The Effects of a Reader Immersion Procedure on the Technical Reading Comprehension Responses of Kindergarten and First Grade Students

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ABSTRACT

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I conducted 2 experiments in which I tested the effects of a reader immersion procedure on the technical reading comprehension responses to print stimuli for 4 kindergarten students and 3 first grade students. The participants selected for this study textually responded to words at a rate of 80 words correct per minute with 0 incorrect words per minute. They demonstrated early reader repertoires and speaker-as-own listener verbal capabilities including incidental language learning (also referred to as Naming), self-talk, and say-do correspondence, all necessary prerequisites for a child to acquire reader-as-own listener capabilities. However, they were not yet verbally governed by print to complete simple tasks as demonstrated by their performance on “read and build” and “read and draw” reading comprehension tasks. In the 1st experiment, the dependent variables were technical reading tasks that included 1) a 10-step “read and build” task and 2) a 10-step “read and draw” task. During pre-intervention and post-intervention probe assessments, each participant was given a list of 10 written directions and the corresponding materials required to complete the tasks. The independent variable was a reader immersion procedure in which the “need to read” was established by providing access to a preferred item after the emission of correct reading-governed (i.e., read and do) responses. Following the reader immersion procedure, responses to novel reading comprehension responses increased for the participants. The participants’ behavior was controlled by print stimuli to complete simple reading tasks in which they had to build a structure or reproduce an image with a writing implement. In the 2nd experiment, 4 participants received the 10-step pre-intervention probe
assessments used in Experiment 1 along with 2 additional pre and post-intervention probes in which they completed a 1) 20-step “read and build” task and 2) a 20-step “read and draw task.” The independent variable was the reader immersion procedure used in Experiment 1. Following the reader immersion procedure, responses to novel reading comprehension tasks increased for all dependent variables. Findings suggest that untaught reading comprehension responses emerged as a function of the reader immersion procedure which included a motivating operation as well as repeated opportunities to mediate behavior in response to print stimuli. I describe technical reading as a verbally governed response to print that is a necessary prerequisite to the advanced reader and writer repertoires that will result in success in STEM (science, technology, engineering, and mathematics) fields of study.
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DEDICATION

I dedicate my work to my second mother, Frances E. Mackey. You were the mother you made the choice to raise me when adopting seven-year-old children with “problems” was not ideal. I never made it easy for you to be a parent. You struggled to make sure my educational needs were met and in the end, you took my education into your own hands. You taught me how to write. You taught me how to take a correction. You believed that teaching was the most prestigious profession that exists. Although our connection is not biological, I am who I am because of you. You never made it to see this day. But I know exactly what you would have said.
Chapter 1

Introduction

Proficient reading comprehension skills have been identified as a necessary prerequisite for the acquisition of skills in STEM (science, technology, engineering and mathematics) fields of study (Fuentes, 1998). The presence or absence these technical reading comprehension skills have been identified as a factor in the performance of students in the United States on both math and science assessments (Fletcher, 2006; Fuchs & Fuchs, 2002). According to the National Education Assessment of Educational Progress (2015), 40% of fourth grade students and 33% of eighth grade students perform at the proficiency (or above) level on mathematics assessments. On reading assessments alone, 36% percent of fourth grade students achieved a score that would identify them as at or above the proficient reading level. When compared to other countries, the United States ranks 28th and 24th in the areas of math literacy and science literacy, respectively.

The statistical evidence indicates there is a need for more effective instruction and interventions to target the deficits in technical reading instruction that are related to STEM fields of study. Several researchers have explored the connection between technical reading skill and the STEM fields, specifically in the areas of mathematics and science (Broto & Greer, 2014; Carter & Dean, 2006; Fuentes, 2010; Pellegren, 2015). These researchers have argued that reading comprehension instruction has been neglected during math and science instruction. Furthermore, most reading comprehension instruction focuses on comprehension of fictional texts. As a result, students are not taught to effectively use technical reading skills to perform algorithms or to understand informational text. To date, many researchers have focused on the poor reading performance of students who are older, specifically fourth grade students and above. There have been a significant number of interventions that target these older readers.
Additionally, researchers have developed interventions to target reading comprehension of informational text. However, these interventions have not had a significant impact on the performance of struggling readers (James-Burdumy et al., 2012). These assessments often require a selection-based response (i.e., multiple choice assessment), which is not an accurate measure of whether or not a reader’s behavior is under control of the print (i.e., text).

Researchers in the field of behavior analysis have successfully implemented interventions to target the behavior of the writer and the writer’s effect on reader behavior, including writing math algorithms or other tasks (Broto & Greer, 2014; Helou, Lai & Sterkin, 2007; Jodlowski, 2000; Reilly-Lawson & Greer, 2006; Visalli-Gold, 2005). To date, researchers have not implemented a procedure to teach a reader to complete a technical reading task. Technical reading or reading in which the reader is verbally governed by print to perform operations might be a necessary prerequisite to writer behavior. The reader should be able to “read and do” for simple reading tasks before he or she learns more complex technical reading associated with STEM fields of study. Greer and Ross (2008) suggested a procedure for “read and do” as an intervention to affect reader behavior. To date, this procedure has been suggested but not empirically tested. Furthermore, a procedure or protocol to induce or increase “read and do” behavior has not been developed or implemented.

In the current study, I tested for the presence of reading-governed responding (i.e., “read and do” behavior) as it is related to verbally governed behavior. I conducted an experiment in which I used a delayed multiple probe design to determine if the behavior of kindergarten and first grade students could be verbally governed by print to perform simple operations in which they 1) read and build a structure and 2) read and draw (i.e., to produce an image). The intervention consisted of a reader immersion procedure in which the participants had to read in
order to access a preferred item. I propose that young children who successfully learn to textually respond to words at a rate of 80 correct words per minute or higher can become verbally governed by print to complete tasks, a potential precursor to the acquisition of more complex forms of verbally governed behavior. A review of the literature is presented in which I briefly discuss reading performance on reading, math, and science assessments in the United States, reading comprehension from non-behavioral perspective, and academic performance in the areas of reading and STEM fields. I include a section in which I discuss reading comprehension from a behavioral perspective, including the connection between speaker-as-own-listener repertoires and reading comprehension as this relates to the progression of more advanced forms of verbal behavior, including verbally governed behavior.

**Literature Review**

**STEM (Science, Technology, Engineering and Mathematics) and Technical Reading**

**Technical reading.** Although reading comprehension has been identified as a factor that can affect performance on STEM assessments, there is a lack of research in which the distinction between types of reading comprehension (and the corresponding re-labeling of these types) is discussed. The term “technical reading” is not typically used by researchers to describe reading comprehension repertoires that are required to complete tasks or assessments in the STEM (science, technology, engineering, and mathematics areas). Moreover, when the term “technical reading” is used, it is not explicitly defined. Vilenius-Tuohimaa, Aunola, and Nurmi (2008) use the term technical reading to investigate the relationship between reading comprehension and performance on math assessments in which problem solving tasks were included. They use the term to refer to the reading of written instructions in which the reader reads written operations, or solves math problems. The authors also include proficient “decoding” or word recognition as a
component of proficient technical reading skills. Fuchs and Fuchs (2002) refer to a type of reading comprehension needed to complete 1) one-step math algorithms 2) multi-step algorithms and 3) math problems presented in paragraph formats. The authors do not specify this type of reading comprehension as technical reading. However, they do argue that reading comprehension skills needed to complete single or multi-step algorithms require a specific set of reading comprehension repertoires.

For the purposes of the current study, the term “technical reading” will be used to describe reading comprehension repertoires required to 1) complete functional reading tasks such as the completion of non-mathematical and mathematical algorithms (i.e., “read and do” tasks and 2) acquire information from non-fiction texts related to STEM fields of study. The description of technical reading as functional reading is defined from the behavior analytic perspective in which the act of reading is viewed in terms of its function as a verbal behavior repertoire.

**STEM assessments and technical reading skills.** In the United States, poor performance in the areas related to the fields of science, technology, engineering and mathematics (STEM) has led researchers to explore the connection between these fields and literacy. Comprehension of STEM text requires that the student is able to read and then subsequently learn in order to acquire knowledge, or perform algorithms. Students encounter significant challenges when attempting to read and learn from science and mathematics texts, including an increased amount of concepts per paragraph, an increased number of vocabulary terms, different visual format for text, and a text style that they may be unfamiliar with (Barton, Heidema & Jordan, 2010).
Technical reading comprehension has been identified as a variable that can affect a student’s performance on math and science tasks (Fuentes, 1998). Researchers have determined that students who perform poorly on math and science assessments typically have poor reading comprehension skills. As a result they lack the skills needed to correctly solve math word problems or independently understand and learn from informational texts (Cromley, 2009; Ozuru, Dempsey & McNamara, 2009; Vilenius-Tuohimaa, Aunola & Nurmi, 2008).

Chall, Jacobs, and Baldwin (1990) categorized children from kindergarten through third grade as learning to read, which involves academic instruction that focuses primarily on what is referred to as decoding instruction (i.e., learning letter sounds, phonics instruction). Chall, Jacobs, and Baldwin (1990) argue that students in grades four through twelve should be capable of reading (and are expected) to read to learn. Although researchers would argue that this philosophy has encouraged educators to discontinue explicit decoding reading instruction too early, there is clearly a shift to content-based curriculum in the upper grades (Houck and Ross, 2012). As students age, they are expected to learn content-specific material in the areas of math and science. This requires that they have the reading comprehension skills needed to comprehend non-fiction or informational content-specific text.

The National Assessment of Educational Progress (2015) conducted assessments to determine how fourth and eighth grade students would perform on math and science skill assessments. The NAEP (2015) determined that only one-third of fourth and eighth grade students achieved scores that were identified as proficient. By the end of high school, many students continue to be poorly prepared for careers or advanced education in the areas of science, technology, engineering, and mathematics (Congressional Research Service, 2008; Barton, Heidema & Jordan, 2002; Kamil & Bernhardt, 2004).
According to the Congressional Research service, students in the United States are ranked at position 28th in math literacy. In the area of science literacy, the United States ranks in the 24th place. These data were collected using an assessment developed by the Trends in International Mathematics and Science Study (TIMSS). Additionally, when compared to other countries, there are a low number of students who attained a university degree in a STEM field. At the time the study was published, 16.8% of STEM degrees were awarded in the United States. The largest percentage of STEM degrees were awarded in China (52.1%) and Japan (64%) (Congressional Research Service, 2008).

**Reading and Literacy in the United States**

There is a significant amount of evidence that students in the United States underperform in the area of reading comprehension. The National Assessment of Educational Progress (2015) conducted an assessment in which they measured reading comprehension skills by asking students to answer comprehension questions that corresponded to grade level texts. They measured responses to both fictional texts and informational texts. Informational texts were defined as “exposition, argumentation and persuasive texts, and procedural texts and documents” (2015, Reading Assessment). Approximately 275,000 students were selected from fourth and eighth grade classrooms located in over 13,000 schools across the country. According to the results of this assessment, 36% percent of fourth grade students achieved a score on the assessment that would identify them as at or above the proficient reading level. The remaining 64% of students performed below the level that was determined to be a proficient reading level.

The NAEP (2015) further divided the test scores across factors such as race, sex, and locations (city/suburb, town/rural). According to the scores and statistics provided by the NEAP, there are significant differences on test scores between races. The NEAP provided a breakdown
of the reading comprehension assessment scores. Within those groups, the students who achieved the high scores were identified as Asian, with 57% performing at or above proficiency level. The students who achieved the lowest scores on the assessment were identified as black, with 18% performing at or above proficiency level. The second highest scores were achieved by students identified as white, with 46% performing at or above proficiency level. Twenty-one percent of students identified as Hispanic performed at proficiency level or above.

In 2002, the RAND Reading Study Group (commission by the U.S. Department of Education) published a report in which they developed a proposal that identified literacy issues, including identification of those students whose reading performance was below grade level. They identified several variables that influence a child’s ability to comprehend what they have read including 1) verbal or oral language skills 2) motivation 3) discourse and domain knowledge and 4) cognitive skills. According to the report, students in the United States continue to underperform on reading comprehension tasks, especially when the content is “discipline-specific” or related to “subject-matter learning.”

**United States Reading and STEM Initiatives**

The United States government has developed several initiatives and programs to target the poor performance of its students on reading and math and science assessments. In 2002, the United States Congress passed the No Child Left Behind Act (NCLB), in an effort to target the poor academic progress of students within the United States. According to the law, each state was responsible for enabling all students to perform at the proficient level on reading and math assessments. Unsuccessful states were in danger of losing federal funding. To date, individual states have not been able to accomplish this goal. However, reading initiatives have been developed to help poor readers become proficient readers. “Reading First” was a program that
was initially developed in 2002, to target the reading instruction and achievement of readers. One of the goals of the reading initiative was to ensure that all students could read proficiently by third grade. By 2008, federal funding was discontinued for this program.

In 2016, the Department of Education allocated funding for the “Innovative Approaches to Literacy program” (Department of Education, 2016). The purpose of the program was to develop programs to target the literacy concerns of children from birth to the 12th grade, including early literacy programs and programs to help with motivation and reading.

With data collected from the National Assessment of Educational Progress (NAEP), federal programs have been developed to target poor reading comprehension skills as well as poor performance on STEM related assessments and tests. A majority of the funding available for STEM related programs was allocated to programs designed to encourage college-bound students to pursue STEM related fields.

In 2004, there were 207 STEM Education programs that received federal funding available, four of which were funded by the Department of Education. However, many of these programs target students at the collegiate level.

The Departments of Labor Health and Human Services (2016) allocated 62.5 million dollars of federal funding toward the development of “Advanced Informal STEM Learning” programs. As a result of the implementation of this act, the Committee on STEM education (CoStem) was established to oversee programs and activities that target the requirements of the America Competes Reauthorization Act (Federal Coordination in STEM Education Task Force, 2012). The committee focused on the improvement of STEM education from Pre-Kindergarten to post-secondary school, including an education strategic plan that included the identification and implementation of evidence-based approaches to improve STEM education.
In 2007, Congress passed the America COMPETES act (America Creating Opportunities to Meaningfully Promote Excellence in Technology, Engineering, Education, and Science Act of 2007). The act was reauthorized in 2010. The purpose of the act was to develop federal programs and initiatives to improve the United States’ performance in STEM-related fields. The goals for this act included 1) an increase in teachers who pursued STEM-related degrees along with teacher certifications. This included 1) advanced training in content-specific knowledge for these teachers, 2) the development of advanced placement programs for STEM related fields, and 3) the development and improvement of teaching practices in elementary and secondary schools for stem related fields.

The Department of Education (DOE) has established that there is a need for an improvement in the performance of students across the areas of reading literacy and in STEM related subjects. The DOE has committed to dedicating funds and other resources to target the deficits in the instruction received by its learners. However, many of the resources and funds are designated for programs that encourage older students to pursue careers related to STEM fields.

**Theories of Reading Comprehension From an Education Perspective**

Since the 1970s, most major theories of reading comprehension (that have guided the reading instruction of teachers in United States public schools) have been developed by cognitive psychologists, with an approach to comprehension that is described in terms of the strategies and mental processes good readers use when they effectively comprehend what they have read (Duffy, Miller, Howerton, & Williams, 2010). Prior to this period, reading comprehension was believed to have occurred as a byproduct of learning to decode or textually respond to print. It should be noted that cognitive researchers argue that the word “comprehension” is inadequate in describing what occurs when a child reads (Kintsch, 1998). Instead, they prefer to use the word
“cognition” when referring to comprehension. I will continue to use the word “comprehension” in this section because it is widely accepted as a word that is used to describe the reader’s response to reading.

