The Effects of a Curriculum Sequence on the Emergence of
Reading Comprehension Involving Derived Relations in First Grade Students

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ABSTRACT

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I conducted 2 experiments to analyze the effects of a reading curriculum, *Corrective Reading*, which has a sequence that trains derived relations, on the emission of (a) derived relations defined as combinatorial entailment in Relational Frame Theory and (b) metaphors with first grade students. In Experiment 1, I compared the curriculum, which has the sequence to train derived relations to a well-known reading curriculum, *RAZ Kids*. *RAZ Kids* served as the content control. I used an experimental group design with a simultaneous treatment and a crossover feature. I selected 14 participants, who were matched then randomly assigned into 2 groups of 7. Both groups received matched instructional trials either in *Corrective Reading* or *RAZ Kids* condition, and each group was post-tested. Upon completion of the Post intervention 1 probes, each group was placed in an alternative condition, where Group 1 received the content control intervention, and Group 2 received instruction from the curriculum that has the sequence to train derived relations. Both groups increased in number of correct responses following the *Corrective Reading* intervention. Two kinds of analyses were done, small group and individual. In Experiment 2, I replicated Experiment 1 using a delayed multiple probe design across 2 first-grade dyads without a content control curriculum. I tested the effects of 5 lessons of the curriculum that has the sequence to train derived relations on the same dependent measures with an addition of implicit/explicit reading comprehension probes. The results showed that the curriculum sequence found within *Corrective Reading* was
effective in increasing the number of correct derived relation responses, while also improving reading comprehension responses.
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~Accomplishments do not mark the end of something great, but rather the beginning of something extraordinary!
DEDICATION

I dedicate this work to my husband, Jeffrey and to my parents, Daniel and Marie. I am grateful for the consistent love and support you have shown me.
We comprehend when our behavior shows the appropriate change intended by the writer or speaker, or when we can respond to specific contingences in our verbal environment successfully (Skinner, 1957, p. 277). In this paper, I tested the possibility that implicit reading and listening comprehension (e.g., deductions) is a type of derived relational responding and I argue that derived relations is a core component of what is required to comprehend (Barnes-Holmes, Barnes-Holmes, Smeets, Cullinan, and Leader, 2004). Briefly, derived relations refer to responses that are based on the appropriate relational context between stimuli, which are included in the instructional history of a learner (Hayes, Barnes-Holmes, & Roche, 2001). Recent research and curricular analyses suggest that this relational responding can be directly taught while traditional approaches to reading instruction may not teach this directly (Engelmann, Haddox, Hanner, & Osborn, 1999; Hayes, Barnes-Holmes, & Roche, 2001; Greer & Ross, 2008; Greer & Speckman, 2009; Howarth, Dudek, & Greer, 2015). Findings from Relational Frame Theory, Naming, Verbal Behavior Development Theory (VBDT) research, and Stimulus Equivalence research contribute to the notion that advanced comprehension is a type of relational responding.

Language and Comprehension from a Behavioral Selection Perspective

Early Views of Language

Early views of language were shaped by modernist philosophers, such as, Descartes, Newton, and Boyle (Heisenberg, 1972). Modernist philosophers placed emphasis on the structure and parts of words, rather than the practical and functional use
of words in relation to contexts and consequences (Heisenberg, 1972). The modernist philosophers held mechanistic values, and sought a universal ideal or perfect language (i.e., each word having one true meaning). Skinner, the originator and founder of the experimental analysis of behavior, originally held modernist views on language, due to the fact that the modernist outlook shaped his early theories pertaining to language (Moxely, 2001). Subsequently, postmodernist philosophers, such as, James (William) and Pierce (Charles) influenced Skinner’s later views on language (Moxely, 2001). These postmodernist philosophers endorsed the ideas of probability, context, and consequences pertaining to language.

Skinner (1957) stated in *Verbal Behavior* that his analysis of language shifted from its original commitment to instances, form and structure, to a more functional analysis involving the role of the verbal community. He advocated that language could not be viewed apart from its audiences, or apart from the communities, which establish the reinforcing contingencies of the language (Skinner, 1957). Listeners, who hold different relations to a speaker, differentially reinforce specific topographies of verbal responses (Skinner, 1957). The human language of an individual becomes more complex and effective when new forms of responses develop and new controlling relations advance (Skinner, 1957). Skinner elaborated on the function of various forms of verbal behavior, which organisms emit under different relevant conditions, such as, mands, tacts, and intraverbals, concluding that language is more than just mechanistic structures and forms (Skinner, 1986).
Skinner’s View of Comprehension

O’Donohue and Ferguson (2001) stated that Skinner used the term, *understanding* to describe language *comprehension* (Skinner, 1957). In this paper, I will be using the terms understanding and comprehension interchangeably. Skinner proposed two definitions of comprehension, a simple definition and a more complex definition of comprehension (O’Donohue & Ferguson, 2001). According to Skinner, comprehension in its simplest definition takes place when a speaker emits a verbal message and the listener repeats what was said (Skinner, 1957). For example, if a listener is told to “Get two dollars from the gray jar” and can vocally repeat the direction precisely, “get two dollars from the gray jar,” he is believed to have understood the speaker’s message to the simplest degree. Reproducing the speaker’s message simply confirms that you have “heard” the message (Skinner, 1957, p. 277). Moreover, according to Skinner, comprehension in a more complex form takes place when a listener’s behavior shows the appropriate change that the speaker intended (Skinner, 1957, p. 277). If, for example, a listener is told to collect two dollars from the gray jar, and responds by getting two dollars from the gray jar, then he is believed to have understood the message due to the fact that the listener’s behavior demonstrated the appropriate change to the corresponding antecedent. The vocal verbal stimuli exerted control of the listener’s behavior. A listener can also demonstrate understanding by emitting a conditioned emotional verbal response, which infers that the listener comprehended the message (Skinner, 1957). For example, if a college football player is given feedback from his coach about his errors during a game and blushes in response to the feedback, he is believed to have understood the message. Conditioned emotional responses are less direct and observable compared to behavioral
responses that have an immediate effect on the environment, so for emotional responses the speaker would have to infer whether the listener comprehended his message or not. Comprehension takes place when a listener’s response is appropriate to the correlating antecedent event.

Skinner (1957) stated that understanding describes the strength of a verbal response in a listener and the sources of that strength. A vocal verbal or textual message to a listener is comprehended only when the message strengthens the behaviors which were already available to the listener. When an individual confirms that he comprehends the message of a writer, he is simply stating that he has identified the variable which was successful in causing him to emit the same response as the writer intended. However, compared to the writer, the reader emits the response under different circumstances (Skinner, 1957). Responses are a part of our verbal repertoire, when the responses are of significant strength. A verbal response has strength when the response is conditioned in the presence of a specific stimulus and other stimuli, which share the same properties as the original stimulus. For example, a listener who laughs in the presence of an ironic statement demonstrates that there was strength in the correct meaning of the statement (i.e., original stimulus). Comprehension can be stimulated when the speaker or writer alters the strength of the listener or reader’s behavior (Skinner, 1957). The strength of a verbal response plays a significant role in the process of generalization. In the process of generalization, a verbal response becomes conditioned in the presence of a particular stimulus and shows some strength in the occurrence of another stimulus that displays some of the properties of the first stimulus (Skinner, 1957). On the contrary, if a verbal response is not conditioned in the presence of a particular stimulus, it may not show
strength in the presence of another stimulus showing similar properties of the first
stimulus. For example, a listener may not understand the oxymoron found in the
statement “authentic replica” if the original meanings for both terms are not of significant
strength.

Skinner identified several techniques, which can alter the strength of a reader’s
verbal repertoire (Skinner, 1957). One technique consists of letting the reader make a key
response to a message, on his own, without any assistance (Skinner, 1957). An example
of this would be a rhetorical question; the effect of a rhetorical question would be lost if
the writer provided the answer. Therefore, the writer lets the reader make a key response
to the question independently, which in turn strengthens the reader’s verbal repertoire.
Another example would be a “surprise ending.” A “surprise ending” strengthens the
reader’s response because the writer provides an ending that is contrary to what the
reader may have expected, which in turn strengthens the reader’s response. Skinner
(1957) identified another strengthening technique that consists of the writer’s emission of
a message that is extremely weak (i.e., message is contrary to evidence), which in turn
causes the reader to emit a stronger form of the message (e.g., denies the accuracy of
message and corrects it). An example of this can be found in irony, sarcasm or oxymoron.
A reader is able to comprehend a writer’s irony when the correct form of the message,
which exists in the listener’s repertoire, is of substantial strength, further resulting in the
reader responding successfully (Skinner, 1957).

