for Students with Special Needs

2006 – 2007  University Supervisor, The Pennsylvania State University
Student practicum experience with an Integrated Inclusion Classroom


**Professional Experience**

2004-05  Behavior Analyst, Community Residences Inc., Southington, CT

1999-03  Behavior Analyst/Adjunct Faculty, University of South Florida and Florida
Department of Children and Families, Tampa, FL.

1998-99  Special Education Teacher, Rocky Mount Charter School, Rocky Mount, NC

**Publications**

reading outcome measures for students with E/BD. Manuscript accepted for publication
in *Behavioral Disorders*.

with emotional and behavioral disorders: A decision making guide. Manuscript accepted
for publication in *Beyond Behavior*.


feelings with daily counts of non-aggressive thoughts and feelings: A self-experiment.