Theories for teaching reading can be divided into one of three categories including the bottom up, top down, or interactive approach to reading. According to the bottom-up theory of reading comprehension, the reader starts with processing the text (i.e., “the bottom”) itself (Gough, 1972; LaBerge & Samuels, 1972). This process assumes that the reader is able to decode or textually respond to the text. Subsequently, the reader processes the words and is able to gradually build a representation of what has been read. This theory focuses on phonics skills as a necessary starting point for adequate comprehension to occur.

The top down theory of reading includes an approach to the teaching of reading comprehension that starts with the teaching of strategies that target the language that a reader is learning as opposed to focusing on the text itself.

Advocates of the interactive approach to reading argue that a good reader will use a combination of both “top down” and “bottom up” strategies in order to effectively comprehend what he or she has read.

Two major theories of reading comprehension from the cognitive perspective are 1) the simple view of reading and 2) the construction integration view of reading. Below, I provide a brief summary of both models. Additionally, I analyze these models from the behavior analytic perspective, specifically from the verbal behavior developmental theory perspective, which is the theoretical perspective from which I have conducted the research for the study herein.

**Simple view of reading.** Within the simple view of reading, successful reading requires that the reader 1) accurately decodes text and 2) has acquired sufficient listening comprehension
skills needed to comprehend what has been decoded (Gough & Tunmer, 1986; Hoover & Gough, 1990). The model is described by a mathematical equation in which reading is represented by the letter “R,” decoding is represented by the letter “D,” and language comprehension is represented by the letter “L.” The complete equation is \( R = D \times L \), with the emphasis of the relation between the variables as a product, instead of a sum. This indicates that neither variable can equal 0 and subsequently result in or equal adequate comprehension (Dreyer and Katz, 1992). Both decoding and language comprehension skills can receive a score of one (perfect) or zero (not present).

This equation has been used to predict the reading comprehension scores of students, with the use of group design experiments to determine a correlation between the presence or absence of decoding and language comprehension on test scores (Catts, Adlof, & Weismer, 2006).

Verbal behavior developmental (VBD) theorists emphasize the importance of both decoding as well as language comprehension. However, verbal behavior developmental theorists describe decoding as textual responses to print, not as decoding. The term decoding is not used because the VBD theorist argues that when a child responds to print stimuli with a vocal response, that there is actually no decoding occurring. Instead the reader emits a “see and say” response to print (Greer & Ross, 2008). A textual response can be used to describe not only the identification of letters, sounds and words but also, numbers or any form of text (i.e., numbers).

Additionally, verbal behavior theorists describe reading as a form of verbal behavior itself, not to be distinguished from a child’s vocal responses to print (Greer & Keohane, 2005; Greer & Ross, 2008; Skinner, 1957). In other words, language comprehension is not distinguished as a component of proficient reading but is identified by the verbal behavior developmental theorist as a form of reading in itself. As such, reading is verbal behavior because
it is an extension of listener behavior. Refer to the section on Verbal Behavior Development Theory for a more detailed description of the theory.

**Construction integration model.** The construction integration (CI) model describes the process of reading comprehension as one that occurs in two phases that include 1) the construction phase and 2) the integration phase (Kintsch, 1998). According to researchers, the CI model the reader takes information from the text and integrates it with knowledge that the reader has previously acquired. This knowledge is stored in what is referred to as “nodes.” Nodes are defined as theoretical pockets of knowledge that join together to form a network of knowledge in which similar content is stored together. Nodes contain both concepts and propositions, which are both terms used to describe forms of knowledge.

The reader who accurately understands what is being read will activate “multiple levels of representation” or knowledge related to the text (McNamara, 2007, p. 12). The levels include 1) the surface code or syntax (i.e., decoding of words or letters), 2) the propositional textbase (constructing meaning from what one has been read), and 3) the situation model/mental model (in which the reader makes connections between what has been read and what one knows).

According to the CI model, a reader must simultaneously activate new “nodes” of knowledge, connect relevant “nodes and knowledge,” and push aside nodes that are irrelevant to what is being read. “Comprehension occurs when and if the elements that enter into the process achieve a stable state in which the majority of elements are meaningfully related to one another and other elements that do not fit the pattern of the majority are suppressed” (Kintsch, 1998 p. 4).

During the integration phase, irrelevant ideas are “suppressed.” As a result, propositions become part of the individual’s long-term memory. According to Kintsch (1998), learning has occurred only when existing knowledge connects with the newly activated concepts and allows
for the individual to apply what was learned to novel ideas and situations. The situation model of the text is the result of true comprehension, as defined by CI theorists. Van Dijk and Kintsch (1983) describe the situation model of reading comprehension in which the reader decodes the text and subsequently uses his or her own general knowledge to create a “representation” of the situation described in the text. This representation develops as the reader uses multiple types of knowledge as well as the ability to comprehend theory of mind. While reading, the reader continuously uses information to create representation of what is occurring. As the reader continues to read, this representation is updated (McNerney, Goodwin, & Radvansky, 2011). The situation model of reading is an extension of the situation model theory that was developed to explain the mental representations that are created when an individual is understanding language (McNerney, Goodwin, & Radvansky, 2011; Van Dijk & Kintsch, 1983).

According to verbal behavior development theory, the reader does not “construct meaning.” However, he or she understands what has been read because the capability that is referred to as Naming (or incidental language learning) is present, in addition to other verbal behavior cusps that are acquired prior to the acquisition of Naming. Naming is a bidirectional capability that allows an individual to learn the name of an item as a speaker and listener during a single Naming experience. This verbal capability is a prerequisite to reading comprehension. Naming allows the reader to learn the names of things. The reader, who is listening to his or her own textual responses, comprehends what has been read because the items are in the reader’s repertoire. The verbal behavior developmental theorist is concerned with functional reader behavior and the way it is described (i.e., as a form of verbal behavior) and measured. Reading is measured by the effect it has on a reader’s behavior. A reader can read to perform simple or
complex operations (Greer & Keohane, 2006). Reading can also have an aesthetic function on the reader in terms of functional effects of literature on emotions.

**Verbal Behavior Development Theory**

Within the field of applied behavior analysis, verbal behavior development theorists have developed a theory of reading comprehension as verbal behavior. According to VBDT, reading comprehension is a form of verbal behavior or “behavior reinforced through mediation of other persons” (Skinner p. 2, 1957). (Greer & Ross, 2008; Skinner, 1957). Greer and Ross (2008) describe the human verbal behavior trajectory as one in which an individual acquires verbal behavior cusps and capabilities that enable him or her to develop advanced reader and writer capabilities. VBDT theorists emphasize the relationship between oral language abilities (specifically Naming) and reader repertories. Reading comprehension occurs when a child who has acquired the prerequisite verbal cusps and capabilities is able to join them with his or her ability to respond to print stimuli.

I briefly describe verbal behavior developmental theory, and the verbal behavior trajectory described by theorists to explain the development of a child from the pre-listener, pre-speaker stages of verbal behavior up until the advanced reader and writer stages of verbal behavior. I include a section in which I discuss the importance of motivation and reading. Additionally, I expand upon verbal behavior theory as it relates to the development of reader behavior that is governed by print (i.e., verbal mediation for problem solving).

**Verbal behavior cusps and capabilities.** Verbal behavior development theorists describe verbal behavior as occurring in stages in which a child acquires verbal cusps and capabilities that eventually results in a child who is a reader and a writer, as defined by verbal behavior theory. A cusp is defined as a skill that not only essential for development but is also
difficult to acquire (Rosales-Ruiz & Baer, 1996). When acquired, a cusp will allow the child to come in contact with more cusps and environments that are necessary for advancement or development. When a cusp is acquired, a child still needs direct contact with the environment, including direct feedback, in order to learn. An example of a cusp that is often used by verbal behavior theorists is crawling. Prior to crawling, the child is stagnant and is capable of interacting only with the tactile world that immediately surrounds him or her. When the child learns to crawl, he or she can access new experiences that can result in more learning. However, he or she continues to lack the repertoires needed to learn in indirect ways, including through observation or through incidental language learning.

A capability, also still considered a cusp, is defined as a skill that results in learning in ways that could not be learned before, and without direct consequences (Greer & Ross, 2008). To date, researchers have identified and empirically tested for the presence or absence of three capabilities which include 1) Naming (referred to as incidental language learning), 2) generalized motor imitation, and 3) observational learning. Naming allows a child to learn language incidentally and without direct instruction. Through Naming experiences, in which an adult or caregiver exposes a child to the names of objects or items in their environment, the child learns the names of these things (Horne & Lowe, 1996; Greer & Ross, 2008; Longano & Greer, 2014). A child without Naming will need to be directly taught the name of each new object. This often requires multiple opportunities to learn the name of a single item. Whereas with Naming, the child can learn the name of a new item after a single experience in which they hear the name of it being said to them. Several studies have been conducted in which experimenters have successfully test for the presence of Naming and induced it (via verbal developmental protocols) when it was identified as absent (Fiorile & Greer, 2005; Gilic & Greer, 2011).
Generalized motor imitation (GMI) results in a child who learns by imitating the behavior of others. For example, a child with generalized motor imitation can learn to play with a new toy after watching a child or adult play with it first. They observe the behavior of the other person and then they subsequently repeat it (Du & Greer, 2014; Greer & Ross, 2008). Observational learning is a capability that results in learning through the reinforcement and correction received by another. In a classroom setting, this capability is essential for learning because it allows a student to learn through the interaction observed between another student and teacher (Greer & Keohane, 2005; Greer & Ross, 2007; Pereira-Delgado & Greer, 2009).

These three capabilities (Naming, observational learning and generalized motor imitation) result in a child learning in ways that they could not before. More importantly, they have been identified as necessary for successful learning of academic repertoires in classrooms.

If a child is missing any single cusp or capability, he or she will lack the repertoires needed to advance along the verbal behavior developmental trajectory. Intervention procedures designed to induce a cusp or capability when it is missing are referred to as verbal behavior developmental protocols (Greer, 2002).

**Verbal behavior stages of development.** According to VBDT, the stages of verbal behavior are pre-listener, listener, speaker, speaker-listener, speaker-as-own listener, reader, writer, self-editor (writer becomes own reader), and the reader/writer who can successfully engage in verbal mediation for problem solving (i.e., read to complete simple or complex problems, engage is what is referred to outside of behavior analysis as “reading to learn”) (Greer & Keohane, 2005; Greer & Ross, 2007). It should be noted that these stages are not believed to occur as a function of maturity. As such, the stages are not designated to occur at certain ages. Each stage of verbal behavior includes the corresponding cusps and capabilities that should be
acquired naturally or through intervention for the child to meet the requirements for acquisition of that cusp (or capability).

According to VBDT, a child starts out as a pre-listener. In this stage of functioning, the child is completely dependent upon adults and caregivers to access needs and wants. Furthermore, the pre-speaker lacks the skills needed to participate socially with the world around them. When a child successfully acquires all pre-listener cusps and milestones, listener behavior begins to emerge. A listener is defined as an individual whose behavior can be mediated by the speaker behavior of others. Listeners have “a measure of independence and can be warned, instructed, comforted, and praised as a result of the topography of behavior of a speaker” (Greer & Ross, 2008, p. 295). A listener is able to follow simple commands (“Pick up the toys”, “Go get your shoes”). A listener has also acquired many verbal developmental cusps. As such, the development of a child from a pre-speaker to a listener is gradual and the result of contingencies in the environment that led to the acquisition of the necessary milestones (or through intervention). After a child has successfully acquired listener behavior, speaker behavior may begin to emerge. A child is considered a speaker, as defined by VBDT, when he or she has acquired all verbal behavior speaker cusps and capabilities and is subsequently capable of mediating or “governing” the behavior of others by speaking.

When a child has acquired both listener and speaker verbal behavior developmental cusps, it is critical for both the listener and speaker repertoires to join together in what is referred to as speaker-as-own-listener behavior. The joining together of listener and speaker behavior is also essential for the development of reader and writer behavior.

**Speaker-as-own-listener.** Speaker-as-own listener behavior is defined as behavior in which the individual can “function as a listener to their own verbal behavior” (Greer and Ross,
Researchers have identified Naming as one of the three speaker-as-own listener repertoires (Greer & Ross, 2008; Greer & Speckman, 2009). The two other speaker-as-own listener cusps are say-do correspondence and self-talk. Say-do correspondence is defined as present if an individual follows the directives that they have given themselves (Greer & Ross, 2008). For example, a child says (to his or herself), “I am going to the kitchen”. Subsequently after emitting the statement, he or she immediately walks to the kitchen. The child’s statement is immediately followed by a corresponding action. Say-do correspondence is a necessary prerequisite to “read and do” behavior. If children do not have “say-do” correspondence, they can learn to textually respond to words. However, they will not also acquire the function of reading tasks, which may require that they read and do (i.e., complete multi-step algorithms after reading).

Self-talk is defined as present if a child emits both speaker and listener behavior. This is usually observed during pretend play episodes in which a child appears to have a conversation with themselves in which he or she rotates between speaking, listening to his or her own voice, and acting as a listener by responding with an appropriate statement (Greer & Ross, 2008; Lodhi & Greer, 1989).

When Naming, a speaker-as-own listener capability, is present, there is joint stimulus control across listener and speaker responses. When a child learns to respond to an item as a listener, he or she will emit the untaught speaker response when presented with the same stimuli at a different time. Also, when a child learns the speaker response for an item, he or she will emit the listener response for the item (without direct instruction). As a result of the acquisition of Naming, a single stimulus controls multiple responses.

All three speaker-as-own-listener cusps are necessary for successful reading.
comprehension. Although a child without any of these cusps can be taught to textually respond to words at a rate of 80 correct words per minute (or higher), he or she will lack the repertoires needed to read for functional purposes, whether it be to read to learn or for pleasure. Reading is an extension of listener behavior. As such, if a child is capable of listening to his or her speaking responses, he or she is ready to listen to their own textual responses. When the child learns to textually respond to words, speaker-as-own-listener cusps result in a child who is a reading and responding to his or her own reading.

**Naming joins with print control.** “Learning to read requires adding print and comprehension components of reading to the joint stimulus control of the speaker, listener, and speaker-as-own-listener classes of responding (Greer & Ross, 2008, p. 233). Joint stimulus control refers to stimuli that evoke several responses, including listener, speaker, reader, and writer responses. When Naming, a speaker-as-own listener capability, is present in a child who has recently acquired textual response, reading comprehension can occur without intervention or direct instruction. This occurs because of the joint stimulus control that occurs when Naming “joins print control” for reading (and writing responses). This begins with the child’s early experiences; the experiences that enable listener and speaker responses to emerge as part of the Naming capability. An example of an early Naming experience is as follows: 1) A child sees a caterpillar on a sidewalk. 2) The child is observes this caterpillar with the use of several senses, typically the visual (i.e., looking at caterpillar) and auditory senses (when applicable). 3) During this experience, an adult may observe the child looking silently at the caterpillar (or could have noticed the insect first and directed the child’s attention to it. 4) The adult says “Look, a caterpillar!!” or a similar statement in which they tell the child the name of insect. This is the moment in which the child learns that the insect is called a caterpillar. The stimulus (caterpillar)
will eventually acquire joint stimulus control over several responses including 1) the listener response (responds correctly to “Point to the caterpillar!”) 2) the speaker response (says “Caterpillar!!” when shown a caterpillar, 3) the textual response (the word caterpillar) and 4) the writer response (Greer & Ross, 2007; Greer & Speckman, 2009). When asked to point to the caterpillar (listener response), the child is able to point to it. When shown a picture of the caterpillar or if the child sees another caterpillar in another setting, he or she is able to emit the tact response for the insect (speaker response – “I see a caterpillar!”). When the child is able to textually respond to the word “caterpillar”, immediate comprehension of the word occurs. The child is also able to emit the written response for “caterpillar” when transformation of stimulus function across saying and writing is present.