Comprehension can take place in the presence of spoken/signed verbal stimuli or
in the presence of textual verbal stimuli. Skinner (1957) stated that language
comprehension could occur in response to non-vocal and intraverbal stimuli. When an
individual is under the control of text, he is considered a reader (Skinner, 1957).

Therefore, when a reader is under the control of text stimuli, he emits a verbal operant identified as textually responding (Greer & Ross, 2008). When an individual has textually responded to hand-written or printed text, this listener’s verbal behavior is solely under the control of the text stimuli; however, the patterns of response to the text exist in auditory form (Skinner, 1957). The reader’s behavioral response to printed stimuli demonstrates whether comprehension has taken place, or not. Listening is a critical part of the reading process (Greer & Ross, 2008; Greer & Speckman, 2009). When a reader is textually responding to print stimuli, he is listening to his own textual responses. For example, when a child who has recently learned to decode phonemes comes in contact with the letters C-A-T, the child will textually respond to the letters while also hearing himself say the word. Verbal developmental theory identifies the reader as his own listener as a level of verbal behavior (Greer & Keohane, 2006; Greer & Ross, 2008; Greer & Speckman, 2009). The reader-as-own-listener demonstrates comprehension when his senses are extended or when he responds accurately to instructions (Greer & Speckman, 2009).

As mentioned previously, for a listener or reader to comprehend verbal stimuli, the verbal stimuli must clarify and strengthen the listener or reader’s behaviors, and these behaviors must already be available in the listener’s repertoire (Skinner, 1957). In other words, if a teacher gives an assignment to her students that requires the students to read a short story and respond to questions about the setting and characters, the teacher has to assume that, 1) the student can textually respond to printed, verbal stimuli, and 2) the necessary prerequisites for the new responses targeted in the assignment were identified.
in all the students’ repertoires and therefore will clarify and guide the student’s behavior. In either case, comprehension can take place under the control of either vocal verbal or printed verbal stimuli. This paper will target comprehension from both hearing (i.e., listening to a story being read) and reading (i.e., reader as own listener).

**Abstraction**

Learners that demonstrate successful comprehension somewhere in their instructional history, acquired relational repertoires such as the ones targeted in this study. These repertoires develop via a verbal process identified as abstraction. Skinner (1957) used the term abstraction to explain the process of extension pertaining to language. Abstraction takes place when a verbal response is reinforced in the presence of any property of a specific stimulus. For example, abstraction takes place when parents reinforce toddlers for saying “bubbles” in the presence of stimuli that share the same properties as bubbles. In turn, the stimulus acquires, some degree of control over the verbal response (Skinner, 1957). The control that the stimulus holds continues to be exercised when the property appears in other combinations (Skinner, 1957). Abstraction is necessary in order to experience successful comprehension, because without it, every stimulus that a reader or listener encounters would share properties with many other stimuli and therefore, would control a countless variety of responses (Skinner, 1957).

If abstraction (i.e., essential stimulus control) according to Engelmann and Carnine (1982) is not present in an individual’s repertoire, the verbal community or teacher addresses this problem by sharpening stimulus control (Skinner, 1957). Multiple Exemplar Instruction (MEI) is a procedure used to teach essential stimulus control and to bring responses that were once independent under joint stimulus control (Greer & Ross,
Moreover, there are two types of MEI (Greer & Ross, 2008). There is MEI that pertains to teaching abstraction and this takes an essential core stimulus and rotates that stimulus across irrelevant dimensions while holding the core aspect of the stimulus constant, which in turn allows for abstraction to emerge. Another form of MEI brings responses, which were independent of each other, under joint stimulus control (Greer & Ross, 2008). This form of MEI involves a rotation of different verbal response forms or topographies (e.g., selection, production) to a single stimulus, which in turn allows a student to develop the capability identified as transformation of stimulus function across verbal responses or topographies. This capability allows a stimulus to jointly control multiple responses despite the fact that a learner may only be taught in one response form (Greer & Ross, 2008). Several studies in verbal behavior analysis have demonstrated that MEI was effective in training essential stimulus control and bringing responses under joint stimulus control (Fiorile & Greer, 2007; Gilic & Greer, 2011; Greer & Ross, 2008; Greer, Stolfi, & Pistoljevic, 2007; Greer, Yuan & Gautreaux, 2005; Helou-Care, 2008; Lo, 2016).

The joining of the speaker and listener repertoires is one of the developmental capabilities identified as Naming and is a type of emergent behavior that involves derived relations (Greer & Speckman, 2009). MEI is an intervention used to induce Naming. In practice, during MEI a learner receives instructional trials, which involves rotating across listener and speaker responses, corrections for incorrect responses, and reinforcement for correct responses (Greer & Speckman, 2009). The instructor presents the child with visual match-to-sample instructional presentations using picture stimuli or 3D objects. During the match to sample component of MEI, the instructor lays out a field of three
stimuli (i.e., one correct stimulus and two non-exemplars) and the target stimulus is presented by the instructor while the instructor vocally says, “match ____ with _____.

The child then must attend to the visual and auditory properties of the stimulus while matching the presented stimulus with the appropriate sample. Next, the instructor presents the child with point-to instructional presentations in which the child is required to hear the teacher say the name of the stimulus then point to the correct picture in a field of three pictures (i.e., two non-exemplars and one correct stimulus). These two listener experiences train joint stimulus control across the visual and auditory dimensions of the stimuli. Also, the instructor presents opportunities for speaker responses by having the child say the name of each stimulus, when presented with a vocal antecedent or when just presented with the picture of the stimulus. The instructor continues to run the instructional presentations until the child demonstrates mastery across listener and speaker responses in all topographies (Greer & Speckman, 2009). The goal is for two or more responses (listener and speaker) to come under the control of a single stimulus. For example, a child who acquires the name for apple as a listener and a speaker while looking through a book, later receives phonemic instruction, then learns how to textually respond to the word apple, which in theory is the same stimulus though presented differently symbolically and another relation emerges.

Skinner (1957) stated that the verbal community sharpens stimulus control by reinforcing responses in the presence of a preferred stimulus property and by punishing responses evoked by unspecified properties. To enumerate this point, suppose a community reinforces the verbal response stop in the presence of a big purple octagon. It is likely that the community would not reinforce the verbal response stop in the presence
of any random purple stimulus or any non-purple octagon shaped stimulus (Skinner, 1957). Furthermore, it is possible that the verbal community would perhaps punish or ignore the response stop, if evoked in the presence of any one of the color, shape, and size properties of the stimulus occurring in other combinations. Moreover, if a community reinforces shapes named octagon in the presence of octagons of different sizes and color properties, then the chosen stimulus property, octagon regardless of size and color, will then acquire the name octagon. This is due to the fact that the response was reinforced by the learner’s verbal community across different dimensions. A verbal response is considered weak when it is not conditioned by the verbal community in the presence of a stimulus and its relevant properties. In the event that an individual is able to respond to the reinforcing and punishing contingencies of his respective verbal community, it paves the way for understanding, or comprehension, to emerge. Quine (1960) stated that language is an abstraction. All things considered, it is possible that an individual who demonstrates difficulty with language comprehension may have some problems with stimulus experience that leads to verbal abstraction.

**Verbal Behavior Developmental Theory**

Verbal behavior developmental theory (VBDT) is an extension Skinner’s verbal behavior theory (Greer & Keohane, 2006; Greer & Ross, 2008). VBDT argues that in order for a learner to become truly verbal; he must function as a listener to his own verbal behavior, that is the speaker-as-own listener capability (Greer & Keohane, 2006; Greer & Ross, 2008; Greer & Speckman, 2009). VBDT provides educators and researchers alike with empirically based interventions and protocols to identify and develop missing functional verbal repertoires in learners (Greer & Ross, 2008; Greer & Speckman, 2009;
Lodhi & Greer, 1989). Greer and Ross (2008) identified developmental cusps and cusps that are new learning capabilities, which provide a clear developmental trajectory of verbal repertoires. Some of the identified cusps and capabilities are conditioned reinforcement for voices, generalized imitation, listener literacy, echoic-to-mand, joining of listener and speaker within the skin (i.e., Naming), Observational Learning, self-talk, print transcription, dictation, textually responding governs responding, and joint stimulus control across saying and writing, to name a few.

Teachers and researchers should find it beneficial to apply instructional interventions such as these when verbal repertoires are missing in learners. As stated previously, these milestones are identified as verbal developmental cusps and cusps that are new learning capabilities (Greer & Ross, 2008). A capability refers to a developmental ability that allows a child to learn skills that he could not access before in a new way. A capability can be induced or acquired incidentally (Greer & Ross, 2008). A cusp changes the interactions between learners and their environment, which further allows the learners to contact new contingencies (Rosales-Ruiz & Baer, 1996, 1997; Greer & Ross, 2008). Verbal behavior is not confined to just vocal behavior, but encompasses various forms or topographies of language, such as sign language systems, gestures, body language, various acoustic vocal topographies, and clicks (Greer & Ross, 2008). For learners to be taught effectively the instruction must be adapted to the learners’ existing verbal repertoire (Greer & Du, 2015; Greer & Ross, 2008; Greer & Speckman, 2009).

Greer and Keohane (2006) addressed the process of verbal behavior development by identifying the functions of language and the types of effects language has on the
listener. VBDT pinpoints critical verbal milestones, which are necessary repertoires in order for an individual to become a successful member within their verbal community (Greer & Ross, 2008). Building on Skinner’s theory (1957), VBDT research identifies verbal cusps and capabilities that align with speaker and listener operants. VBDT not only examines the relations that exist between the speaker and the listener, but it also uses scientifically tested experiences that allow such behaviors to emerge when previously not present.

**Naming and Comprehension**

VBDT presents the theory that incidental learning of names is useful when one reads aloud for the first time (Greer & Ross, 2008). In Naming, when a child learns the name of a stimulus as a listener and derives the name from the listener to speaker function the child is demonstrating transformation of stimulus function. Correspondingly, when a child demonstrates symmetry (i.e., mutual entailment) and transitivity (i.e., combinatorial entailment) relations then he derived the transformation of stimulus function from one stimulus to another related stimulus, which evokes the same kind of stimulus control found in Naming. These relations will be discussed in further detail in the following sections. In education, when instructors are teaching children, we can observe transformation of stimulus function take place when the learners are engaged with a book and learn the name of a stimulus incidentally (e.g., elephant) as a listener and speaker, then learn to phonemically respond to consonants and vowels, which in turn leads to them textually responding to the word that they previously learned (e.g., elephant). Reading the word elephant can also stimulate an emotional response, whether
it is a fear of large animals or a happy emotion due to a previous positive experience with elephants at a zoo.

All in all, we see that learners build on one derived relation and continue to add relations due to experiences within their verbal community. One can determine if a learner comprehends by observing if the learner reliably demonstrates derived relations. Debatably, we could say that it is not necessarily the person who derives the relation; rather it is the person’s history of the relation with the stimuli that reliably derives the relation for the learner. We can determine successful comprehension by observing if a learner can acquire new relations as a listener or reader and demonstrate those relations as a speaker (i.e., if he has joint stimulus control or a bidirectional relationship between the speaker-listener capabilities). According to Greer and Ross (2008), when children hear the name of a stimulus within the environment as a listener, and can later emit the correct vocal response as a listener and a speaker for the same stimulus, without direct instruction, he are demonstrating a phenomenon identified as Naming, or incidental language acquisition (Greer & Ross, 2008). When an individual has Naming, learning a single stimulus (e.g., spoken word) results in multiple responses such as matching, pointing, producing a picture, and gesturing (Greer & Ross, 2008).

Naming is itself a derived relation and may facilitate the learning of other derived relations (Horne & Lowe, 1996; Barnes-Holmes, Barnes-Holmes & Cullinan, 2000; Miguel, Carr, & Michael, 2001). Reading involves the same process as Naming. Similar to reading, during the Naming process a learner must look at a visual stimulus while simultaneously saying the name of the stimulus. This process takes place in reading when a learner attends to print stimuli and textually responds (i.e., decodes) to the print stimuli.
Naming is a phenomenon that involves joint stimulus control, which is demonstrated when a child learns word-name-object relations as well as other responses like emotions. Naming is incidental language acquisition and a learner demonstrates this by emitting correct listener responses and correct speaker responses as a result of an unreinforced observing experience. These unreinforced observing responses result in untaught responses emerging without direct reinforcement or direct instruction (Greer & Ross, 2008). As a result of the initial observing experience, the stimuli acquire joint control over untaught speaker and listener responses. In addition, the presence of Naming in a learner’s repertoire allows the learner to learn from a model learn unit and acquire new operants at a faster rate without direct reinforcement (Greer, Corwin, & Buttigieg, 2011; Hranchuk, 2016).

Naming is a higher order operant (Barnes-Holmes, Barnes-Holmes & Cullinan, 2000; Catania, 2007; Greer & Longano, 2010; Greer & Speckman, 2009). According to Hayes (1989), a relational frame involves a certain relation being established between stimuli or a certain stimulus function being selected due to its established relation, which is governed by contextual cues. Horne and Lowe (1996) identified Naming as a fundamental behavioral unit within a higher order operant class, which involves the combining of listener and speaker repertoires within one’s own skin (Lodhi & Greer, 1989). The Naming capability can be present in the repertoire of young learners. Lodhi and Greer (1989) identified speaker as own listener with five-year-old learners. Greer and Ross (2008) stated that Naming is a critical stage in verbal development and increases the student’s learning capacity threefold. Naming is one of the milestones in verbal behavior analysis that allows an organism to develop basic speaker verbal operants and acquire
new operants incidentally (Greer & Ross, 2008). The VBDT research identified Naming as a verbal developmental cusp that is a capability, which not only brings an individual into contact with new stimuli but allows a student to learn at a faster rate, and learn in a new way (Greer & Longano, 2010; Fiorile & Greer, 2006; Gilic, & Greer, 2011; Hayes, Fox, Gifford, Wilson, & Barnes-Holmes, 2001; Speckman-Collins, Park, & Greer, 2007; Mariano-Lapidus, 2005; Meincke-Matthews, 2005). According to Horne and Lowe (1996) and Greer and Ross (2008), learners are not truly verbal until they have Naming because without it, the initially independent listener and speaker repertoires are not joined.

**VBDT and Naming**

Naming or incidental language acquisition is a relational frame (Barnes-Holmes, Barnes-Holmes, & Cullinan, 2000). When a learner has Naming in his repertoire it impacts his ability to acquire new relations while listening to or reading texts. Full Naming is a capability (Greer & Ross, 2008). A verbal capability allows learners to learn new, accessible repertoires (Greer & Ross, 2008). A capability is a developmental stage of a learner that can either be induced or acquired incidentally. When a learner acquires a verbal capability or a higher order operant this permits the learner to acquire new classes of operants, which he was previously incapable of acquiring. A behavioral developmental cusp is a new behavior that stimulates many other branches of behavior, which lead to further behavior change (Rosales-Ruiz & Baer, 1996, 1997). According to Rosales-Ruiz and Baer (1996,1997), a behavioral developmental cusp refers to a transformation that takes place in the organism’s environment-interaction, which in turn allows the developing learner to come in contact with new contingencies that provide consequences
beyond the change itself (e.g., learning to walk). When an organism acquires a behavioral cusp, exposure to the new contingencies helps develop other critical cusps through new interactions (Greer & Ross, 2008). It is important for educators to identify whether cusps or capabilities are missing in learners so that teachers can implement necessary interventions, which will set the learner on a path that leads to advanced verbal stages.

Naming is an important capability for students to have in order to learn new skills successfully. Horne, Lowe, & Randle (2004) conducted a study and determined that learners who only have the listener repertoire are not able to emit correct tact responses to taught listener responses (Horne, Lowe, & Randle, 2004). Numerous studies have successfully induced the Naming capability by implementing multiple exemplar instruction interventions (Gilic, 2005; Hayes, Fox, Gifford, Wilson, & Barnes-Holmes, 2001; Lee Park; 2005; Mariano-Lapidus, 2005; Matthews, 2005). Greer, Stolfi, Chavez-Brown, and Rivera-Valdez (2005) conducted the first research study on Naming as a developmental stage.

Gilic and Greer (2011) used a multiple probe design to investigate the bidirectional component of Naming and its effect on the acquisition of Naming in typically developing two-year-old participants. The dependent variable was the participants’ listener and speaker responses to target stimuli presented by the experimenter during the probe sessions. The listener responses involved matching and pointing, and the speaker responses targeted pure and impure tact behaviors. The experimenter examined possible sequences to teach Naming as generative behavior. Following multiple exemplar instruction Naming emerged for two of the participants when they were presented with novel stimuli. Two participants attained the
transformation of stimulus function from listener to speaker, which allowed them to respond accurately to a group of novel stimuli. The findings of this study demonstrated a functional relation between multiple exemplar instruction and the emergence of Naming.