**Reading from a verbal behavior perspective.** Verbal behavior developmental theorists describe the act of reading as an extension of verbal behavior, specifically listener behavior. “Writing and reading are extensions of speaking and listening in that readers respond to print stimuli in the same way that listeners respond to auditory stimuli” (Greer & Ross, 2007 p. 250). When a child has acquired the pre-reader cusps and capabilities listed in the previous section, he or she will have the prerequisites needed to acquire reader and writer capabilities (Greer & Longano, 2010; Greer & Ross, 2007; Greer & Speckman; 2009). A child is defined as an early reader if 1) he or she has conditioned reinforcement for observing book stimuli (which indicates that they independently choose to look at books) (Greer & Ross, 2008; Buttigieg, 2015), 2) he or she can textually respond to print (see print and say the word), and 3) he or she can match the word in print to either the word itself, the word when said vocally, the object or action (that corresponds to the word) (Greer & Keohane, 2005; Tsai & Greer, 2006; Park, 2005). Additionally, the reader must listen to his or her own textual responses when reading because
reading is an extension of speaker-as-own-listener behavior (Hill, 2015).

A textual response as defined by Skinner (1957) is a verbal operant “under the control of printed, verbal stimuli” (Greer & Ross, 2007) (When a child sees the word “dog” in print, he or she says dog). When a child can textually respond to words at a rate of 80 words per minute, he or she has acquired a critical reader repertoire. Reading fluency has been identified as a necessary skill that is required for successful reading to occur (Allington, 1983). Moreover, slow reading has been identified as a factor in poor comprehension (Mastropieri, Leinart, & Scruggs, 1999; Greer and Ross, 2008). Criterion for what is considered fluent reading varies. Additionally, common core standards do not indicate a reading fluency rate that is sufficient. However, the standards state that first grade students should “read with sufficient accuracy and fluency to support comprehension” (CCSS.ELA-LITERACY.RF.1.4.). Currently, there is no widely accepted standard rate criterion. Greer and Ross (2008) describe a beginning fluent reader as one who textually responds to words at a rate of 80 correct words per minute, with 0 incorrect words per minute. In the current study, I use this criterion to determine what is considered the beginning of fluent reading.

Although the acquisition of textual responses to sounds and words is necessary for reading repertoires to emerge, it is only one component of reading (Greer & Ross 2008; Greer & Keohane, 2005). Greer and Ross (2008) argue that advanced reader (and writer) repertoires develop as a result of the acquisition of several verbal cusps and capabilities (Greer & Ross, 2007; Greer & Speckman, 2009; Skinner, 1957; Greer & Ross, 2007).

After a child has acquired 1) pre-reader cusps or capabilities (through intervention or naturally), 2) textual responses to phonemes, and 3) can textually respond to words at a minimum rate of 80 or more words per minute, the development of complex reader repertoires is
possible.

**Verbal behavior protocols to induce reader and writer behavior.** There has been a significant amount of research dedicated to the identification of reader and writer cusps as well as protocols designed to induce these cusps when they have been demonstrated to be missing.

*Reader protocols.* To date, there have been several studies in which reader cusps were induced as a function of systematically designed procedures. Helou-Care (2008) tested the effects of a procedure in which she induced the naming capability in middle school students who could textually respond to words at a fluent rate, but demonstrated poor reading comprehension skills. The dependent variable was the number of correct responses to questions to novel stories, which included sets of contrived words. Following the use of a multiple exemplar instructional procedure in which opportunities to respond as a listener and speaker were rotated, reading comprehension responses increased for the participants.

Lyons (2014) developed a computer-based auditory match-to-sample procedure in which she taught preschool and kindergarten aged students to accurately match segmented words to the corresponding blended words (ex: “m-a-t” to “mat”). During instructional sessions, instruction rotated between matching of sounds to words (“m-a-t” to “mat”) and words to sounds (“mat” to “m-a-t”). Following the auditory match-to-sample procedure, vocal blending responses and untaught spelling responses increased.

Hill (2015) conducted an experiment in which she taught third grade students to read silently and correctly respond to reading comprehension questions composed of both listener and speaker responses. Hill (2015) used a peer yoked contingency in which pairs of participants received reinforcement when both participants emitted silent reading repertoires along with correct responses to reading comprehension questions.
Writer protocols (writer immersion) and algorithms. According to VBDT, writing is an extension of speaker behavior (Greer & Keohane, 2005; Skinner, 1957). As such, VBD theorists have investigated writing as functional behavior that should be measured in terms of its effect on reader behavior. A protocol referred to as writer immersion has been empirically tested as an intervention to target both the structural (i.e., grammar, punctuation) and functional (effect on the reader) components of writing (Broto & Greer, 2014; Helou, Lau & Sterkin, 2007; Jodlowski, 2008; Madho, 1997; Pellegren, 2015; Reilly-Lawson & Greer, 2006; Visalli-Gold, 2005).

Writer immersion consists of a procedure in which the writer learns to affect the behavior of the reader by rewriting until the reader can correctly complete the task or behavior by independently reading the instructions given to them by the writer (i.e., read and do). Writer immersion protocols include the use of motivating operations for both the reader and writer. Reilly-Lawson and Greer (2005) conducted two experiments in which the participants wrote instructions to teach a reader how to draw a picture. The participants were provided with an image that consisted of a variety of shapes, colors, letters, and words that were placed in various locations on the paper. The writer was instructed to write directions so that a reader could reproduce the image. Although the writers received opportunities to edit their responses (after the reader attempted to reproduce the image), they did not write accurate directions until they received the writer immersion procedure. During the procedure, the participants continued to edit structural and functional components of their writing until the reader could correctly read and complete the task with 100% accuracy. Following the procedure, both functional and structural writing components increased. The procedure was effective in teaching the writers to affect reader behavior.

Functional algorithms. The writer immersion procedures described in the previous
section have consisted of interventions and pre-intervention assessments in which the target participants wrote mathematical and non-mathematical algorithms. An algorithm is defined as “a precisely defined set of rules telling how to produce specified output information in a finite number of steps (National Research Council, 2011). These rules are typically used to complete operations that consist of steps to solve math problems (National Research Council, 2001).

Writer immersion studies demonstrated that the participants could learn to write functional algorithms in which they wrote step-by-step rules that a reader could follow in order to solve a math problem or reproduce an image. In the current study, the participants read in order to complete non-mathematical algorithms that consisted of step-by-step procedures in which they 1) reproduced an image and 2) manipulated items in order to build a contrived structure.

**Verbal Mediation for Problem Solving**

In their description of the evolution of verbal milestones, Greer and Keohane (2005) describe the most advanced form of verbal behavior as the verbal mediation for solving problems. This repertoire is acquired only when the individual has the cusps and capabilities that correspond to the previous stages of verbal behavior (from pre-listener to writer-as-own-reader). Speaker-as-own-listener capabilities are necessary prerequisites. Verbal mediation is present if the individual’s problem solving repertoires are under the control of either verbal or written stimuli (Greer & Keohane, 2005; Marsico, 1998; Greer & Speckman, 2009). The control of written stimuli is essentially a “read and do” response in which the reader’s behavior is governed or controlled by print. This repertoire is essential for independently learning (by reading) the content knowledge for specific disciplines. Verbal mediation for problem solving expands upon the concept of reading “comprehension” because it specifies comprehension as occurring when the reader’s behavior is controlled by print. Thus allowing comprehension to be measureable and
observable when the reader’s behavior is taken into account.

**Reading, Motivation and Establishing the “Need to Read”**

Researchers have described motivation during reading as “reading engagement” or “attitude towards reading” (Wigfield, 1997). Guthrie and Wigfield (1999) describe reading motivation as a component of reading comprehension that “influences the individual’s activities, interactions, and learning with text”. Researchers have also discussed motivation in terms of reading efficacy or a child’s beliefs about his or her own reading ability, achievement values and social reasons for reading. Wigfield and Guthrie (1997) determined that reading motivation had an effect on the “amount and breadth” of a child’s reading. The authors argue that a child with strong beliefs about their reading ability still require motivation (in terms of intrinsic and extrinsic motivation) or a purpose for reading. Extrinsic motivation is defined in terms of desire to perform well during reading because of the desire to succeed in reading competitions or to just receive a good grade. The author defined intrinsic motivation as composed of two components included 1) reading curiosity and 2) reading involvement or natural enjoyment of reading. Extrinsic motivation has been associated with poor reading results and consequences (Guthrie & Wigfield, 2000; Paris & McNaughton, 2010). However, extrinsic motivation has been also by defined by these theorists as motivation in which the reader is reading to achieve goals such as good grades or other rewards.

VBD theorists describe the role of reinforcement in reading as one that requires conditioned reinforcement for reading as well as the establishment of “need to read” condition. The connection between books and motivation in necessary to establish even before a child is able to read. Greer and Ross (2008) identified conditioned reinforcement for books as an important pre-reader cusp. The cusp is present if the child chooses to select and look at book
stimuli (when provided with other non-book stimuli including toys) for up to five minutes at a time. When a child does not select books, interventions including stimulus-stimulus pairing and observational learning procedures have successfully increased the amount of time that young children will attend to book stimuli (Tsai & Greer, 2006; Singer-Dudek, Oblak, & Greer, 2011). Tsai and Greer (2006) demonstrated that conditioned reinforcement for books increased the number of accurate textual responses for preschool age students. Buttigieg (2015) investigated the effect of several procedures to establish conditioned reinforcement for books for preschool age children. Following the acquisition of conditioned reinforcement for books, the rate of acquisition for textual responses increased.

Greer and Ross (2008) describe motivation in reading in terms of the “need to read”. The “need to read” is a key part of reading and an important component to establish during early reading instruction. The authors describe procedures that can establish the need to read by a tactic in which the reader can access a hidden item by reading directions accurately. This suggested procedure has been used to design the intervention procedure for the current study.

**Motivating operations.** Within the field of behavior analysis, researchers have determined that there are environmental effects that can influence behavior. These effects are referred to as motivating operations. The presence of a motivating operation (MO) has a value-altering and behavior-altering effect on the consequences received for a particular behavior. In order for a motivating operation to be considered as present it must alter the value of a reinforcer (i.e. make it more or less desirable) and have an effect on a behavior (Laraway, Snyders, Michael & Poling, 2003; Michael, 1982; Michael, 2007). When a motivating operation is present, there is a corresponding increase in behavior (evocative effect) or decrease in behavior (abative effect). Food consumption is often used as an example of a motivating operation.
When food is present and an individual is hungry, behavior that will result in the consumption of food will also increase. However, if a person is full of food (i.e. satiated), even the most desirable food loses its value. Also, there is an effect on behaviors that would result in food consumption.

Motivating operations have been further categorized by researchers as either an establishing operation or an abolishing operation (Laraway, Snycerski, Michael & Poling, 2003). An establishing operation (EO) is a condition in which the value of reinforcer increases. Conversely, an abolishing operation will decrease the effectiveness of a reinforcer.

Motivating operations can either be unlearned or learned. For example, deprivation of food is an unlearned motivating operation. Food is essential for survival and the deprivation of it will naturally result in 1) an increase in its value and 2) an increase in the behaviors that result in its acquisition. Unlearned motivational operations are referred to as unconditioned motivating operations (UMO) (Micheal, 2007). Other UMOs include water, sleep, oxygen, sex, as well as stimuli that result in the increase or decrease in pain or temperature. Conditioned motivating operations occur as a result of a learned pairing in which the value-altering effective of the reinforcer is learned. In the current study, a motivating operation is used to create the “need to read” intervention condition. The motivating operation consists of deprivation of a preferred item. The item can only be accessed by reading. The preferred item is not an essential for survival (i.e., food, water, oxygen). As such, the motivating operation will be learned as a result of the intervention. The “need to read” deprivation condition acts as a motivating operation because it 1) increases the value of the item that the participants will look for during the intervention and 2) increases the behavior that the participants will emit in order to receive the preferred item.

**Verbal Behavior Immersion Protocols**
Within the field of behavior analysis, immersion (and emersion) procedures have been developed to induce or increase verbal behavior. These procedures include listener emersion, speaker immersion, and writer immersion (Greer, Chavez-Brown, Nirgudkar, Stolfi, & Rivera-Valdes, 2005; Pistoljevic, Cahill & Casarini, 2010; Ross, Nuzzolo, Stolfi, & Natarelli, 2006). These immersion procedures consist of the use of motivating conditions to increase verbal behavior. During these procedures children are fully “immersed” in conditions in which they receive reinforcement for emitting the relevant verbal behavior.

Greer and Ross (2008) suggested a protocol for reading, in which a motivating condition could be used increase functional reader behavior. However, this procedure has not been empirically tested. The reader immersion procedure in the current study will be the first immersion procedure implemented to increase reader behavior.

**Reading Instruction and Assessment in the U.S.**

**Reading comprehension assessments.** Davis (1944) conducted a study in which he created a systematic method for assessing reading comprehension skills. He identified nine skills to test for during reading comprehension assessments that included 1) selection responses in which the student was asked to identify the correct word meaning, 2) answer questions about what was read, 3) select literary devices, 4) select the main idea of a passage, and 5) a writer’s purpose. These skills were assessed with the use of multiple choice assessment tests that consisted 5 choices for each question.

The National Assessment of Educational Progress utilized “frameworks” designed to develop assessments to use for students throughout the United States. The frameworks determined which types of comprehension skills to assess and the method in which they would be assessed. The NAEP (2015) continues to use a multiple choice format, “constructed
response” questions, which require a short written answer, and questions which require a longer written response to assess reading comprehension skills (NAEP, 2010). “Teacher educators and reading teachers” designed the assessments use frameworks to determine the type of questions that should be asked and the method by which mastery of these types of questions is determined. This assessment was heavily influenced by cognitive theories of reading comprehension and as a result were designed to test the unobservable processes that occur during comprehension tasks as well as vocabulary knowledge.

Prior to 2009, students across fourth, eighth, and twelfth grade were assessed on their ability to comprehend fictional (identification of story elements or “read for literary experience”) and informational text. They were also assessed on their ability to read “practical text” and perform a task (grades eight and twelve only) (NAEP, 2007). “Practical text may include charts, bus or train schedules, directions for games or repairs, classroom or library procedures, tax or insurance forms, recipes, voter registration materials, maps, referenda, consumer warranties, or office memos” (NEAP, 2009). However, the task completion assessment was removed from reading assessments. Since 2009, the NAEP has not revised the framework used to design reading comprehension assessments.

Although NAEP’s governing board discontinued direct assessments in which students were tested for reading comprehension performance for procedural tasks, included was a definition of a type of informational text that was identified as a procedural text.

“The third type of informational text is often categorized as procedural texts or documents (Kirsch and Mosenthal 1990; Mosenthal 1996; Mosenthal 1998). Procedural texts convey information in the form of directions for accomplishing a task. A distinguishing characteristic of such text is that it is composed of discrete steps to be performed in a strict sequence with an implicit end product or goal. After reading the text, the reader should be able to reach a goal or complete a product. Examples include (but are not limited to) manuals and product support materials, directions for art activities and hobbies, and song. Procedural texts may include information arranged in graphs, charts, or maps, in addition to prose.”
During assessments for procedural texts, students are expected to understand maps, timelines, and charts (4th grade), recipes and schedules (8th grade) and manuals and contracts (12th grade) as well as graphic features including titles, labels, headings, and subheadings.