Fiorile and Greer (2007) used a multiple probe design to examine the effects of multiple exemplar instruction (MEI) on the emergence of the Naming (i.e., speaker to listener and listener to speaker) repertoire. There were four participants who took part in this experiment and prior to this study the students did not have tacts or Naming in repertoire. The experimenter conducted tact training during the initial training condition; however, it did not induce Naming or echoic-to-tact repertoires. Subsequently, MEI was implemented and Naming emerged immediately following MEI. During the MEI condition, instruction was rotated across speaker and listener repertoires. The results of this study showed that Naming did not emerge from tact training alone because transformation of stimulus function did not take place; however, Naming did emerge for all four participants when the intervention, MEI, was implemented.

Greer, Chavez-Brown, and Rivera-Valdes (2005) used a multiple probe design across word sets and across participants to examine the effects of multiple exemplar instruction (MEI) on the transformation of stimulus function across listener and speaker responses. The dependent variable in this experiment was the numbers of correct responses to probe trials of untaught listener responses and probe trials of untaught speaker responses. The probes were conducted after the participants mastered the matching (i.e., listener) response to two sets of novel stimuli. This experiment consisted of three sets of novel stimuli (i.e., pictures). During the baseline condition, the experimenters presented instruction in matching responses for the first set of pictures.
The matching session was followed by probe sessions on untaught speaker and listener responses to the pictures in the first set (i.e., tact, impure tact and point-to responses). The probes consisted of verbal antecedents and non-verbal antecedents. Following the baseline condition, the experimenter implemented the multiple exemplar instruction intervention, which involved a rotation across four response topographies (i.e., match, point-to, tact and intraverbal) to all the stimuli in Set two. Following MEI, the participants were probed on the untaught responses for Set one. The results of this experiment demonstrated that untaught speaker responses emerged for all three participants. Moreover, these studies demonstrated that MEI was an effective intervention to induce the Naming capability.

More recent studies have expanded upon the Naming research and demonstrated that Naming is an important capability for learners to have in repertoire when they are acquiring new skills and when they are being taught in different ways if they are to be successful in general education (Cao, 2016; Greer, Corwin and Buttigieg, 2011; Hranchuk, 2016; Lo, 2016; Mosca, 2015). In school settings students are expected to learn from teacher instructional demonstrations, however to do so they must have Naming in repertoire. Greer, Corwin and Buttigieg (2011) conducted a study, which demonstrated that teacher instructional demonstration was a more effective instructional procedure for learners who had the Naming capability. Lo (2016) conducted studies, which demonstrated that repeated exposures to auditory and visual stimuli established stimulus control for spoken and non-spoken auditory stimuli with learners who had the listener component of Naming for visual stimuli. Hranchak (2016) found that learners with Naming learned at a faster rate in an instructional condition that involved an
instructional demonstration and that the learners in the instructional demonstration condition required fewer learn units to master new skills compared to the learners with Naming in the standard learn unit instruction condition. Cao (2016) demonstrated that an echoic training intervention was effective in inducing the Naming capability in Chinese with contrived and non-contrived stimuli. Mosca’s (2015) examined if the presence of the Naming capability was language specific across bilingual and monolingual learners. Mosca’s (2015) study results showed that the bilingual learners demonstrated full Naming in English and their native language (i.e., Swedish) and that the listener component of Naming was present in both languages for the monolingual participants. Overall, it is clear that Naming is an essential capability for learners to have in order to learn most effectively. See Figures 1-3 for examples of relations based on Naming, Stimulus Equivalence, and RFT.
Figure 1. Transitivity (SE) and Combinatorial Entailment (RFT)
All cows give milk.

Kefir is a product of milk.

So, Kefir comes from _cows_.

*Figure 2. An example of a deduction learn unit during Corrective Reading.*
Figure 3. An example of the Naming experience in which the word in the center, cow is the spoken stimulus.
Stimulus Equivalence

The demonstration of the phenomenon of stimulus equivalence was suggested by Sidman to explain language comprehension and generative verbal behavior at a primitive level (Sidman, 1971). According to Sidman (1990), stimulus equivalence is a biological prearranged capability. His stimulus equivalence theory of language sought to explain how complex relations emerge in human language without being directly taught (Sidman, 1971). Prior to empirical identification of stimulus equivalence reaching mainstream research, one would have argued that all language was acquired due to the types of consequences that governed behavior; behavior was either punished or reinforced (Hayes, Barnes-Holmes, & Roche, 2001). Chomsky (1959) noted that most language is not acquired by direct instruction and he argued that this was a fatal flaw of Skinner’s (1957) theory. These basic principles of behavior provided an explanation for behavior that was acquired through direct contingencies. However, it did not explain how human organisms could acquire complex language, without coming in direct contact with reinforcement or punishment contingencies (Chomsky, 1959). Chomsky argued that Skinner (1957) focused on the causation of external, observable, verbal behavior but did not spend enough time discussing the functional complexity of language (Chomsky, 2006). Sidman’s identification of stimulus equivalence provides explanation for the functional complexity of language in terms of language acquisition without direct instruction.

According to Sidman (1971, 1994) stimulus equivalence refers to all the stimuli within a specific class that are viewed as interchangeable, although only some of the relations were taught or trained directly. Stimulus equivalence consists of three properties
and I will relate two of the three properties to comprehension. The first property is reflexivity (A=A), which refers to the ability to match a stimulus with another identical stimulus within its class (Sidman, 1971, 1994). Reflexivity can take place in reading comprehension when a learner matches the printed word *horse* with the printed word *horse* despite the fact that certain dimensions of the second version of the word *horse* may be different such as size, font, or boldness. The second property is symmetry. Symmetry is apparent when a new relation is formed, after an individual is taught to match one stimulus to a comparison stimulus (Sidman, 1971, 1994). Symmetry refers to conditional relations that are symmetrical. For example, if a learner selects B in the presence of A and also selects A in the presence of B, without direct training, then the learner is demonstrating what Sidman identified as the symmetry property of stimulus equivalence. Symmetry can take place during reading comprehension when a reader forms a new relation pertaining to a stimulus found in his text, for example the reader sees the picture *horse* and matches it to the word *horse* then reads the word *horse* and matches it to the picture *horse*. The last property of stimulus equivalence is transitivity. Transitivity is apparent when untaught relations emerge between two stimuli after being trained via match-to-sample (Sidman, 1971, 1994). After a learner is trained to match A with B and B with C, then experimenters can test for transitivity of the trained conditional relations, by probing to observe whether the learner will select A in the presence of C, without direct training. The typical procedure for a stimulus equivalence experiment involves training via operant learning conditions. Transitivity can take place during reading comprehension when a reader is taught two stimuli by matching to sample (e.g.,
Sidman (1971) proposed the term equivalence relations and related it to reading comprehension. He proposed that textually responding involved stimulus-response relations, which bring visual and print stimuli under joint stimulus control. According to Sidman (1971), learners must have stimulus equivalence in order to keep reading comprehension from becoming solely dependent on two-dimensional visual cues. The human capacity for stimulus equivalence underlies comprehension. Table 1 displays a comparison between Stimulus Equivalence, Relational Frame Theory, and reading comprehension.

Evidence pertaining to stimulus equivalence has demonstrated theoretical support of the phenomena. Sidman and Tailby (1982) investigated conditional discrimination versus match-to-sample and it resulted in an expansion of the testing paradigm, which refers to an increase in emergent relations. Sidman and Tailby (1982) enlarged each class by one member, which in turn, brought about an increase in emergent relations. In the Sidman and Tailby (1982) study, stimulus A1 and stimulus B1 became equivalent members of one stimulus class and stimulus A2 and stimulus B2 became equivalent members of another stimulus class. Upon teaching the participants six sample comparison relations, six new relations emerged, resulting in a four-member stimulus-class.

Sidman, Cresson, and Wilson-Morris (1974) taught two atypically developing participants match-to-sample and proposed that the use of match-to-sample instruction could relate to the acquisition of reading comprehension and vocal textual responding. According to Sidman, et al. (1974), the first level of reading comprehension involved
matching printed words to pictures. The second level of reading comprehension was identified as auditory comprehension, and involved matching pictures to dictated words. The third level of reading comprehension was identified as auditory receptive reading, which involved matching printed words to dictated words. Spradlin, Cotter, and Baxely (1973) established a conditional relation without direct training.

As mentioned previously, Sidman (1971) argued that learners must have stimulus equivalence in order to keep reading comprehension from becoming solely dependent on 2 dimensional visual cues. In addition, Sidman and Cresson (1973) used a match-to-sample procedure to establish conditional discriminations. Furthermore, a learner must have auditory-visual stimulus equivalence or reading receptive equivalence to demonstrate true comprehension (Sidman, 1971). Sidman (2000) proposed that equivalence relations emerge from direct contact with reinforcement contingencies. Therefore, the use of differential responses and reinforcers should cause the emergence of derived conditional discriminations.

**Relational Frame Theory**

Relational Frame Theory (RFT) was built on Sidman’s stimulus equivalence and verbal behavior. Researchers supporting RFT proposed that derived relations are generalized operants and that a relational frame refers to relations inside frames that are acquired by individuals (Hayes, Barnes-Holmes, & Roche, 2001; Healy, Barnes-Holmes, & Smeets, 2000). Hayes (1986) and Hayes and Hayes (1989) argued that equivalence is just one of a larger number of different types of relations. These relations are based on an individual’s reinforcement history with arbitrary and non-arbitrary relations and how the relations combine to affect stimulus functions. Hayes, Barnes-Holmes, and Roche (2001)
proposed that people put events in relations and respond to these events based on previous relations. Unlike stimulus equivalence, which initially only addressed symbolic relations, RFT targeted verbal behavior or sound combination words that functioned as cues for the speaker.

Similar to Sidman’s (1994) stimulus equivalence, RFT consists of three properties to explain language acquisition: mutual entailment, combinatorial entailment, and transformation of stimulus functions (Hayes, Barnes-Holmes, and Roche, 2001). Mutual entailment refers to the bidirectional relationship between two stimuli (e.g., chair = silla, then silla = chair) therefore, responding to a relation in one direction occasions responding to the relation in the opposite direction. The second property is combinatorial entailment and this refers to a network of relations or a combination of two or more stimulus relations. Combinatorial entailment differs from mutual entailment because it requires at least three related stimuli or events and mutual entailment requires only two. The final property is transformation of stimulus functions and this refers to the function of a stimulus changing based on how it relates to other stimuli. Similar to verbal behavior developmental theory’s Naming, RFT argues that relations are formed when a learner acquires a name for an object while observing the visual properties of that item (Horne & Lowe, 1996; Greer, Stolfi, Chavez-Brown, & Rivera-Valdez, 2005; Greer, Stolfi, & Pistoljevic, 2007; Greer & Speckman, 2009). VBDT (Greer & Ross, 2008) and RFT are both behavior analytic approaches to human language and cognition (Gross & Fox, 2009).
RFT and Reading Comprehension

The experience of hearing the name of a specific stimulus while simultaneously observing the visual stimulus takes place every day in a typical child’s natural environment, especially during early book engagement experiences. For example, when a teacher says, “globe” while pointing to a globe in the class textbook, certain students within the class would then acquire the tact for globe while attending to the visual stimulus. Experiments have expanded upon the fact that specific experiences can impact a learner’s performance pertaining to relational responding. Barnes, Hegarty, and Smeets (1997) analyzed complex human functioning from a relational framing perspective by using a delayed match-to-sample procedure to examine relations between equivalence and non-equivalence relations in adults and children and found that contextual cues (e.g., either similar letters or numbers) functioned as a prompt for the participants further allowing them to accurately match the pairs of the same with same and different with different. Stewart, Barnes-Holmes, Roche, & Smeets (2001) conducted an empirical study that extended the RFT approach to language and cognition. Stewart et al. (2001) used a delayed matching-to-sample procedure, which involved selecting a specific nonsense syllable in the presence of four blue and four red geometric shapes. The results showed that after receiving the delayed matching-to-sample procedure all nine participants demonstrated equivalence formation based on the abstraction of color. Certain experiences can build a learner’s relational repertoire and help them become more successful learners.

From an RFT perspective (Barnes-Holmes, D., Barnes-Holmes, Smeets, Cullinan, & Leader, 2004) and based on VBDT research (Greer & Ross, 2008; Greer & Speckman,
2009), reading comprehension involves experientially acquired derived stimulus relations. Therefore, comprehension is relational responding and is implicitly learned through certain types of experiences (Barnes-Homes et al., 2004). It is instructional histories that allow a learner to respond to arbitrary relations between or among stimuli. If students are to be successful in reading comprehension, we must determine whether students have an instructional history of deriving relations. See Table 1 for a visual comparison between RFT, Stimulus Equivalence, and reading comprehension.

Many people assume that one can simply teach reading comprehension using well-known reading strategies such as question-answer relationships, which involves student examining how questions are written in order to improve their reading comprehension responses (Raphael, 1986), reciprocal teaching (Palincsar & Brown, 1984), or collaborative strategic reading, which involves students working cooperatively by discussing reading questions together (Klingner & Vaughn, 1998) and in turn reading comprehension should emerge (Armbruster, Lehr, & Osborn, 2003). However, this study sought to determine that learners who respond accurately to implicit reading comprehension do so because they learned from specific types of experiences involving derived relations.

**Relation Between RFT and Corrective Reading**

Advanced reading comprehension, such as inferences and deductions involve relational responding. For many years the sequence found within *Corrective Reading* (Engelmann, Haddox, Hanner, & Osborn, 1999), a remedial reading curriculum, has been training derived relations by providing multiple exemplar instruction procedures. *Corrective Reading* has a sequence that trains derived stimulus relations across multiple
exemplars within one mode of responding and these sequences allow the process of relating to become abstracted in the appropriate context (Barnes-Holmes, 2004). Experimental tests of whether or not this is the case have not been done yet, however the results from this current study show that the sequence of the curriculum provides multiple exemplar experiences for derived stimulus relations (Becker, Engelmann, & Thomas, 1971; Engelmann, Carnine, & Johnson, 1999).

The sequence found within Corrective Reading curriculum trains derived relations by providing instruction that teaches explicit comprehension skills, (i.e., mutual entailment) and implicit comprehension skills (i.e., combinatorial entailment). Explicit reading comprehension is mutual entailment because it assess for the bidirectional relationship between two stimuli (e.g., between word and picture, between word and word) explicitly stated in a text. For example, when a reader sees the picture of a type of pot, cauldron and matches it to the word cauldron then reads the word cauldron and matches it to the picture cauldron then the reader is demonstrating explicit comprehension because he identified the bidirectional relationship between two stimuli (i.e., picture and word) presented in a text. Responding to the relation in one-direction (i.e., cauldron picture = cauldron word) occasioned responding to the relation in the opposite direction (i.e., cauldron word = cauldron picture). Furthermore, implicit reading comprehension is combinatorial entailment because it assesses for a network of relations, which is between at least three related stimuli or events. This involves the reader connecting their personal experience to what he is reading or making inferences based on textual clues given by the writer. For example, a reader is demonstrating implicit comprehension skills when the reader can form a new relation between two taught
relations from a text (e.g., surgical instruments = medieval era) after being taught two stimuli by match–to-sample (e.g., balista = surgical instrument and medieval era = balista).

Numerous reading assessments test for student performance with implicit and explicit comprehension skills, such as the Developmental Reading Assessment (Beaver, 1997), the Qualitative Reading Inventory (Leslie & Caldwell, 2010), Fountas and Pinnell (Fountas & Pinnell, 2010) and Dynamic Indicators of Basic Early Literacy Skills for retell comprehension (Good, 2003). See Figure 1 for a sample of the Developmental Reading Assessment (DRA) scoring rubric. In the column labeled Advanced of the DRA scoring rubric sample, the Advanced-response and Advanced-reflection sections are highlighted to show that these particular sections are assessing for implicit comprehension (i.e., combinatorial entailment).
**DRA Comprehension Rubrics**

**Fiction Comprehension**

<table>
<thead>
<tr>
<th>DRA Comprehension</th>
<th>Intervention</th>
<th>Instructional</th>
<th>Independent</th>
<th>Advanced</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>Retelling: Sequence of Events</strong></td>
<td>1 Includes only 1 or 2 events or details (limited retelling)</td>
<td>2 Includes at least 3 events, generally in random order (partial retelling)</td>
<td>3 Includes most of the important events from the beginning, middle, and end, generally in sequence</td>
<td>4 Includes all important events from the beginning, middle, and end in sequence</td>
</tr>
<tr>
<td><strong>Retelling: Details</strong></td>
<td>1 Includes few or no important details from text</td>
<td>2 Includes some important details from text</td>
<td>3 Includes many important details from text</td>
<td>4 Includes most important details and key language or vocabulary from text</td>
</tr>
<tr>
<td><strong>Retelling: Characters</strong></td>
<td>1 Refers to 1 or 2 characters or topics using pronouns (he, she, it, they)</td>
<td>2 Refers to 1 or 2 characters or topics by generic name or label (boy, girl, dog)</td>
<td>3 Refers to many characters or topics by name in text (Ben, Giant, Monkey, Otter)</td>
<td>4 Refers to all characters or topics by specific name (Old Ben Bailey, green turtle, Sammy Sosa)</td>
</tr>
<tr>
<td><strong>Response</strong></td>
<td>1 Responds with incorrect information</td>
<td>2 Responds with some misinterpretation</td>
<td>3 Responds with literal interpretation</td>
<td>4 Responds with interpretation that reflects higher-level thinking</td>
</tr>
<tr>
<td><strong>Reflection</strong></td>
<td>1 Provides limited or no response to teacher questions and prompts</td>
<td>2 Provides some response to teacher questions and prompts</td>
<td>3 Provides adequate response to teacher questions and prompts</td>
<td>4 Provides insightful response to teacher questions and prompts</td>
</tr>
<tr>
<td><strong>Retelling: Teacher Support</strong></td>
<td>1 Requires many questions or prompts</td>
<td>2 Requires 4 or 5 questions or prompts</td>
<td>3 Requires 2 or 3 questions or prompts</td>
<td>4 Requires 1 or no questions or prompts</td>
</tr>
</tbody>
</table>