Other popular assessments used in the United States include standardized tests, formal and informal assessments, norm referenced tests, criterion-referenced or formative assessments and/or summative assessments (McKenna & Stahl, 2015). The results of these tests are reported as a grade (summative), percentile scores or stanine scores or grade equivalents (standardized tests), and/or comparison scores (norm-referenced or criterion-referenced). Many of these measure a student’s skills in the areas of decoding, fluency, retelling, or the comprehension questions. The primary method of assessing reading comprehension skill is through the use of a variety of questions that correspond to requirements provided within the Common Core State Standards (CCSS), a United States reading initiative that outlines what skills students should have mastered across the areas of language arts (and mathematics) (McKenna & Stahl, 2015).

To date, there are a lack of reading comprehension assessments outside of the field of behavior analysis in which a reader’s comprehension is measured by functional responses to print stimuli. Moreover, reading comprehension tests at the national level do not take into account that young children in the elementary levels are capable of learning to textually respond to words at a high rate of criterion (80 correct words per minute or more). As such, reading assessment and instruction should reflect the younger readers’ ability to fluently textually respond to material and to subsequently comprehend what has been read.

**Reading comprehension instruction in the United States.** Reading instruction for comprehension in the United States is guided by federal policy as well as reading theories on
comprehension (Barr, Kamil, Mosenthal & Pearson, 2015). However, teachers and educators do not always use theory to guide practices (Barr, Kamil, Mosenthal & Pearson, 2015; Department of Education, 2011). In order to receive federal funding and to remain in compliance with the No Child Left Behind Act, school districts must select curricula and teaching practices that adhere to these guidelines. As per the National Reading Panel report (2000) teachers were asked to identify “question words” and that the student is able to “summarize, compare, and analyze”. The emphasis is on reading strategies in which they are taught to monitor their own comprehension strategies (Schwanenflugel and Knapp, 2016; Kamil, Pearson, Birr Moje, Afflerbach, 2011).

**Rationale and Research Questions**

Technical reading comprehension, defined from the behavior analytic perspective, requires that the reader is verbally governed by print to perform simple or complex operations, which can result in 1) the learning of new repertoires (required for success in specific disciplines) or 2) learning to complete math algorithms. Research in and out of the field of behavior analysis has identified deficits in reading comprehension that can result in poor results on assessments in the STEM fields of study. Despite initiatives and resources designed by the United States government to target the poor performance of students on reading, math and science assessments, students continue to struggle to perform at a proficient level or above on these assessments. Furthermore, current traditional instructional practices for reading comprehension do not target the functional effects of reader behavior. There is a need for empirically tested interventions that target functional reader behavior in which the reader initially learns to read and do (i.e., learns the function of reading). This might be a necessary prerequisite to more advanced forms of reader behavior in which the reader reads in order to complete math
algorithms or to learn content-specific material. “Read and do” behavior may also be a prerequisite to writer repertoires, such as writing to affect the behavior of the reader.

In the current study, I tested the effects of a reader immersion procedure in which the participants read in order to access reinforcement. The procedure consisted of a “need to read” condition in which the participants read in order to access a preferred item. The dependent variable consists of untaught reading comprehension responses to “read and build” and “read and draw” tasks. The probe assessment materials were adapted from writer immersion procedures (Reilly-Lawson & Greer, 2005).

My research question is: What is the effect of the establishment of a “need to read” motivational condition on the novel reading comprehension responses of young children who have learned to fluently textually respond to words?
Participants

The three participants in Experiment 1 were selected from kindergarten and first grade inclusion classrooms located in a public elementary school. Both classrooms were identified as CABAS © AIL classrooms. (CABAS © and AIL are acronyms that stand for “Comprehensive Application of Behavior Analysis to Schooling” and “Accelerated Independent Learner”, respectively). The participants were between the ages of five and seven. Participant 3 was diagnosed with autism and had an individualized education plan (IEP) which mandated that she receive speech, occupational, and physical therapy services. This participant was also identified as a student who spoke English as a second language.

The participants’ relevant cusps and capabilities included: speaker-as-own listener capabilities (Naming, say-do correspondence, self-talk), observational learning, print transcription (see-write writing response), print dictation (hear-write writing response), textual responding joins with naming, conditioned reinforcement for observing book stimuli, and textual responses to words at a rate of 80 correct words or more per minute (with 0 incorrect per minute). Refer to Tables 1 and 2 for a detailed description of each participant including demographic and verbal behavior information).
Table 1

*Participant Description (Demographic)*

<table>
<thead>
<tr>
<th>Participant</th>
<th>Participant 1</th>
<th>Participant 2</th>
<th>Participant 3</th>
</tr>
</thead>
<tbody>
<tr>
<td>Age</td>
<td>6.0</td>
<td>6.8</td>
<td>5.0</td>
</tr>
<tr>
<td>Gender</td>
<td>Male</td>
<td>Female</td>
<td>Female</td>
</tr>
<tr>
<td>Diagnosis</td>
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<td>None</td>
<td>Autism</td>
</tr>
<tr>
<td>English As</td>
<td>No</td>
<td>No</td>
<td>Yes</td>
</tr>
<tr>
<td>Second Language</td>
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<td></td>
<td></td>
</tr>
<tr>
<td>Free-Reduced Lunch</td>
<td>Yes</td>
<td>Yes</td>
<td>Yes</td>
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</tbody>
</table>

<table>
<thead>
<tr>
<th>Grade</th>
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<th>1&lt;sup&gt;st&lt;/sup&gt; Grade</th>
<th>Kindergarten</th>
</tr>
</thead>
<tbody>
<tr>
<td>DRA 2 (Overall)</td>
<td>14</td>
<td>10</td>
<td>4</td>
</tr>
<tr>
<td>DRA 2 (Oral Reading Level)</td>
<td>16</td>
<td>16</td>
<td>10</td>
</tr>
<tr>
<td>Reading Grade Level</td>
<td>1&lt;sup&gt;st&lt;/sup&gt; Grade</td>
<td>1&lt;sup&gt;st&lt;/sup&gt; Grade</td>
<td>1&lt;sup&gt;st&lt;/sup&gt; Grade</td>
</tr>
</tbody>
</table>
Table 2

*Participant Description (Verbal Behavior Description)*

<table>
<thead>
<tr>
<th>Participant ID</th>
<th>Participant 1</th>
<th>Participant 2</th>
<th>Participant 3</th>
</tr>
</thead>
<tbody>
<tr>
<td>Naming</td>
<td>YES</td>
<td>YES</td>
<td>YES</td>
</tr>
<tr>
<td>Say-Do</td>
<td>YES</td>
<td>YES</td>
<td>YES</td>
</tr>
<tr>
<td>Correspondence</td>
<td>YES</td>
<td>YES</td>
<td>YES</td>
</tr>
<tr>
<td>Self-talk</td>
<td>YES</td>
<td>YES</td>
<td>YES</td>
</tr>
<tr>
<td>Conditioned</td>
<td>YES</td>
<td>YES</td>
<td>YES</td>
</tr>
<tr>
<td>Reinforcement</td>
<td>YES</td>
<td>YES</td>
<td>YES</td>
</tr>
<tr>
<td>for books</td>
<td>YES</td>
<td>YES</td>
<td>YES</td>
</tr>
<tr>
<td>Responds to Own Textual Responses as a listener</td>
<td>YES</td>
<td>YES</td>
<td>YES</td>
</tr>
<tr>
<td>Textually responds to words at a rate of 80 WPM</td>
<td>YES</td>
<td>YES</td>
<td>YES</td>
</tr>
<tr>
<td>Print Transcription (See-Write)</td>
<td>YES</td>
<td>YES</td>
<td>YES</td>
</tr>
<tr>
<td>Print Dictation (Hear-Write)</td>
<td>YES</td>
<td>YES</td>
<td>YES</td>
</tr>
<tr>
<td>Reading Governs Responding</td>
<td>NO</td>
<td>NO</td>
<td>NO</td>
</tr>
<tr>
<td>Naming Joins with Print Control</td>
<td>YES</td>
<td>YES</td>
<td>YES</td>
</tr>
<tr>
<td>Textually responding for Complex Operations</td>
<td>NO</td>
<td>NO</td>
<td>NO</td>
</tr>
</tbody>
</table>
Each student received a Developmental Reading Assessment 2 (DRA2) score which included an assessment of their respective reading comprehension skills (i.e., story retelling accuracy, making text-to-self connections), oral reading fluency, and engagement with books. Oral reading fluency was a measure of whether or not the student emitted correct textual responses in response to print stimuli. Oral reading fluency responses were timed for DRA2 assessments for Level 14 and above only. DRA2 assessments between Levels A and 12 measured oral reading accuracy only (without a fluency measurement). Refer to Table 2 for the DRA2 score for each participant. Included are 1) the overall DRA2 score (for oral reading fluency and comprehension) for each participant and 2) the DRA2 score which corresponds to the participant’s oral reading fluency score only.

All participants were selected from a CABAS© AIL inclusion classroom. A CABAS© classroom is distinguished from the traditional classroom by the application of teaching strategies and tactics selected from the science of behavior analysis to teach academic and self-management repertoires. Teachers in these classrooms (who were state certified and CABAS© certified teachers) measured student and teacher responses for self-management and all academic teaching. They also used the verbal behavior of the science to describe student responding and progress. This indicated that they used terminology consistent with the field of teaching as applied behavior analysis. All students received instruction for academic and self-management repertoires in the form of the learn unit (Albers & Greer, 1991). A learn unit was defined as a “three term contingency” that included an antecedent, a behavior and a consequence. (Greer & Ross, 2008). Teachers in the CABAS © classroom were trained to deliver instruction in the form of learn units, while using strategies such as positive reinforcement, teaching of skills to mastery and fluency, choral responding, and peer tutoring. These teachers also used verbal
behavior developmental protocols as needed to induce missing cusps and capabilities when they were demonstrated as not present. Throughout the school day, the students in the classroom received instruction in small groups (consisting of four to seven students) in which the students were separated into groups by skill level and level of verbal behavior. All instruction was individualized for each student. As a result, each student learned all academic repertoires to a predetermined criterion level that indicated mastery of the skill (fluency instruction followed when relevant). Students were reinforced for correct academic responding and appropriate behavior with social praise and tokens that were used to trade in for reinforcers (preferred games or activities). Reinforcement was used to reinforce academic responding when conditioned reinforcement for reading, math, or writing was not present (i.e., student’s correct academic responding for reading, math, or writing was not dependent upon intrinsic reinforcement).

The CABAS © AIL classrooms from which the participants were selected from included students with individualized education plans (IEP) and those without. The student teacher ratio of the kindergarten classrooms (Participants 1 and 3) was 19 students, one teacher, and two teaching assistants. There was one student in the kindergarten classroom who had an Individualized Education Plan (IEP). This student’s diagnosis was autism. In the first grade classroom (Participant 2), the student-teacher ratio was 19 students, one teacher, and two teaching assistants. There were five students with IEPs. Three of the students had a diagnosis of autism, one student had a diagnosis of attention deficit hyperactivity disorder (ADHD), and one student had a diagnosis of communication impairment.

The participants were included in the current study because they lacked verbally governed responding in which they could 1) textually respond to print and 2) subsequently complete multi-step algorithms in which they built a structure or reproduced an image. In order
to be considered for the current study each participant had to have cusps and capabilities needed to acquire advanced reader repertoires including speaker-as-own listener cusps (Naming, say-do correspondence, self-talk) and textual responses to words at a rate of 80 words or more per minute (with 0 incorrect words per minute). Words correct per minute were determined by student textual responses to first grade reading passages that were used by the participants’ classroom teachers during timed fluency instruction for textual responses. Fluency reading passages corresponded to Reading Level F books or above and included words that corresponded to first grade Common Core phonics standards. These words including the following components: 1) consonant digraphs, 2) long vowel sounds composed of two vowels (“team”, “meet”), 3) words composed of one or two syllables, 4) words that contained inflectional endings (-ing, -ed, -s, -es), and irregularly spelled words. Reading passages included high frequency words selected from Dolch word lists (Dolch, 1948). Dolch words include a list of 220 common words and 95 nouns. Many Dolch words cannot be read phonetically. As a result, readers are taught to read them by sight, in which they see the word and say the word (without attempting to segment or blend the sounds of the word). Dolch words are frequently categorized by grade level lists of words (pre-primer, primer, first, second grade, third grade and nouns). However, Dolch words from each category were included in reading fluency passages.

**Setting**

All pre-intervention probe sessions and intervention sessions were conducted in the classrooms in which the participants received daily instruction for academic and self-management repertoires. All classrooms contained three to four tables that were used for seating during small group instruction. Each classroom contained a small area designated for free-play. Each free-play area contained pretend play toys, toy cars, wooden and plastic blocks, and
anthropomorphic toys. Students in each classroom were given access to this area contingent upon correct academic responses or appropriate behavior (sitting appropriately in chair, following teacher directions). The teachers of the respective classrooms reinforced these behaviors with social praise and the delivery of tokens that were used by the students to trade in for playtime or prosthetic reinforcers. The walls of each classroom contained grade-level appropriate signs, posters, decorations as well as positive behavior support posters.

All pre-intervention and post-intervention probe sessions were conducted at small desks that were located in the classroom. Participants sat in child-sized chairs. During pre-intervention and post-intervention probe sessions, participants sat alone at the table or desk. The experimenter stood close by but did not sit directly next to the participant.

Reader immersion sessions were also conducted in the classroom in which the participants received academic instruction. During parts of the reader immersion sessions, the participants needed to leave the classroom in order to successfully complete the intervention. This included the area directly in front of the classroom door as well as the hallway located outside of the classroom.

**Materials**

**Pre- and post-intervention materials.** During the pre- and post-intervention assessments and intervention sessions, I used reading passages that consisted of 10-step reading instructions for two reading tasks including 1) a 10-step “read and build” task and 2) a 10-step “read and draw” task. Reading stimuli for pre-intervention, post-intervention and intervention sessions were presented in typed format on standard sized (8.5 X 11 inches) paper. All pre-intervention, intervention, and post intervention probe text stimuli were created using the
Microsoft Word 2013© program. For all text stimuli, I used size 12 font (pre- and post-intervention reading passages) or size 14 font (intervention passages) and Times New Roman font interface. See Figures 1 and 2 for a sample of reading passages used for the 10-step “read and build” and 10-step “read and draw” pre-intervention and post-intervention probe sessions.

Reading passages for the “read and draw” tasks were adapted from pre-intervention and post-intervention probes developed by Reilly-Lawson and Greer (2005). Reilly-Lawson and Greer (2005) developed a writer immersion procedure in which middle-school students wrote instructions so that a peer reader could reproduce an image (using writing implements) that consisted of various colored shapes, lines, and words. The experimenters measured the total number of components correctly drawn by the reader as well as the total number of correct and incorrect structural components written by the writer. In the current study, the reading passages for the pre- and post-intervention “read and draw” tasks included the same components used in the procedure developed by Reilly-Lawson and Greer (2005). However, instructions were written by the experimenter instead of a peer writer.

During the pre-reader immersion sessions, novel probe assessments were conducted with additional versions of the probe stimuli used prior to the novel probe assessments. The probes were conducted in order to determine if responses in correct and incorrect responding would remain consistent across probe stimuli. Differences in responding across probe stimuli could have indicated to the experimenter that responding may have occurred as a result of an issue related to the stimuli and not as a result behavior that was not verbally governed by print.

Materials for the “read and draw” task included white standard-sized paper (8.5 X 11 inches) and Crayola® large size crayons (4 inches long, 7/16” diameter). During the pre- and post-intervention probe sessions the participants were provided with one single sheet of paper
and seven crayons (red, blue, green, yellow, orange, black purple, and brown). The crayons provided to the participant included positive and negative exemplars so that the participant discriminated between textual responses that corresponded to each color.

The 10-step “read and build” tasks were developed for this experiment to measure whether or not the participants could complete a multi-step algorithm that included manipulation of three-dimensional items and objects (without the use of a writing implement). The materials for “read and build” tasks included 60 objects and one green square Lego® mat (10”X10”). These three dimensional items included 1) Lego® bricks (red, green, yellow, white, blue), 2) solid color wooden blocks, 3) flat, plastic geometric shapes (squares, triangles, circles, rectangles), 4) miniature toy animals (dog, bird, horse), 5) plastic pretend play food (strawberry, donut), and 6) plastic coins (quarter, dime, nickel, penny). White Lego® bricks were selected from a Lego® brick calendar set which included Lego® bricks that contained either numbers (between 1-31) or months of the year. (During the pre-intervention and post-intervention probe sessions, reading passages included instructions such as, “Pick up the white Lego block with the word September on it”). All three-dimensional items were placed in an open wooden box (10.5 inches X 11.5 inches). The green Lego® mat was placed next to the wooden box during all pre-intervention and post-intervention probe sessions. See Appendix 1 and Appendix 2 for 3-dimensional items used during pre-intervention and post-intervention probe sessions.

During pre-intervention and post-intervention probe sessions for the “read and build” tasks, the participant had access to all 60 objects and items, including items needed for the probe sessions as well those that were not needed. As a result, participants had to discriminate between items of similar color or shape.
Draw the picture described below.

Step 1: Draw an orange circle on the bottom left hand corner of the page.

Step 2: In the middle of the page, use the black crayon to write the word “silly” in lowercase letters.

Step 3: Draw an orange straight line from the top left hand corner to the bottom left hand corner of the page.

Figure 1. Sample of the 10-Step “read and draw” reading passage used during unconsequated pre-intervention and post-intervention sessions. During probe sessions, each participant received this sheet of paper along with 10 crayons consisting of positive and negative exemplars needed to produce the image. After the participant produced the image, the experimenter collected data on 10 components that corresponded to color of crayon used, orientation on page, and word written. Participants continued on to the intervention phase if they emitted less than 80% of correct components.
Read and build as described below.

Step 1: Place a flat blue rectangle on the top right corner of the Lego mat.

Step 2: Place a red triangle on the left side of the blue rectangle block.

Step 3: Place a white Lego block that has “January” on the bottom left corner of the Lego mat.

Step 4: Place a blue arch block on top of the flat blue rectangle block.

Step 5: Place a dog on top of the “January” Lego block.

Step 6: Place a flat yellow circle in the middle of the Lego mat.

Step 7: Find two red Lego blocks and place it on the yellow circle.

Step 8: Find a white Lego block that says “18,” and put it on the top left corner of the Lego mat.

Step 9: Place a white Lego block that says “19,” and put it on top of blue arch block.

Step 10: When you are done say “I’m done!”

*Figure 2.* Sample of the 10-Step “read and build” reading passage used during unconsequated pre-intervention and post-intervention sessions. Participant was given this sheet of paper along with a box of 3-dimensional materials that included positive and negative exemplars for each item. Each step corresponded to one probe trial. Participants continued onto the intervention phase if they emitted less than 80% of correct responses.
**Intervention materials.** Materials for the reader immersion procedure included 1) the reader immersion reading passage and 2) objects (two-dimensional and three-dimensional) used by the participants during the procedure. The reader immersion passage consisted of 20 directions that were printed onto one white standard-sized (8.5 X 11 inches) sheet of paper, using Times New Roman font (size 14). See Procedure section for a sample of the reader immersion passage used during the intervention. During the intervention, the participants textually responded to written sentences in which they were directed to 1) manipulate the objects and 2) move around the classroom in order to correctly complete each step. The objects included 1) tiny acrylic craft pom poms (red, black, purple, pink, blue, red, yellow, green), 2) solid wood building blocks, 3) shapes made out of construction paper (heart, rectangle, square, star, triangle), and 4) beaded necklaces (each of which had a shape taped to them). Each wooden block served as a pass that the participants used to leave the classroom. The blocks contained the words “hall pass,” “nurses pass,” or “office pass.” At the start of each new reader immersion session, the participants received a set of directions that was different from the one they had used in previous reader immersion sessions. This was done to ensure that participants’ responses would come under control of the print stimuli, as opposed to memorization of steps.

**Dependent Variables and Data Collection**

The dependent variables included two reading comprehension tasks in which the participants had to read to complete a multi-step algorithm. An algorithm was defined as The tasks included 1) a “read and build” task and 2) a “read and draw” task. Both reading tasks consisted of 10 components. The “read and build” task was presented in list format as 10 steps. The “read and draw” task, which also consisted of 10 components, was presented in list format as three steps. All pre-intervention and post-intervention probe sessions were unconsequated.
The experimenter created multiple exemplars of both types of checklists so that the sets were counterbalanced across the participants and so that each participant encountered a different set of directions during each intervention session. During all probe sessions, the participants were given positive and negative exemplars of the objects (items or crayons) needed for the “read and build” or “read and draw” task. This was done to ensure that the participant’s responding was under the control of print stimuli, and not occurring as a result of memorization of the steps.

**Dependent variable 1: 10-step read and build reading task.** The first dependent variable was the 10-step “read and build” reading comprehension task, which consisted of a multi-step algorithm that provided instructions on how to build a structure with three-dimensional objects. The task consisted of 10 steps presented in list format. During the pre-intervention and post-intervention probes, the participants textually responded to the 10-step “read and build” algorithm and subsequently attempted to manipulate three-dimensional objects around the Lego® mat. Each step corresponded to a single component. Data were collected on the total number of correct and incorrect components completed. Refer to Appendix 3 for an exemplar of a “read and build” structure completed by a participant.

**Dependent variable 2: 10-step read and draw reading task.** The second dependent variable was the “read and draw” reading comprehension task. The reading comprehension task was adapted from the Reilly-Lawson and Greer (2005) writer immersion procedure. The task in the current study consisted of a multi-step algorithm that provided instructions on how to produce an image using writing implements (crayons). The list of instructions was presented in list format as a three-step procedure. However, the entire task was composed of 10 components. The components measured were: 1) shape 2) color of the shape 3) position of the shape on the paper 4) word written 5) upper or lowercase letters written 6) color of the word 7) position of the
word 8) line drawn on paper 9) color of the line and 10) position of the line on paper. Data were collected on the total number of correct and incorrect components completed. Refer to Appendix 4 for an exemplar of a “read and draw” task completed by a participant.

**Independent Variable and Data Collection**

The independent variable consisted of the reader immersion procedure (which was referred to during the intervention as a “Treasure Hunt.” During the reader immersion procedure, a motivating operation was used to establish the “need to read” condition. In order to access reinforcement, the participants had to textually respond to and follow 20 written directions, presented in paragraph format. The participants could access reinforcement when they correctly completed all 20 directions with 100 percent accuracy. At the start of the procedure, the participant was given 1) a list of instructions written in paragraph format and 2) access to a plastic bin which contained all of the objects needed to complete each step. During the procedure, positive and negative exemplars of each object were available to the participant. An example of a written direction used in the procedure is, “Pick up a large blue pom pom”. After textually responding to this direction, the participant was expected to discriminate between 1) a small blue pom pom, 2) other large pom poms which were not blue, and 3) other objects which were blue but not pom poms. The experimenter delivered corrections for incorrect responses by using the least intrusive correction procedure and selecting more intrusive correction procedures if the participant did not repeat the step they completed incorrectly. Correction procedures included 1) point prompts to reread step in which the experimenter pointed to the sentence that corresponded to the step completed incorrectly (after which the participant completed the step after independently rereading the sentence) 2) written prompts delivered by the experimenter in which the experimenter wrote down additional instructions on a separate piece of paper and 3)
written prompts delivered by the experimenter in which she wrote down additional steps and modeled the correct response for the participants. See Appendix 5 for a list of correction procedures used by the experimenter. It should be noted that most of the participants required the least intrusive correction procedure during the intervention. Correct responses were not reinforced by the experimenter because reinforcement for correct responding occurred as a function of the motivating operation. Criterion for mastery of the intervention was 100% across one session.

**Procedure.** See Figure 3 for a sample of the reading passage used during the intervention. In the passage, there is solid black line that separates the top paragraph on the paper from the rest of the paragraphs. The experimenter separated these two sections of the paper so that the participant could access the second half of the paper by textually responding to and following the directions provided in the first half.

Prior to the start of the procedure, the experimenter allowed the participant to select a preferred item (referred to as the “treasure” during the intervention). Throughout the entire study, this preferred item was only used during the reader immersion procedure. It was not used to reinforce behavior during regular academic instruction or self-management routines in the classroom. The experimenter began the procedure by giving the participant the first set of directions while saying “You are going on a treasure hunt. You have to read these directions so that you can find the treasure. If you get one step wrong, the treasure hunt will end and you will have a chance to try again next time.” During the procedure, the participant was allowed to textually respond to the steps at his or her own pace. Also, the experimenter did not stand directly next to the participant. The experimenter stood three to five feet away from the participant while holding a set of the written directions that were identical to the set that the
participant was using. The experimenter’s set of directions was used to record data on correct and incorrect responses for each step in the algorithm. As the participant completed each step correctly, the experimenter recorded a plus (+) for correct responses or a minus (-) for incorrect responses. As the participant continued through each step of the procedure, they collected items that would be used during subsequent steps. For example, at the beginning of one version of the procedure, a participant textually responded to the direction, “Pick up the large, green pom pom”. Several steps later, the participant textually responded to the direction “Give a large pom pom to teacher before leaving the classroom”. If the participant did not have the pom pom, or had a pom pom that was not large, they would not advance further into the intervention.

During the intervention, the experimenter did not reinforce correct responses. The consequence for correct responses was included in the procedure, as a function of the motivating operation that was in place. The participants could not advance through the procedure if 1) they missed steps or 2) emitted an incorrect response for a step (by selecting the wrong item). If a participant emitted an incorrect response, the experimenter waited for the participant to come in contact with the natural consequence of the error. For example, if the participant reached the door of the classroom and did not have a “hall pass” or the correct pass, they were not allowed to leave the classroom. The experimenter recorded a minus (-) next to the first direction that was completed incorrectly. Although the participant was allowed to continue textually responding to the steps after emitting an incorrect response (i.e., until they came in contact with the natural consequence of the error), the experimenter recorded a minus sign (-) for all directions that followed the first direction that was completed incorrectly. The correction procedure consisted of a least-to-most intrusive correction procedure in which the experimenter began the correction procedure by using the least intrusive prompt necessary. The experimenter used more intrusive
corrections as needed. See Appendix 5 for a sequence of the correction procedure used during the reader immersion intervention sessions. Written corrections were provided if the participant did not reread the direction and complete the step independently. The experimenter wrote corrections on a dry erase board and presented them to the participant. An example of a written correction was a sentence such as “You picked up a large blue pom pom, instead of a small blue pom pom”.

When the participant completed all 20 steps correctly, they received the preferred item. This item was not given to them at the end of the procedure because they completed all of the steps correctly (e.g. “You got them all right so you get a prize!”). However, it was delivered as a result of successful completion of the procedure. If the participant completed each step correctly, eventually they would emit a behavior that resulted in finding the “treasure” in an area of the classroom or school. Criterion for mastery of the intervention was 100% accuracy across one session.
You are going on an adventure. At the end of the adventure, you will find a treasure. You need directions for this adventure. The directions are in a book that is on the big carpet. The title of the book is “Dinosaurs.” Find page 9. Take the directions out of the book. Read the directions.

Before you can begin your adventure, you need to find 1 large purple pom pom, 1 small blue pom pom and 1”office pass” block.

Bring the pom poms and the hall pass to the door. Say “I’m going on an adventure.” Give 1 small pom pom to the teacher. Wait for the teacher to say “Goodluck!”

Walk to the door and open it. Walk to the flag that is behind the Hillcrest Bank. Find a green star. Bring the star to Room 16. Give it to the teacher wearing a purple necklace that has a green star on it. Wait for the teacher to give you a green and a blue star. Follow the direction written on the blue star.

Figure 3. Sample of passage used during Reader Immersion intervention sessions. Each passage consisted of 20 components. During each Reader Immersion session, a different version of the passage was used in which the color of items, size of items, locations of items, or teacher phrases were changed. The structure of each sentence and the number of steps remained the same for each version. Criterion for mastery of the intervention was set at 100% across one session. Following mastery of the intervention, probe sessions were repeated for both the “read and build” and “read and draw” tasks.
Design

The experimenter used a delayed multiple probe design (Horner & Baer, 1978) with counterbalanced stimuli to test the effects of the reader immersion procedure on the number of correct untaught and novel reading comprehension responses emitted by each participant. During pre-intervention and post-intervention probe sessions, versions of the “read and build” and “read and draw” comprehension tasks were counterbalanced across participants. If Participant 1 used Version 1 of “read and build” comprehension task during pre-intervention probe sessions, Participant 2 received this version of the “read and build” comprehension task for the novel post-intervention probe (conducted after the participant met criterion for mastery of the reader immersion intervention and the initial post-intervention probe).

Experimental Sequence for Participants

The sequence for the experiment was as follows: 1) the experimenter conducted pre-intervention probes for the 10-step “read and build” and 10-step “read and draw” tasks 2) the reader immersion procedure was repeated until the participant achieved mastery criterion of 100% correct responses across one session 3) the experimenter repeated post-intervention probes for 10-step “read and build” and 10-step “read an draw” reading comprehension tasks (using the same reading passages used in the pre-intervention probe sessions) 4) the experimenter conducted novel “read and build” and “read and draw” reading comprehension probes if the participant emitted 80% correct responses (or higher) on the post-intervention probes 5) experimenter repeated the reader immersion procedure for participants who did not meet criterion on either the initial or novel “read and build” or “read and draw” tasks. See Figure 4 for the experimental sequence.
Interobserver Agreement (IOA) and Interscorer Agreement (ISA)

During pre-intervention and post-intervention probe sessions, interscorer agreement (ISA) was conducted by a second scorer who independently recorded data on correct and incorrect responses. Interscorer agreement was conducted for 66% of pre-intervention probe sessions and 60% of post-intervention probe sessions. There was 100% agreement.

During intervention sessions, IOA was conducted by a second observer who recorded data on the correct and incorrect responses emitted by the participants during the reader immersion intervention. Interobserver agreement was calculated by dividing the total number of agreements by the total number of agreements plus disagreements. The result was multiplied by 100. IOA was also conducted for 57% of intervention sessions. There was 100% agreement.

RESULTS

Dependent Variable 1: 10-Step Read and Build Reading Comprehension Task

Following mastery of the reader immersion procedure, untaught and novel correct responses during the “read and build” reading comprehension tasks increased for Participants 1, 2, and 3. Participant 1 emitted 30% of correct responses across all pre-intervention probe sessions and 75% of correct responses across all post-intervention probes. Participant 2 emitted 47% of correct responses across all pre-intervention probe sessions and 90% of correct responses across all post-intervention probe sessions. Participant 3 emitted 10% of correct responses across all pre-intervention probe sessions and 80% of correct responses across all post-intervention probe sessions. Figure 4 represents the total percentage of correct responses emitted by Participants 1, 2, and 3 during the pre-intervention and post-intervention probes for the “read and build” task.
**Dependent Variable 2. 10 Step Read and Draw Comprehension Task**

Following mastery of the reader immersion intervention procedure, untaught and novel correct responses increased during the “read and draw” reading comprehension tasks for Participants 1, 2 and 3. Participant 1 emitted 48% of correct responses during pre-intervention probe sessions and 70% of correct responses during post-intervention probe sessions. Participant 2 emitted 65% of correct responses during pre-intervention probe sessions and 100% of correct responses during post-intervention probe sessions. Participant 3 emitted 40% of correct responses during the pre-intervention probe sessions and 85% of correct responses during post-intervention probe sessions. Figure 5 represents the total percentage of correct responses emitted by Participants 1, 2, and 3 during pre-intervention and post-intervention probes for the “read and draw” task.