**Figure 4.** An example of the scoring rubric page found in the Developmental Reading Assessment. The Advanced-response section and Advanced-reflection section is describing comprehension responses involving derived relations (i.e., combinatorial entailment).
RFT and Metaphors

Understanding metaphors will also help learners comprehend while textually responding to various aesthetic writings. According to Greer and Ross (2008), metaphors and derived relations are a type of extended tact and metaphors are found in aesthetic writing in which the writer writes to effect the emotions of the reader. RFT theorists interpreted and discussed the definition and function of metaphors (Stewart & Barnes-Holmes, 2001). RFT’s interpretation of metaphors is an extension of Skinner’s (1957) description of metaphors. Skinner (1957) interpreted metaphors as a type of extension that occurs because of the control exercised by specific dimensions of a stimulus. Metaphorical responses are a reflection of the speaker’s reinforcement history and the community to which the speaker is attached, in which certain metaphorical responses were previously conditioned under specific circumstances. Skinner (1957) provided an example of a metaphor stating, “Juliet is [like] the sun.” In this example, the listener notes that the sun and Juliet share similar properties. The listener identifies, which properties the two targets have in common based on the kind of situation in which the response was reinforced and emitted.

RFT states that a metaphor involves four different rudiments. According to Stewart and Barnes-Holmes (2001, p. 191) the four components are, “(a) establishing two separate equivalence relations, (b) deriving an equivalence relation between these relations, (c) discriminating a formal relation via this equivalence-equivalence relation, and (d) a transformation of function on the basis of the formal relation discriminated in the third element.” An example of a metaphor provided by Stewart and Barnes-Holmes (2001) is, “struggling with anxiety is [as] struggling in quicksand.” In this example, both
anxiety and quicksand involve a form of struggling (psychological or physical), however the listener contacts the fact that struggling in quicksand leads to drowning based on his previous reinforcement history and subsequently begins to relate that to anxiety. Therefore, the listener makes relations between the two different events and a transfer of function from one stimulus to the other occurs (Stewart & Barnes-Holmes, 2001). Readers who come in contact with metaphors must have the relational experiences that allow derived relations in order to comprehend. Understanding metaphors is a critical component to strengthening a learner’s reading comprehension skills.

Corrective Reading is a curriculum that has a sequence, which trains derived relations while providing the reinforcement history to derive relations. RFT argues that an individual learns relations inside frames based on their reinforcement history with non-arbitrary and arbitrary relations. The curriculum sequence found within Corrective Reading provides the reinforcement history for relational responding. Neither the RFT nor the Direct Instruction theorists claim or appear to be cognizant of this relation. An example of relations being taught in Corrective Reading can be found in Lesson 4, Exercise 8 of the “Thinking Basics” Comprehension A, teacher presentation book (Engelman, Haddox, Hanner, & Osborn, 1999). This exercise targets deductions and has the following interaction presented: “Listen to this rule. All snakes crawl. Rattlers are snakes. Listen, all snakes crawl, rattlers are snakes. So rattlers?” The teacher then pauses and provides a signal. The students then chorally respond to the signal with the word “crawl.” In this example one can see that “snakes crawl” was the first taught relation (A=B). “Rattlers are snakes” was the second taught relation (A=C). Lastly, “rattlers crawl” was the untaught derived relation (C=B). In the scripted component of exercise 8,
the instructor s required to reinforce and explain the relation by stating, “you know that rattlers crawl because all snakes crawl. How do you know that rattlers crawl?”

Table 1. A visual comparison between RFT, Stimulus Equivalence and reading comprehension.

<table>
<thead>
<tr>
<th>Stimulus Equivalence</th>
<th>Relational Frame Theory</th>
<th>Reading Comprehension</th>
<th>Assessment Examples</th>
</tr>
</thead>
<tbody>
<tr>
<td>A=B [\rightarrow] B=A</td>
<td>Symmetry</td>
<td>Mutual Entailment</td>
<td>Explicit: information directly stated in text.</td>
</tr>
<tr>
<td>A= B [\rightarrow] B=C</td>
<td>Transitivity</td>
<td>Combinatorial Entailment</td>
<td>Implicit: Information inferred from the text.</td>
</tr>
</tbody>
</table>

**Direct Instruction**

“Teaching is the process that follows the specifications provided by the curriculum” (Engelmann & Carnine, 1982). Direct instruction (DI) refers to a systematic form of instruction that builds skills and produces academic achievement for learners (Slocam, 2004). DI programs consist of three comprehensive components that can be translated into instructional practices. The first component of DI centers on the curriculum content and organization. DI curricula teach generalizable strategies (Engelmann & Carnine, 1982). The programs address the prerequisite skills first, then build upon those skills, further allowing all learner’s with the necessary prerequisite repertoires to access the program objectives (Slocam, 2004). DI programs organize the subject content and specify the procedures to teach the skills and concepts. Thus, the DI
curricula are organized in a systematic fashion further allowing the learners to abstract the skills and concepts learned.

The second component of Direction Instruction (DI) addresses the specific programs that systematically build the skills of learners (Slocam, 2004). DI programs are precisely organized lessons that introduce every academic skill within a sequential order while also decreasing the amount of support the student may need to perform or master the skill (Slocam, 2004). DI programs entail detailed teaching procedures and all instruction is clear, precise, and direct. The sequence of DI programs typically follows three guidelines. The first guideline is that all prerequisite skills are taught and practiced. The second guideline is to teach a strategy until it is mastered before introducing exceptions to the strategy. The third guideline is to separate irrelevant items that would increase the probability of the learner being confused. Engelmann and Bruner (1995) demonstrated this in *Reading Mastery I* by introducing the letter *d* in lesson 27 and later introducing the letter *b* in lesson 121. DI programs prepare learners to acquire and apply rules by teaching the concepts and terms to mastery before the rule is verbally presented (Slocam, 2004). Dixon and Engelmann (1999) demonstrate this in *Spelling Mastery Level C* by teaching the learners to identify morphographs, vowels, consonant-vowels, consonant patterns, and short words (less than five letters) before presenting a rule that includes those terms. An example of a rule from *Spelling Mastery Level C* is, “when a short word ends with a CVC [pattern] and the next morphograph begins with a vowel letter, you double the last consonant.” Due to the systematic building of skills, learners are prepared before rules are introduced. Students are taught to vocally re-state the rules until the student is able to reliably state the rule without any assistance. The students are
required to apply the rule when presented with a wide range of positive and negative examples.

The third component of DI expands upon the teacher and student interaction (Slocam, 2004). This component provides thorough details regarding the instructional exchange that should take place between a teacher and her student. Program designers of DI curricula use scripts to keep the teachers focused on simply presenting the material accurately and in an engaging manner (Slocam, 2004). The teachers are required to motivate the students by arranging contingencies so that reinforcement for academic and performance repertories are in place during instruction. Teachers are required to record data on student responses during instruction and make instructional decisions based on student progress. The teachers can analyze the data collected during instruction to determine whether the lesson pacing needs to change, groupings need to be adjusted, or lessons need to be repeated (Slocam, 2004). In order to most effectively use DI curricula teachers must understand and practice the following key points: students are attending, the required responses are in the students’ repertoires, definition of responses are clear, data collection is accurate, reinforcement is in place, and the corrections function to prompt correct responses (Slocam, 2004).

**DI and Corrective Reading**

*Corrective Reading* is a DI curriculum and the sequence of the curriculum trains derived relations, which in turn improves listening/reading comprehension skills (Engelmann, Haddox, Hanner, & Osborn, 1999). *Corrective Reading* provides over 30 lessons and within each lesson are multiple exercises targeting various skills relating to listening and reading comprehension. The curriculum provides exercises that provide
opportunities to acquire repertoires such as True/False, inferences, deductions and Some/All/None. The curriculum provides multiple exemplar experiences by rotating between listener and speaker responses and selection and production responses. One of the key features behind the sequence found within Corrective Reading is that it teaches strategies with support that gradually fades. It also provides a clear and explicit instructional sequence that systematically builds comprehension skills. The sequence within Corrective Reading also emphasizes practice and provides concise, unambiguous instructions to the teacher. Corrective Reading is effective for low socio-economic status (SES) readers and not necessary for on grade level learners.

Rationale and Educational Significance

I argue that advanced reading comprehension involves relational responding and can be taught directly. Relational responding is a necessary repertoire for advanced reading comprehension to take place, such as comprehension that involves deductions, inferences, and metaphors. I am investigating to determine whether the curriculum sequence found within Corrective Reading, which appears to train derived relations, can increase correct responding for metaphors and derived relations in first grade learners.

Can we instruct beginning, fluent readers to use advanced comprehension skills, such as derived relations, especially before reading comprehension becomes a problem later on? The purpose of Experiment I was to examine and compare the effects of Corrective Reading, a curriculum which appears to train derived relations, to a common reading curriculum, identified as RAZ Kids, to further determine if the curriculum sequence of Corrective Reading can train derived relations, as well as increase correct responses for metaphors. RAZ Kids differs from the curriculum sequence found in
Corrective Reading due to the fact that the RAZ Kids curriculum is a traditional curriculum that allows the learner to indirectly come in contact with explicit and implicit reading content. I tested the effects of the curriculum, which appears to train derived relations on the number of correct metaphors, derived relations from letters/numbers, and deductions, while using RAZ Kids as content control. I controlled the pedagogy by matching the numbers of instructional units presented in Corrective Reading to the number of learn units (Albers & Greer, 1991) presented in RAZ Kids under both intervention conditions.
Method

Participants

Fourteen participants from a first grade inclusion classroom participated in this study. Participant C6 had an Individualized Education Plan (IEP) with an Autism diagnosis at the onset of the study; the other participants were typically developing first grade students without IEPs. Participant C6 was included in this study due to the fact that he was above grade level for textually responding; however, he demonstrated difficulty with reading comprehension. There were a total of eight males and six females. All students were seven years of age at the start of the study. The classroom employed the Comprehensive Application of Behavior Analysis to Schooling (CABAS®) and Accelerated Independent Learner (A.I.L.) model of instruction. It was located in a Title I public elementary school. The classroom was comprised of 17 students in total. The classroom consisted of one lead teacher and two teaching assistants who were all trained to use the comprehensive application of behavior analysis methodologies. Some features of a CABAS®, A.I.L.® classroom include, but are not limited to: small group instruction, data-driven instruction, response boards, choral responding, math fluency, reading fluency, mastery of scripted common core objectives, and comportment graphs. See Table 1 for a detailed outline of the AIL® classroom procedures.

At the onset of the school year and at mid-year point, all participants were assessed using the *Verbal Behavior Developmental Assessment* (Greer & Ross, 2008) to determine existing verbal developmental capabilities (e.g., Naming & Observational Learning). All participants were also tested using school-wide assessments required by
the school district to determine existing educational repertoires (e.g., Math assessment, reading, and spelling assessment). The results of these assessments provided the experimenter with data and information pertaining to the participants’ instructional history and existing cups and capabilities (Greer & Ross, 2008). In addition to this, the results of the assessments helped determine instructional groupings and how the students should be taught objectives within their instructional group.

In AIL® classrooms there are two critical capabilities all students must have in order to learn new skills successfully and to learn new skills at a fast rate in a general education classroom. The two capabilities are full Naming (i.e., incidental language acquisition) and Observational Learning (Greer & Ross, 2008). The experimenter assessed these pre-determined CABAS® repertoires by using the standard Naming and Observational Learning (OL) probes (Greer & Ross, 2008). See Table 3 below for explanation of repertoires. At the onset of the study all but Participant C7 and Participant 3E, had full Naming. Participants C7 and E3 only had the listener half of Naming. All the participants had Observational Learning in repertoire. All participants functioned at Listener/Speaker and Reader/Writer levels of verbal behavior (see Table 3, for detailed demographics and participant information). The following prerequisites were required in order to be a participant in this study: read-do (i.e., for written instructions), DRA score of eight or higher (i.e., grade equivalent is the middle of first grade), Observational Learning, and conditioned reinforcement for observing books. The experimenter selected 14 participants due to the low numbers of correct responses emitted across all of the following dependent variables: derived relations from letters/numbers, deductions, and metaphors. The participants were typical 1st grade students and yet they did not
demonstrate derived relations (i.e., following direct training for relations \(A=B\) and \(C=B\), participants did not demonstrate combinatorial entailment, the untaught relation \(A=C\)). The participants’ emitted low numbers of correct responses during the derived relations probe conditions or did not emit any correct responses, which showed that derived relations and metaphors were not in repertoire. Also, this confirms the possibility that relational responding may not automatically emerge when early readers (i.e., 1st graders) become fluent readers.
Table 2

*Overview of the procedures and tactics presented in all AIL® classrooms*

<table>
<thead>
<tr>
<th>Performance</th>
<th>Teaching &amp; Learning</th>
<th>Staff Measures &amp; Public Posting</th>
</tr>
</thead>
<tbody>
<tr>
<td>Positive Rules</td>
<td>Math/Reading Fluency</td>
<td>TPRA Graphs (weekly)</td>
</tr>
<tr>
<td></td>
<td></td>
<td>Class-wide TPRAs cumulative (weekly)</td>
</tr>
<tr>
<td>Positive Reinforcement for Rule Following (4/pm)</td>
<td>Mastery of Objectives</td>
<td>Decision Graphs (weekly)</td>
</tr>
<tr>
<td>Point System</td>
<td>Learn Units and Presentation Types</td>
<td>Class Total and Correct</td>
</tr>
<tr>
<td>Back-up Reinforcers</td>
<td></td>
<td>Learn Units (daily)</td>
</tr>
<tr>
<td>Names on Desk</td>
<td>Permanent Product Folder per student</td>
<td>Cumulative Objectives (weekly)</td>
</tr>
<tr>
<td>Comportment Tactics &amp; Graphs (for significant social behaviors)</td>
<td>Choral Responding/Response Boards</td>
<td>CABAS® Ranks posted</td>
</tr>
<tr>
<td>Reinforcement for Academic Responding</td>
<td>Differentiated Instruction/Small Group</td>
<td>AIL® Summary Grid</td>
</tr>
<tr>
<td>Yoked-Contingencies</td>
<td>Personalized System of Instruction (PSI) folder</td>
<td>Data Sheets/Teachers Recording Data</td>
</tr>
<tr>
<td>Transition Graphs</td>
<td>Book Reports</td>
<td>Graphs for Self-Management</td>
</tr>
<tr>
<td></td>
<td>Peer Tutoring</td>
<td>Module Graphs Weekly</td>
</tr>
<tr>
<td></td>
<td>Learning Pictures for Math &amp; Reading</td>
<td></td>
</tr>
</tbody>
</table>

See Greer (2002) for all of the tactics listed above.
Table 3

*Description of Participants by qualification for free/reduced lunch, gender, Individualized Education Plan, Naming capability, Observational Learning capability, Grade level equivalent reading level and Developmental Reading Assessment score.*