**Total Number of Correct Components During Pre- and Post-Intervention Probe sessions**

Figure 6 represents the total number of correct responses emitted across all pre-intervention and post-intervention sessions for Participants 1, 2, and 3. Participant 1 emitted 40% of correct responses during pre-intervention probes and 70% of correct responses during post-intervention probes. Participant 2 emitted 50% of correct responses during pre-intervention probe sessions and 90% of correct responses during post-intervention probe sessions. Participant 3 emitted 25% of correct responses during pre-intervention probe sessions and 80% of correct responses during post-intervention probe sessions.
Figure 4. Total number of correct responses emitted during pre-reader immersion, and post-reader immersion probes for Participants 1, 2 and 3 for the 10-step read and build tasks. Included are correct and incorrect to novel probe stimuli. Post-intervention probes were completed when participants met criterion for mastery of the reader immersion intervention. Novel probes for “read and build” tasks were conducted if participants emitted 80% correct responses to probe stimuli used during the pre-intervention probe sessions. Participant 1 required two cycles of the Reader Immersion procedure because he emitted less than 80% correct responses after the first cycle of reader immersion. The space between solid lines indicated time that occurred between the pre-reader immersion procedures and the post-reader immersion procedures during which the participants received the reader immersion intervention. During this time, the participants met criterion for the reader immersion intervention one or two times. The post-intervention probes are delayed across participants to maintain experimental control for maturation and instructional experience.
Figure 5. Total number of correct responses emitted during pre-intervention, and post-intervention probes for Participants 1, 2 and 3 for the 10-step read and draw tasks. Post-intervention probes were conducted if the participant met criterion for mastery of the reader immersion intervention. Probes for novel read and draw tasks were conducted if participants emitted 80% of correct responses for the original read and draw probe stimuli used during the pre-intervention probe sessions. Participant 1 required two cycles of the reader immersion procedure. The space between solid lines indicated time that occurred between the pre-reader immersion procedures and the post-reader immersion procedures during which the participants received the reader immersion intervention. During this time, the participants met criterion for the reader immersion intervention one or two times. The post-intervention probes are delayed across participants to maintain experimental control for maturation and instructional experience.
Figure 6. Total percentage of correct responses emitted during pre-intervention, and post-intervention probes for Participants 1, 2 and 3 for both the “read and build” and “read and draw” reading comprehension tasks. Included is the total percentage of correct responses across all pre-intervention and post-intervention probe sessions.
**Intervention Results**

Figure 7 represents the total number of correct responses emitted by Participants 1, 2 and 3 during the intervention sessions. Criterion for mastery of the intervention procedure was set at 100% across one session. Participants 1 and 3 required two cycles of the reader immersion procedure. A phase change line is used to separate the first and second reader immersion cycles.
Figure 7. Total number of correct responses emitted by Participants 1, 2 and 3 during reader immersion intervention sessions. The reader immersion procedure consisted of 20 components. Each graph indicates the total number of components (out of 20) correctly completed by each participant during each session. Criterion for the mastery of the intervention was 100% across 1 session. Participant 1 repeated the reader immersion procedure.
Discussion

In Experiment 1, I investigated the effects of a reader immersion procedure on the number of correct, untaught reading comprehension responses for two reading tasks. Following one or two cycles of the reader immersion procedure, all participants emitted a higher percentage of correct responses to untaught and novel stimuli. Responses increased for each participant for both the “read and build” tasks and the “read and draw” tasks. During the pre-intervention, post-intervention, and intervention sessions, the participants demonstrated that their behavior was coming under the control of print stimuli. Moreover, the participants demonstrated an increase or emergence of verbally governed behavior for written stimuli. These results are significant because they indicate that the participants have mastered a prerequisite skill needed to master more complex algorithms. As a function of the reader immersion procedure, the participants learned to manipulate their behavior in response to written stimuli (and not other strategies such as memorization or the use of picture prompts). Prior to the intervention procedure, the participants emitted errors including 1) completing steps memorized in the prior reader immersion sessions 2) textually responding to partial parts of sentences or 3) skipping or missing steps. During the pre-intervention probes for the “read and build” task, Participant 3 put all the correct shapes an items on the Lego ® mat board. However, all of the shapes were placed in a pile on the board and not in the correct locations on the mat. Following the intervention, this participant emitted a high number of correct responses to novel instructions in which she emitted correct responses for object, color, and location.

Greer and Ross (2008) suggested that the establishment of a “need to read” might be effective as an intervention to target reader behavior. The results of this experiment indicate that a motivational condition can be an effective strategy to induce or increase reading-governed
behavior. The writer immersion procedure has also been used a motivation operation to target writer behavior and the effect the writer has on the reader’s behavior (Helou, Lau & Sterkin, 2007; Jodlowski, 2008; Madho, 1997; Pellegrin, 2015; Reilly-Lawson & Greer, 2006; Visalli-Gold, 2005). The results of writer immersion studies and the results of the current experiment indicate that motivation may be a key component of writer and reader behavior.

There were several limitations in Experiment 1. There were a low number of participants in this experiment. An increased number of participants is needed to further demonstrate the effectiveness of the reader immersion procedure. Another limitation is that there were ceiling effects for Participant 2 during the “read and write” reading task. The participant’s responses were close to mastery level (at 70% correct and then 60% correct). This participant continued onto the intervention phase of the experiment because she emitted a lower number of correct responses during the “read and build” tasks. Following the reader immersion procedure, there was slight increase in her correct responses for both dependent variables.

Each participant increased the number of steps he or she completed independently after the intervention. However, the participants (with the exception of Participant 2’s responses to the read and draw task) did not emit responses with 100% accuracy on either dependent variable. This may indicate that the participants were not ready to complete complex written algorithms, such as math algorithms. However, more complex pre-intervention and post-intervention procedures may be needed to determine if the participants can emit verbally governed responses to more complex written stimuli (that does not yet consist of math algorithms). The reading stimuli used in the 10-step “read and build” and 10-step “read and draw” tasks included written steps which were presented in stepwise format. Each direction was preceded by the word “Step” and the corresponding step number (“Step 1..Step 2). The stepwise format may have been a
prompt for the participants when completing each step (in that it prompted them to continue onto the next step). A more advanced version of the “read and draw” and “read and build” tasks should include the presentation of steps in paragraph form.

In Experiment II, I intended to investigate the effects of the same reader immersion procedure used in Experiment I on the untaught, novel responses to longer, more complex versions of the “read and build” and “read and draw” tasks. In Experiment II, I conducted the same pre-intervention probes used in Experiment I in addition to 20-step versions of the probes.
CHAPTER III

EXPERIMENT II

Rationale and Experimental Questions

In Experiment 1, the participants’ verbally governed responses to written instructions increased for a 10-step “read and build” task and a 10-step “read and draw task.” This experiment demonstrated that the reader immersion procedure was effective in increasing untaught and novel responses to written stimuli. In Experiment II, I investigated whether the reader immersion procedure would result in increased responses for 1) the 10 step reading tasks (“read and build” and “read and draw”) used in Experiment I and 2) 20-step tasks for both the “read and build” and “read and draw” probe stimuli.

Research Questions

1) What is the effect of the reader immersion procedure, which included a motivating operation, on the untaught and novel verbally governed responses to print for 20 step algorithms?

2) Can a reader immersion procedure be used to increase the verbally governed responses to print stimuli for 1) 10-step reading comprehension tasks and 2) 20-step reading comprehension tasks?
Methods

The setting, materials, design, and criterion for inclusion in Experiment II were identical to those of Experiment 1. The differences in the experiments include the addition of dependent variables. In Experiment 1, the dependent variables were two 10-step technical reading tasks. In Experiment 2, the additional variables were 1) a 20-step “read and build” reading task and 2) a 20-step “read and draw” reading task. The participants received pre-intervention and post-intervention probes for all four dependent measures. The materials used in Experiment 1 were also used in Experiment II.

Participants

Participants consisted of one kindergarten student and three first grade students who were selected from the classrooms described in Experiment 1. Participant 2 was diagnosed with autism. He received occupational therapy services. Refer to Tables 3 and 4 for a description of each participant, including demographic information and levels of verbal behavior.
Table 3

Demographic Information for Each Participant

<table>
<thead>
<tr>
<th>Participant</th>
<th>Participant 1</th>
<th>Participant 2</th>
<th>Participant 3</th>
<th>Participant 4</th>
</tr>
</thead>
<tbody>
<tr>
<td>Age</td>
<td>5.0</td>
<td>6.7</td>
<td>6.3</td>
<td>5.5</td>
</tr>
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<td>Gender</td>
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<td>None</td>
<td>None</td>
</tr>
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<td>English As Second Language</td>
<td>Yes</td>
<td>No</td>
<td>No</td>
<td>Yes</td>
</tr>
<tr>
<td>Free-Reduced Lunch</td>
<td>Yes</td>
<td>No</td>
<td>No</td>
<td>Yes</td>
</tr>
<tr>
<td>Grade</td>
<td>Kindergarten</td>
<td>1&lt;sup&gt;st&lt;/sup&gt; Grade</td>
<td>1&lt;sup&gt;st&lt;/sup&gt; Grade</td>
<td>Kindergarten</td>
</tr>
<tr>
<td>DRA 2 (Overall)</td>
<td>10</td>
<td>10</td>
<td>8</td>
<td>8</td>
</tr>
<tr>
<td>DRA 2 (Oral Reading Level)</td>
<td>16</td>
<td>20</td>
<td>10</td>
<td>10</td>
</tr>
<tr>
<td>Reading Grade Level</td>
<td>1&lt;sup&gt;st&lt;/sup&gt; Grade</td>
<td>1&lt;sup&gt;st&lt;/sup&gt; Grade</td>
<td>1&lt;sup&gt;st&lt;/sup&gt; Grade</td>
<td>1&lt;sup&gt;st&lt;/sup&gt; Grade</td>
</tr>
</tbody>
</table>
Table 4

*Verbal Behavior Developmental Information for Relevant Pre-Reader and Reader Cusps For Each Participant*

<table>
<thead>
<tr>
<th>Participant ID</th>
<th>Participant 1</th>
<th>Participant 2</th>
<th>Participant 3</th>
<th>Participant 4</th>
</tr>
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<tbody>
<tr>
<td>Naming</td>
<td>YES</td>
<td>YES</td>
<td>YES</td>
<td>YES</td>
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<tr>
<td>Say-Do Correspondence</td>
<td>YES</td>
<td>YES</td>
<td>YES</td>
<td>YES</td>
</tr>
<tr>
<td>Self-talk</td>
<td>YES</td>
<td>YES</td>
<td>YES</td>
<td>YES</td>
</tr>
<tr>
<td>Conditioned Reinforcement for books</td>
<td>YES</td>
<td>YES</td>
<td>YES</td>
<td>YES</td>
</tr>
<tr>
<td>Responds to Own Textual Responses as a listener</td>
<td>YES</td>
<td>YES</td>
<td>YES</td>
<td>YES</td>
</tr>
<tr>
<td>Textually Responds to words at a rate of 80 WPM</td>
<td>YES</td>
<td>YES</td>
<td>YES</td>
<td>YES</td>
</tr>
<tr>
<td>Print Transcription (See-Write)</td>
<td>YES</td>
<td>YES</td>
<td>YES</td>
<td>YES</td>
</tr>
<tr>
<td>Print Dictation (Hear-Write)</td>
<td>YES</td>
<td>YES</td>
<td>YES</td>
<td>YES</td>
</tr>
<tr>
<td>Reading Governs Responding</td>
<td>NO</td>
<td>NO</td>
<td>NO</td>
<td>NO</td>
</tr>
<tr>
<td>Naming Joins with Print Control</td>
<td>YES</td>
<td>YES</td>
<td>YES</td>
<td>YES</td>
</tr>
<tr>
<td>Textually Responding for Complex Operations</td>
<td>NO</td>
<td>NO</td>
<td>NO</td>
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</tr>
</tbody>
</table>
Settings

The settings for pre-intervention, post-intervention, and intervention sessions were identical to those in Experiment 1.

Materials

The materials used in Experiment 2 were identical to those used in Experiment 1. Although the additional dependent variables contained more components, the experimenter used the same materials because an extensive amount of positive and negative exemplars were used for both the “read and draw” and “read and build” pre-intervention and post-intervention sessions in Experiment 1. The experimenter also used the same materials that were used during the Experiment 2 intervention sessions.

Definition of Variables

Dependent variables 1 and 2: 10-step read and build and 10-step read and draw task. Dependent Variables 1 (10-Step “read and build”) and 2 (10-Step “read and draw”) were identical in definition to those described in Experiment 1. Refer to Figure 1 and 2 for a sample of the probe stimuli used for these dependent variables.

Dependent variable 3: 20-step read and draw task. In Experiment 2, the 20-step “read and draw” task contained the same components as the 10-step “read and draw” task, including 1) shape, 2) color of the shape, 3) position of the shape on the paper, 4) word written, 5) upper or lowercase letters written, 6) color of the word, 7) position of the word, 8) line drawn on paper, 9) color of the line, and 10) position of the line on paper. The differences between the tasks were that the 20-step “read and draw” task included 1) presentation of steps in paragraph format only (not list format) and 2) an increased number of steps (20 steps instead of 10). Each sentence
corresponded to one probe trial. As a result, the participants had to correctly complete all components in a sentence in order for the response to be recorded as correct. In Experiment 1, each component corresponded to a probe trial response. Refer to Figure 8 for a sample of the “read and draw” task used during pre-intervention and post-intervention probe sessions.
These directions will show you how to draw a picture. Read each direction and do not skip any steps.

Draw a red triangle on the top left corner of the page. Use a blue crayon to color in the triangle. Draw a green circle on the bottom left corner of the page. Do not color in the circle.

Pick up a purple crayon and write the number “7” in the green circle. On the top right corner of the page, use an orange crayon to write the word “MOON” in uppercase letters. Draw a blue line from the number “7” to the word “MOON”. The line should connect the number “7” to the word “MOON”. Use a black crayon to underline the red triangle.

Figure 8. Sample of reading passage used during 20-step “read and draw” pre-intervention, post-intervention and novel probe sessions for all participants. Each sentence corresponds to one probe trial. During probe sessions, participants were given this sheet of paper along with positive and negative exemplars of crayons needed to complete the task. Criterion for mastery of the intervention was set at 100% across one session.
**Dependent variable 4: 20-step read and build task.** The 20-step “read and build” task consisted of the same components as the 10-step “read and build” task. The differences between the 10-step “read and build” and the 20-step “read and build” task included 1) an increased number of steps and 2) presentation in paragraph format (instead of list format). Similar to Experiment 1, the participants manipulated 3-dimensional objects and items around a Lego © mat, in order to build a contrived structure. Each sentence corresponded to one probe trial. Each probe trial required the correct completion of multiple components that included 1) color of the object or shape 2) orientation on the board 3) correct object or shape size or 4) type of object selected. Refer to Figure 9 for a sample of the 20-step “read and build” task used during pre-intervention and post-intervention probe sessions.
You are going to use Lego blocks, wooden blocks, shapes, and toy animals to build. Everything you need to build is in the wooden box.

Pick up the white Lego block that has the word “September” on it. Put it in the bottom left corner of the Lego mat. Place a flat red circle in the middle of the Lego mat. Place a bird on top of the flat red circle. Pick up two red Lego blocks and put both blocks next to the bird. The bird should be placed between the two red Lego blocks.

Place a red square on the top right corner of the Lego mat. Pick up a green square block and put it on top of the red square. Pick up a white Lego block that has the word “January” on it. Put it on top of the “September” Lego block.

Pick up 1 blue arch block and 1 yellow arch block. Put the blue arch block on the top left corner of the Lego mat. Place the yellow arch block on top of the blue arch block. Pick up a penny, and put it under the blue arch block. The penny should now be under the blue arch block.

Find a white Lego block that has the number “19” on it and place it on the bottom right corner of the Lego mat. Place a white Lego block that has the number “18” on top of the Lego block that has the number “19” on it. When you are done fold your hands and say “I’m done!”

**Figure 9.** Sample of reading passage used during 20-step “read and build” pre-intervention, post-intervention and novel probe sessions for all participants. Each sentence corresponds to one probe trial. Participants were given positive and negative exemplars of 3-dimensional items needed to complete all steps. Probe sessions were unconsequated.
**Independent variable and data collection.** The independent variable was the Reader Immersion intervention procedure. The intervention was identical to the intervention used in Experiment 1. There were no modifications or additions included in the passages used across both experiments in the reader immersion procedure. The reader immersion procedure was not changed so that it could be determined whether or not the intervention would have an effect on the number of untaught responses for more complex multi-step algorithms.

**Procedure.** The procedure used in Experiment 2 was identical to the procedure used in Experiment 1. The intervention consisted of the reader immersion procedure.

**Experimental Design**

The experimental design was the same design used in Experiment 1. The sequence for Experiment 2 was as follows: 1) the experimenter conducted pre-intervention probes for the 10-step “read and build,” 10-step “read and draw” tasks, 20-step “read and build” tasks, and 20-step “read and draw” tasks, 2) the reader immersion procedure was repeated until the participant achieved mastery criterion of 100% correct responses across one session, 3) the experimenter repeated post-intervention probes for 10-step “read and build” tasks, 10-step “read an draw” tasks, 20-step “read and build” task, and 20-step “read and draw” reading comprehension tasks, 4) the experimenter conducted novel “read and build” and “read and draw” reading comprehension probes if the participant emitted 80% correct responses (or higher) on the post-intervention probes, and 5) experimenter repeated reader immersion procedure for participants who did not meet criterion on either the initial or novel “read and build” or “read and draw” tasks.

**Interobserver and Interscorer Agreement**
Interobserver and interscorer agreement were collected using the methods used during Experiment 1. During pre-intervention and post-intervention probe sessions, interscorer agreement (ISA) was conducted by a second scorer who independently recorded data on correct and incorrect responses. In order to record data on the participant’s responses, the second observer looked at the completed structure made during the “read and build” task or looked at the image produced during the “read and draw” task. Interscorer agreement was conducted for 80% of pre-intervention probe sessions and 90% of post-intervention probe sessions. There was 100% agreement.

During intervention sessions, IOA was conducted by a second observer who recorded data on the correct and incorrect responses emitted by the participants during the reader immersion intervention. Interobserver agreement was calculated by dividing the total number of agreements by the total number of agreements plus disagreements. The result was multiplied by 100. IOA was also conducted for 40% of intervention sessions. There was 100% agreement.

Results

**Dependent variable 1: 10-step read and build reading comprehension task.**

Following mastery of the reader immersion procedure, untaught and novel correct responses during the 10-step “read and build” reading comprehension tasks increased for Participants 1, 2, 3, and 4. Participant 1 emitted 53% of correct responses across all pre-intervention probe sessions and 85% of correct responses across all post-intervention probes. Participant 2 emitted 40% of correct responses across all pre-intervention probe sessions and 95% of correct responses across all post-intervention probe sessions. Participant 3 emitted 10% of correct responses across all pre-intervention probe sessions and 80% of correct responses across all post-
intervention probe sessions. Participant 4 emitted 0% of correct responses across all pre-intervention probe sessions and 85% of correct responses across all post-intervention probe sessions. Figure 10 represents the total percentage of correct responses emitted by Participants 1, 2, 3 and 4 during the pre-intervention and post-intervention probes for the 10-step “read and build” task.
Correct Response to Pre-intervention and Post-intervention Probe Trials for 10-Step Read and Build Task

Figure 10. Pre-intervention and post-intervention unconsequated probe responses for Participants 1, 2, 3 and 4 for the 10-step “Read and Build” reading comprehension task. Following mastery of the reader immersion procedure, post-intervention probes were conducted with original probe stimuli. Participants who emitted 80% or higher on probe sessions using original probe stimuli, received an additional probe with novel probe stimuli. Reader immersion intervention was repeated if participants emitted 80% or less during probe sessions with original or novel probe stimuli. The space between solid lines indicated time that occurred between the pre-reader immersion procedures and the post-reader immersion procedures during which the participants received the reader immersion intervention. During this time, the participants met criterion for the reader immersion intervention one or two times. The post-intervention probes are delayed across participants to maintain experimental control for maturation and instructional experience.
Dependent variable 2: 10 step read and draw comprehension task. Following mastery of the reader immersion intervention procedure, untaught correct responses increased during the “read and draw” reading comprehension tasks for Participants 1, 2, and 3. Participant 1 emitted 50% of correct responses during pre-intervention probe sessions and 85% of correct responses during post-intervention probe sessions. Participant 2 emitted 70% of correct responses during pre-intervention probe sessions and 90% of correct responses during post-intervention probe sessions. Participant 3 emitted 45% of correct responses during the pre-intervention probe sessions and 90% of correct responses during post-intervention probe sessions. Participant 4 emitted 0% of correct responses during pre-intervention probe sessions and 85% of correct responses during post-intervention probe sessions. Figure 11 represents the total percentage of correct responses emitted by Participants 1, 2, 3, and 4 during pre-intervention and post-intervention probes for the 10-step “read and draw” task.
Figure 11. Pre-intervention and post-intervention unconsequated probe responses for Participants 1, 2, 3 and 4 for the 10-step “Read and Draw” reading comprehension task. Following mastery of the reader immersion procedure, post-intervention probes were conducted with original probe stimuli. Participants who emitted 80% or higher on probe sessions using original probe stimuli, received an additional probe with novel probe stimuli. Reader immersion intervention was repeated if participants emitted 80% or less during probes sessions with original or novel probe stimuli.
**Dependent variable 3: 20 step read and build comprehension task.** Following mastery of the reader immersion intervention procedure, untaught correct responses increased during the 20-step “read and build” reading comprehension tasks for Participants 1, 2, 3, and 4. Participant 1 emitted 42% of correct responses during pre-intervention probe sessions and 82% of correct responses during post-intervention probe sessions. Participant 2 emitted 30% of correct responses during pre-intervention probe sessions and 92% of correct responses during post-intervention probe sessions. Participant 3 emitted 20% of correct responses during the pre-intervention probe sessions and 85% of correct responses during post-intervention probe sessions. Participant 4 emitted 0% of correct responses during pre-intervention probe sessions and 98% of correct responses during post-intervention probe sessions. Figure 12 represents the total percentage of correct responses emitted by Participants 1, 2, 3, and 4 during pre-intervention and post-intervention probes for the 20-step “read and build” task.
Figure 12. Pre-intervention and post-intervention unconsequated probe responses for Participants 1, 2, 3 and 4 for the 20-step “Read and Build” reading comprehension task. Data were collected on total components completed out of 20 components. Following mastery of the reader immersion procedure, post-intervention probes were conducted with original probe stimuli. Participants who emitted 80% or higher on probe sessions using original probe stimuli, received an additional probe with novel probe stimuli. Reader immersion intervention was repeated if participants emitted 80% or less during probes sessions with original or novel probe stimuli.
Dependent Variable 4. 20 step read and draw comprehension task. Following mastery of the reader immersion intervention procedure, untaught correct responses increased during the 20-step “read and draw” reading comprehension tasks for Participants 1, 2, 3, and 4. Participant 1 emitted 58% of correct responses during pre-intervention probe sessions and 82% of correct responses during post-intervention probe sessions. Participant 2 emitted 65% of correct responses during pre-intervention probe sessions and 95% of correct responses during post-intervention probe sessions. Participant 3 emitted 40% of correct responses during the pre-intervention probe sessions and 80% of correct responses during post-intervention probe sessions. Participant 4 emitted 0% of correct responses during pre-intervention probe sessions and 90% of correct responses during post-intervention probe sessions. Figure 13 represents the total percentage of correct responses emitted by Participants 1, 2, 3, and 4 during pre-intervention and post-intervention probes for the 20-step “read and draw” task.
Figure 13. Pre-intervention and post-intervention unconsequated probe responses for Participants 1, 2, 3 and 4 for the 20-Step “Read and Draw” reading comprehension task. Data were collected on total number of components completed (out of 20 components). Following mastery of the reader immersion procedure, post-intervention probes were conducted with original probe stimuli. Participants who emitted 80% or higher on probe sessions using original probe stimuli, received an additional probe with novel probe stimuli. Reader immersion intervention was repeated if participants emitted 80% or less during probes sessions with original or novel probe stimuli.
Total number of correct responses during pre- and post-intervention probe sessions.

Figure 14 represents the total number of correct responses emitted across all pre-intervention and post-intervention sessions for Participants 1, 2, 3, and 4. Participant 1 emitted 51% of correct responses during pre-intervention probes and 83% of correct responses during post-intervention probes. Participant 2 emitted 53% of correct responses during pre-intervention probe sessions and 95% of correct responses during post-intervention probe sessions. Participant 3 emitted 29% of correct responses during pre-intervention probe sessions and 83% of correct responses during post-intervention probe sessions. Participant 4 emitted 0% of correct responses during pre-intervention probes and 90% of correct responses during post-intervention probes.
Figure 14. Total percentage of correct components completed by Participants 1, 2, 3 and 4 during pre-intervention and post-intervention probe sessions. Included are the total percentage of components completed across all four dependent variables (10-step read and build, 10-step read and draw, 20-step read and build, 20-step read and build) prior to and after the reader immersion intervention.
**Intervention results.** Figure 15 represents the total number of correct responses emitted by Participants 1, 2, 3, and 4 during the intervention sessions. Criterion for mastery of the intervention procedure was set at 100% across one session. Participant 2 required two cycles of the reader immersion procedure. A phase change line is used to separate the first and second reader immersion cycles.
Figure 15. Total number of components completed for each participant during the reader immersion intervention sessions. Data were collected on total number of responses completed out of 20 components. Criterion for mastery of the intervention was 100% across one session. Participant 2 required 2 cycles of the reader immersion procedure. Participants who emitted less than 80% of correct responses during the post-intervention probes using original stimuli or novel stimuli received the reader immersion intervention again.
Discussion

Following the reader immersion procedure, responses increased for all participants across all four tasks in which they had to complete untaught multi-step algorithms. During both experiments, the same independent variable, the reader immersion procedure, was used as an intervention to increase untaught reading comprehension responses for two 10-step reading tasks and two 20-step reading tasks. The results across participants for the 10-step reading tasks are consistent with the findings from Experiment 1, in which responses to these same tasks increased after the reader immersion procedure was used. Experiment 2 results demonstrate the procedure may be an effective intervention to increase untaught responses to longer, more complex algorithms.

During the pre-intervention and post-intervention probe sessions, the participants emitted similar errors to those observed in Experiment 1 including 1) missing or completing partial components of steps or 2) repeating steps memorized in previous versions of the reader immersion task. Participant 4 textually responded to the print without emitting the corresponding behaviors (i.e., reading the entire passage and then stating that she was done).

Limitations included a potential ceiling effect for responses for Participant 2. For Participant 2, there was only a slight increase in correct responses following the reader immersion procedure (for “read and draw” tasks only). Prior to the intervention, he emitted a percentage of correct responses during 10-step and 20-step “read and draw” tasks that was close to 80%. Following the intervention, there was a slight increase in correct responses for both these variables. This indicates that there may have been a ceiling effect for this participant for the two “read and draw” variables. However, this participant emitted a lower number of correct responses for both “read and build” tasks. Additionally, he required two cycles of the reader
immersion procedure before responses increased for these tasks. The results for this participant demonstrate that he may have continued to benefit from the reader immersion procedure.
Overview

In two Experiments, I investigated the effects of “need to read” motivating operations on technical reading comprehension responses (i.e., verbally governed responses to print stimuli). The motivating operation was used to teach the function of reading (i.e., “read and do” responses to a written algorithm). Unconsequated responses increased for technical reading comprehension tasks for all participants. As a result, there was a shift in reinforcement for reading from the prosthetic reinforcement (i.e., preferred item) used in the motivating condition to “read and do” responding occurring as a result of automatic reinforcement. I propose that responses emitted after the reader immersion occurred as a result of automatic reinforcement because in the absence of the motivating operations, high rates of correct responding continued.

In Experiment 1, the reader immersion procedure was used as an intervention to increase the number of reading comprehension responses to novel print stimuli that consisted of 10-step algorithms. The print stimuli used during the pre-reader and post-reader immersion probe sessions consisted of simple non-mathematical algorithms that were composed of a set of directions presented in step-wise format. Following mastery of the intervention, the three participants in Experiment 1 emitted a higher number of novel responses to print stimuli. The responses of the participants were directly controlled by print and no other variable in the environment.

In Experiment 2, I sought to test whether the same reader immersion procedure used in Experiment 1 could be used an intervention to increase technical reading responses to simple (i.e., 10-step algorithm) and more advanced algorithms (i.e., 20-step algorithm), in which the
participants had to demonstrate verbally governed responses to print stimuli by 1) textually responding to print and 2) emitted the corresponding behavior. Although the probe stimuli used for the more advanced probe included more steps and the absence of the step-wise format used for the simple probe stimuli (in Experiment 1), responses to novel probe stimuli increased for the four participants in Experiment 2. The results across both experiments suggest that motivation was a critical component in inducing or increasing verbally governed behavior. Also, motivation was effective in teaching the function of technical reading to children who had acquired all the verbal behavior cusps and capabilities necessary to learn it. The participants emitted correct responses in the absence of the motivational conditions used during the reader immersion procedure. These results suggest that the reinforcement for correct responding occurred as a result of the teaching of the function of reading to the participants. In the following sections, I will discuss the major findings of these experiments as well as the implications and educational significance of the results. In terms of major findings, I combine the discussion for both experiments.

**Major Findings**

**Findings across Experiment 1 and 2**

**Technical reading comprehension as verbally governed behavior.** Verbally governed behavior is behavior that is controlled by either a written stimulus or a vocal stimulus (Greer & Keohane, 2005). Across both Experiments 1 and 2, the behavior of the participants during the intervention procedure and the post-reader immersion initial and novel probes were controlled by the written (or print) stimuli. In both experiments, the print stimuli consisted of two variations of algorithms, both of which were used to represent technical reading comprehension tasks. The participants developed verbally governed behavior for simple operations as demonstrated by
responses to the non-mathematical algorithms in Experiments 1 and 2. Although this the first
time that a reader immersion procedure has been empirically tested, the findings are consistent
with the predicted outcome of the procedure that was suggested by Greer and Ross (2008).
Additionally, the findings are consistent with prior research conducted in which writer behavior
was measured by the effects on reader behavior (Broto & Greer, 2014; Fas, 2015; Helou, Lai &
Sterkin, 2007; Madho, 1997; Pellegrin, 2015; Reilly-Lawson & Greer, 2006;). The readers in
these writer immersion studies, although not the target participants, were verbally governed by
the print stimuli (i.e., algorithms) produced by the peer writers. In these studies, the peer writers
demonstrated an increase in functional and technical writing of non-math algorithms by learning
to affect the verbally governed behavior of the reader. Reilly, Lawson, and Greer (2006) tested
the effects of the writer immersion procedure on the technical writing of middle school students.
Following the writer immersion procedure, the correct number of structural and functional
components of technical writing increased for the participants. Correct writing responses were
measured in terms of their effect on the reader. In the current study, the “read and draw”
technical reading tasks were adapted directly Reilly, Lawson and Greer (2006). However, the
target participants read the algorithm. Also, the target participants were significantly older than
the participants in the current study. The results from the current study demonstrated that an
immersion procedure for reading could affect reader behavior in the same way that the writer
immersion procedure affects writing behavior. Furthermore, the results demonstrated that the
same intervention procedure could be used as an intervention to increase responses to algorithms
presented in a stepwise format as well as longer algorithms in which steps were presented in
paragraph format.
**Motivational function of reading.** Greer and Ross (2008) discussed the importance teaching children the “need to read” during reading instruction. The authors suggested that prosthetic reinforcement and contrived opportunities in which the “need to read” is established could affect reader behavior. The results of the current study suggest that motivating operations can have a significant impact on reader behavior. The participants in this study read because they needed to in order to access a preferred item that they did not have the opportunity to get outside of the intervention sessions. They could not use speaker repertoires to access the item (i.e., vocally asking for it). During the intervention sessions, all seven participants across Experiments 1 and 2, successfully accessed preferred items (one or two times) by emitting “read and do” behavior with 100% accuracy within a single session of the intervention.

Motivating operations, also called establishing operations, have also been used to increase behavior in other immersion and emersion procedures such as writer immersion, speaker immersion, and listener emersion (Broto & Greer, 2014; Fas, 2015; Helou, Lai & Sterkin, 2007; Madho, 1997; Reilly-Lawson & Greer, 2006; Pellegrin, 2015; Pistoljevic, Cahill & Casarini, 2011; Ross, Nuzzolo, Stolfi, & Natarelli, 2011; Greer and Ross, 2008). The importance of the motivating operation in inducing or increasing various forms of verbal behavior has been established in the previously mentioned immersion studies as well as the current study. The results demonstrated that the use of a motivating operation is an effective strategy to increase verbally governed responses to print.

Additionally, the increase in correct responses during the intervention procedure most likely occurred as a result of a conditioned motivating operation (CMO). A CMO is a type of motivating operation in which the behavior is learned (i.e. as opposed to occurring as a function of biological necessity) as a result of a pairing of behavior with a reinforcer whose value is
increased or decreased by the motivating operation. A motivating operation (MO) consists of
two functions (Micheal, 1993; Michael, 2007). The first is that the MO should alter the value of
the reinforcer, by increasing (establishing operations) or decreasing the value (abolishing
operations). Secondly, the MO should have a behavior altering effect. An establishing operation
(which is one type of motivating operation) can result in an increase in behavior because the
behavior itself has been paired with reinforcement. The “need to read” condition contained both
components of an MO. The value of the preferred items was altered because the deprivation of
the items increased the value of the items. Moreover, the “need to read” condition affected the
behavior of the participants in that the deprivation of the item motivated them to emit behavior
that would enable them to have access to it. The “need to read” condition created an establishing
operation in which the participants emitted correct responses during the intervention because 1)
deprivation of the preferred item made the item more appealing to them and 2) reading resulted
in access to this item. The “need to read” condition is a conditioned motivating operation
(CMO) because the participants learned that the act of reading was paired with access to a
desired item. As a result, responses increased when the motivating operation was in place.

Although the effects of a motivating operation are typically short term, the results of the
post-reader immersion probes would indicate that the participants learned the function of
reading. During the post-reader immersion probe sessions, the participants continued to emit a
high number of correct responses in the absence of a motivating condition. These results
demonstrate that the teaching the function of reading resulting in automatic reinforcement for
completing simple algorithms. These results are consistent with the findings of studies in which
a motivational condition was used to induce or increase verbal behavior. In these studies 1) the
function of verbal behavior (spoken or written) was taught and 2) untaught responses emerged or increased when the motivational condition was not in place.

**Limitations**

There were several limitations in the current study. As reported in the preceding discussion sections, there were ceiling effects in both Experiment 1 and 2. In Experiment 1, Participant 2 emitted a high number of correct “read and draw” responses prior to the implementation of the intervention. He continued on to the intervention phase because he emitted a lower number of correct responses during the “read and build” pre-reader immersion probe sessions. However, due to the high number of correct responses emitted during the “read and draw” phase, it is difficult to determine if the increase in correct responses for this measure could be attributed to the use of the intervention procedure. Similar effects were noted for Participant 2 (in Experiment 2), during the 10-step and 20-step “read and draw” pre-reader immersion probe sessions.

A second limitation is that self-editing behavior was not measured during Experiment 1 or Experiment 2. Self-editing has been identified as a critical component of writing behavior. Greer and Keohane (2005) describe a stage of verbal behavior development as the “writer as own reader” stage in which the writer acts his or her own editor. As a result, he or she emits verbally governed behavior that is controlled by the writer’s own written responses. The writer “finds discrepancies between what she reads and what she has written, writer and reader in the same skin” (Greer & Keohane, 2005). During the pre-reader immersion and post-reader immersion probes, several participants independently edited their responses. These instances of self-corrections were observed by the experimenter. However, data were not collected on these responses. During these times, the participants independently 1) put an object down on the Lego
mat, 2) re-read the corresponding step, and 3) moved the Lego piece to another location on the mat. These anecdotal observations would indicate that the participants emitted self-editing responses during the course of the study. Greer and Keohane (2005) describe a self-editor as an individual who independently solves complex problems while under the control of written or verbal stimuli. The authors refer to the solving of complex problems as those that can occur in specific disciplines or fields of study. In the current study, the participants’ self-editing responses may have occurred as a result of learning to solve simple problems. The “problems” in the current study consisted of the “read and build” and “read and draw” algorithms. In future studies, self-editing should be included as a dependent measure during the pre-reader immersion, post-reader immersion, and intervention sessions to determine if participants acquire verbally governed responses to print as well as a self-editing repertoire. Self-editing could be a critical component of both writer and reader behavior. If the writer can act as his or her own editor when writing, the reader, who is emitting reader-as-own-listener behavior, can also emit problem solving repertoires in which he or she self-corrects verbally governed responses to print.

**Future Research**

In addition to the measurement of self-editing behavior (as discussed in the previous section), future research should include math algorithms as a measure of the effects of motivational conditions for verbally governed responses to print stimuli. In the current study, non-mathematical algorithms were developed and used as measures to determine if the participants could acquire verbally governed responses to print that consisted of simple written algorithms that did not consist of math problems. These measures were used to demonstrate that young children who could textually respond to words fluently could learn to complete simple non-math algorithms. Also, if the participants could not complete the algorithms in the current
study, they would have been missing the basic “read and do” repertoires required to complete more complex operations such as math algorithms. However, once the child can demonstrate verbally governed behavior for non-math algorithms, they may be ready to complete more complex algorithms that consist of written steps to solve math problems. Current research in the field of behavior analysis includes procedures used to target the technical writing of math algorithms by 2nd, 3rd and 4th grade students (Broto & Greer, 2014; Pellegren, 2015; Weber, 2016). These studies demonstrated that students in the previously mentioned grade levels could learn to write algorithms that other peers could follow in order to complete algorithms. Future research should test for the presence of verbally governed behavior (i.e., “read and do”) to print stimuli for solving math algorithms. Moreover, the research should include younger participants who can fluently textually respond to words and have mastered prerequisite skills needed to learn math algorithms.

Future research should also determine if technical reading comprehension repertoires develop independently from aesthetic reading comprehension repertoires. Greer and Ross (2008) describe aesthetic reading as reading in which the function of reading is to affect the emotions of the reader (i.e., reading that results in feelings of sadness, happiness, or in laughter). In the current study, the DRA2 reading assessment scores for fiction text were reported for each participant. (Non-fiction reading assessments are administered at DRA level 16 and above only.) All kindergarten participants across both Experiments 1 and 2 had reading comprehension scores that placed them at the first grade level in the area of oral reading fluency and comprehension. Although the kindergarten-aged participants performed above grade level on the DRA2 assessment, they did not emit a high number of reading comprehension responses for the technical reading tasks measured in the current study. Also, the DRA2 assessments do not
directly measure the emotional effects of reading fiction text. Additional research is needed to
determine if technical reading and aesthetic reading comprehension repertoires develop
independently.

In the current study the participants included several students who were identified 1) as
students who speak English as a second language (Participant 3 – Experiment 1, Participant 1, 4
– Experiment 2), 2) as having a diagnosis of Autism (Participant 1,3 – Experiment 1, Participant
2 – Experiment 2) and, 3) as qualifying for free/reduced lunch (all participants in Experiment 1,
Participants 1 and 3 – Experiment 2). There was no observable trend in the correct and incorrect
responding across the participants in either experiment. However, the total number of
participants in each experiment may have not been significant enough to determine if their were
trends across responding across the participants with Autism, free/reduced lunch status, or those
participants who spoke English as a second language. Future research should investigate the
differences in “read and do” reading responses across these characterisitics.

**Educational Significance**

Statistical evidence indicates that by fourth grade, most children have demonstrated that
they do not have proficient reading comprehension skills or the skills needed to demonstrate
proficiency on math or science assessments (NAEP, 2015). Technical reading has been identified
as a factor that affects performance on math and science assessments (Piia, Vilenius-Tuohimaa,
Kaisa & Jari-Erik, 2008). In the current, study I demonstrated that young children who could
fluently textually respond to words could also demonstrate technical reading repertoires. The
technical reading responses measured in the current study did not consist of math algorithms.
However, these technical reading comprehension skills could be identified outside of the field of
behavior analysis as early technical reading comprehension. There is a need for instruction in
technical reading to begin at an earlier age. This instruction should also focus on teaching the function of reading. The results in this study indicate that young children can learn the function of reading. As a result, their behavior can come under the control of print. This will result in acquisition of verbally governed behavior in which the learning of new repertoires (i.e., acquisition of new stimulus controls) can occur as a function of one’s own reading.

The educational significance in the current study extends to the teaching of young children to fluently textually respond to print. Greer and Ross (2008) identify fluent textual responses as a prerequisite to the acquisition of cusps and capabilities that result in comprehension. Across Experiments 1 and 2, participant selection criteria in the current study included textual responses to words at a rate of 80 words per minute, with 0 incorrect words per minute. All participant in this study textually responded to words at a minimum of 80 words per minute, with some participants emitting accurate textual responses at a rate or 90-100 words per minute, with 0 incorrect words per minute. If fluent textual responses can be learned at a young age (i.e., kindergarten grade level), instruction to teach the function of reading should also begin at this level. Poor performance on reading comprehension and math and science assessments at the 4th grade level in the United States might be the result of a lack of instruction in the earlier grade levels in the areas of both comprehension and fluent textual responding repertoires.

The questions of whether or the current study could be replicated by a traditional teacher (who does not utilize the principals of applied behavior analysis) is an important one. The author of the current study proposes that the reader immersion procedure could be replicated successfully in a traditional classroom. The procedure could be incorporated into reading comprehension instruction because 1) it requires a minimal amount of instructional materials 2)
each intervention session lasts a duration of two to five minutes and 3) teacher presence is not required for students to complete every step of the algorithm.

The significance of the study herein may also have implications for the field of verbal behavior. Verbal developmental theorists have described the verbal behavior trajectory of humans as one that occurs in stages (Greer & Ross, 2008; Keohane and Greer, 2006). Verbal behavior repertoires cannot be acquired without mastery of preceding cusps and capabilities. For example, pre-listener behavior is a prerequisite to listener behavior. Listener behavior is a prerequisite to speaker behavior. Reader behavior is a prerequisite to writer behavior. To date, there have been several studies in which listener behavior, speaker behavior, and writer behavior were induced. There is a corresponding immersion protocol for each of these stages of verbal behavior development (Broto & Greer, 2014; Fas, 2015; Greer, Chavez-Brown, Nirgudkar, Stolfi & Rivera-Valdes, 2005; Helou, Lai & Sterkin, 2007; Madho, 1997; Reilly-Lawson & Greer, 2006; Pellegrin, 2015; Pistoljevic, Cahill & Casarini, 2011; Ross, Nuzzolo, Stolfi, & Natarelli, 2011; Greer and Ross, 2008). The results of this study indicate that the reader immersion procedure used in the current study could be identified as a protocol to induce or increase verbally governed responses to print, when they have been identified as absent.

Conclusion

The purpose of the current study was to test the effects of a reader immersion procedure on the technical reading comprehension responses of kindergarten and first grade students. Across both Experiments 1 and Experiment 2, the results demonstrated that motivation could be used to increase technical reading responses for multi-step algorithms. Additionally, the participants learned the function of reading, which may have resulted in the increase of correct responses to novel algorithms. In the absence of prosthetics reinforcement, the reinforcement for
correct responding occurred as a result of teaching the function of reading. This could be a prerequisite to learning technical reading repertoires in which the reader needs to read in order to solve math algorithms, a critical repertoire for success in the STEM fields of study.

Instructional practices should include the teaching of the function of technical reading and assessments that demonstrate whether or not students’ behavior can be verbally governed by print.
References


APPENDIX

Appendix 1

3-Dimensional Items and Objects Used During the Pre-intervention and Post-intervention Sessions for the 10-Step and 20-Step Read and Build Probe Sessions
Appendix 2

Lego Mat and Box of 3-Dimensional Materials that were Provided to the Participants during the 10-Step and 20-Step Read and Build Pre and Post Intervention Sessions
Appendix 3

Participant Exemplar of Completed 10-step Read and Build Task
Appendix 4

Participant Exemplar of Completed 10-Step Read and Build Task
Appendix 5

**Correction Procedure for Reader Immersion Intervention Across Experiment 1 and Experiment 2**

1. Following an incorrect response emitted by participant, point to the first word of the sentence that corresponds to the step completed incorrectly. This will indicate to the participant that this is the step they completed incorrectly. Participant should reread the sentence and subsequently perform the corresponding action. If the participant correctly completes the action, end the reader immersion session. Tell the participant that they will have another chance to try again. If the participant does not correctly complete the action, move onto the second step in the correction procedure.

2. Using a separate piece of paper, write down additional instructional instructions that the participant will need to complete the correction procedure. The additional written instructions can include prompts to reread the sentence and complete the step (i.e., “You need to read it again. After you read it, you have to do what the sentence says”). You can also tell the participant which part of the step they completed incorrectly (i.e., “You picked up a red pom pom instead of a blue pom pom”). After you have written the instruction, the participant should independently complete the step. After they have completed the correction, end the reader immersion session. Tell the participant that they will have another chance to try again. If the participant does not correctly complete the action, move onto the third step in the correction procedure.

3. This correction procedure should only be used if previous correction procedures (i.e., Step 1, Step 2) have not resulted in the correct completion of the step that was completed incorrectly during the intervention session. Additionally, frequent use of this correction procedure may indicate that the participant is missing prerequisites required for successful acquisition of “read and do” behavior. During this correction procedure, point to the first word of the sentence that corresponds to the direction that was read incorrectly. After moving your finger across the sentence (while making sure the participant is observing the sentence), provide a model in which you read the sentence and complete the corresponding step. After you complete the model, prompt the participant to read the sentence. Immediately after reading the sentence, point to the object or location that the participant should pick up or walk to. The participant should not have an opportunity to select the incorrect item or walk to the incorrect location (i.e., there should be zero second latency period between the reading of the direction and the completion of the corresponding step). After the participant has completed the correction procedure, end the reader immersion session.