<table>
<thead>
<tr>
<th>Participants</th>
<th>Qualification for Free/Reduced Lunch</th>
<th>Gender</th>
<th>IEP</th>
<th>Full Naming</th>
<th>Observational Learning</th>
<th>Reading Rate (cwpm)</th>
<th>Grade Level Equivalent Reading Level</th>
<th>DRA Score</th>
</tr>
</thead>
<tbody>
<tr>
<td>C1:</td>
<td>N</td>
<td>M</td>
<td>N</td>
<td>Y</td>
<td>Y</td>
<td>90</td>
<td>Grade 1: E</td>
<td>16</td>
</tr>
<tr>
<td>C2:</td>
<td>Y</td>
<td>F</td>
<td>N</td>
<td>Y</td>
<td>Y</td>
<td>20</td>
<td>Grade 1: M</td>
<td>10</td>
</tr>
<tr>
<td>C3:</td>
<td>Y</td>
<td>F</td>
<td>N</td>
<td>Y</td>
<td>Y</td>
<td>50</td>
<td>Grade 1: M</td>
<td>10</td>
</tr>
<tr>
<td>C4:</td>
<td>N</td>
<td>M</td>
<td>N</td>
<td>Y</td>
<td>Y</td>
<td>100</td>
<td>Grade 1: E</td>
<td>16</td>
</tr>
<tr>
<td>C5:</td>
<td>N</td>
<td>M</td>
<td>N</td>
<td>Y</td>
<td>Y</td>
<td>80</td>
<td>Grade 1: E</td>
<td>16</td>
</tr>
<tr>
<td>C6:</td>
<td>N</td>
<td>M</td>
<td>Y</td>
<td>Y</td>
<td>Y</td>
<td>50</td>
<td>Grade 1: M</td>
<td>12</td>
</tr>
<tr>
<td>C7:</td>
<td>Y</td>
<td>M</td>
<td>N</td>
<td>N</td>
<td>Y</td>
<td>90</td>
<td>Grade 1: M</td>
<td>8</td>
</tr>
<tr>
<td>E1:</td>
<td>N</td>
<td>F</td>
<td>N</td>
<td>Y</td>
<td>Y</td>
<td>100</td>
<td>Grade 1: E</td>
<td>16</td>
</tr>
<tr>
<td>E2:</td>
<td>N</td>
<td>F</td>
<td>N</td>
<td>Y</td>
<td>Y</td>
<td>40</td>
<td>Grade 1: M</td>
<td>10</td>
</tr>
<tr>
<td>E3:</td>
<td>N</td>
<td>M</td>
<td>N</td>
<td>N</td>
<td>Y</td>
<td>50</td>
<td>Grade 1: M</td>
<td>10</td>
</tr>
<tr>
<td>E4:</td>
<td>N</td>
<td>F</td>
<td>N</td>
<td>Y</td>
<td>Y</td>
<td>30</td>
<td>Grade 1: M</td>
<td>8</td>
</tr>
<tr>
<td>E5:</td>
<td>N</td>
<td>M</td>
<td>N</td>
<td>Y</td>
<td>Y</td>
<td>80</td>
<td>Grade 1: E</td>
<td>16</td>
</tr>
<tr>
<td>E6:</td>
<td>N</td>
<td>F</td>
<td>N</td>
<td>Y</td>
<td>Y</td>
<td>100</td>
<td>Grade 1: E</td>
<td>16</td>
</tr>
<tr>
<td>E7:</td>
<td>N</td>
<td>M</td>
<td>N</td>
<td>Y</td>
<td>Y</td>
<td>90</td>
<td>Grade 1: E</td>
<td>16</td>
</tr>
</tbody>
</table>

Note. A *Y* denotes a Yes, which means that the participant demonstrated the repertoire according to information provided by the school district and Verbal Behavior Development Assessment procedures (Greer & Ross, 2008). An *N* denotes a No, which means that the participant did not have the characteristic in repertoire according to information provided by the school district and Verbal Behavior Development Assessment procedures (Greer & Ross, 2008).

a IEP refers to Individualized Education Plan.
b Full Naming refers to incidental language acquisition and is demonstrated when a learner acquires the tact as a listener for a stimulus after receiving reinforcement or correction on matching the visual stimulus while attending to the auditory name and later emits the name for the stimulus as a speaker.
c Observational Learning refers to a learner who demonstrates the capability of acquiring new skills after observing a peer receive instruction in the form of reinforcement or correction.
d DRA refers to the *Developmental Reading Assessment®,* which is a reading test.
e An *E* refers to “end of year” reading level.
f An *M* refers to “mid year” reading level.
Setting

The pre-intervention and post-intervention probe sessions were conducted within the first grade classroom at the group tables, u-shaped table, or directly outside of the first grade classroom in the hallway alcove. The hallway alcove measured approximately 12ft (3.6m) x 4ft (1.2m) and was comprised of two child-sized chairs for the experimenter and the participant.

The classroom was comprised of six large rectangular group tables with two child-sized chairs on each side, one large u-shaped table at the entrance of the classroom, one small rectangular table as teacher desk, and five shelves, each positioned in front of a wall within the classroom. One shelf contained leisure activities and games such as puzzles, bingo, cars, puppets, and play-doh. The other shelves contained various reading texts and teaching materials. The desks within the classroom, u-shape table, and chairs were child-sized, further allowing all participants to sit comfortably during probe sessions, with the experimenter sitting adjacent to the participant at the designated table. The tables in which the probes took place were located at the far left or far right side of the classroom.

During all probe sessions, the remaining participants were either on the rug or at a table in the center of the classroom partaking in class-wide lessons across various academic domains. The participants were required to sit adjacent to the experimenter while sitting at the desks or u-shape table during all pre-intervention and post-intervention probe sessions to ensure that the participants were attending to the teacher and probe materials. During all probe sessions, the experimenter used a MacBook pro laptop to display probe stimuli and record vocal responses during each probe trial for
purposes of interobserver agreement. During the Corrective Reading (CR) placement test, students sat at rectangular tables within the classroom in groups of six or more. The experimenter read each instruction while each student within the group was required to follow along and emit a response in written form on his/her CR packet. During the Corrective Reading Placement Test II, which required individualized vocal responses, the experimenter probed each participant in a one to one setting.

The experimenter conducted the Corrective Reading intervention in a small book room located in the back of the school library. The Corrective Reading intervention was conducted in the book room in order to prevent Group 2 from being exposed to the Corrective Reading curriculum instruction. Within the center of the bookroom, there was a long rectangular table with a total of four child-sized and three adult-sized chairs surrounding the table. The students sat around the table in the chairs and the experimenter stood up near all the students at the table while presenting instruction to the group.

The experimenter conducted the RAZ Kids reading program within the first grade classroom at a rectangular table in the center far left side of the classroom. There were seven participants in both intervention groups. The participants were required to sit at the rectangular table while the experimenter presented each instruction from the curriculum to the students. The experimenter presented vocal instruction to the participants. The experimenter provided the participants with instruction on which book to read, guidance during the reading, and gave feedback on correct and incorrect responses. During the RAZ Kids intervention the participants were required to sit in front of laptops (MAC 2013) or iPads since the RAZ Kids reading program was on an online curriculum.
Materials

During all pre-intervention and post-intervention probe sessions, the experimenter used the Corrective Reading: Appendix A (CR) placement test materials (Engelmann, Haddox, Hanner & Osborn, 1999), a MacBook Pro© with Garage Band to record vocal responses, an iPhone © with Voice Memos application to record all vocal responses to the probes, PowerPoint® application to present the derived relations letters/numbers probe, pencils, data sheets, and pens.

The Corrective Reading Placement Test is a screening assessment used to determine the comprehension level of Corrective Reading the learners should be placed. The screening assessment was conducted prior to the implementation of the interventions. The experimenter conducted the Corrective Reading Placement Test using the Signature Individual Placement Form provided by the CR curriculum (Engelmann, Haddox, Hanner & Osborn, 1999). A sample of the Corrective Reading placement assessment sheet is shown in Figure 5 below.
Figure 5. Sample page of the Corrective Reading Placement Assessment packet that was used by the experimenter to record the number of correct responses emitted to comprehension questions. The participants were required to respond in written and vocal form to comprehension questions. The responses emitted during this assessment determined the participants’ placement for the Corrective Reading intervention.
The derived relations from letters/numbers probe consisted of alphabetic letters and Arabic numbers, which were presented using the PowerPoint® for Mac (2011) application. This assessment was conducted during the pre-intervention and post-intervention conditions. The first two slides within the probe presented a contrived letter/number or number/letter direct relation (e.g., A=5 and 5=H) and the third slide for each trial probed the untaught relation defined as combinatorial entail according to RFT. A sample of the derived relation responding PowerPoint probe is shown in Figure 6 below.
Figure 6. Sample of the derived relations from letters/numbers probe presented using PowerPoint®. The participants were trained for the first two relations (mutual entailment) but were probed on the last relation (i.e., combinatorial entailment). The participants were provided with 10 probe trials.
The deduction probes were conducted near a MacBook Pro© (2008) using the Garage Band application to record the vocal responses. The materials required to effectively implement this probe were a sheet of 8” x 11” paper consisting of 15 deduction trials, a data sheet, and a pen to record responses. The experimenter presented five rules during each probe and each rule provided three opportunities to respond to a missing relation (i.e., combinatorial entailment). Therefore, there were a total of 15 opportunities to respond. A sample of the deduction probe is shown in Figure 7 below.
Figure 7. This is a sample of the deductions (i.e., derived relation from sentence) probe. The participants were required to attend to the vocal antecedents and emit vocal responses to each relation.
The materials required to implement the metaphor probe was a sheet of 8” x 11” paper consisting of multiple sets of five metaphor questions. The experimenter presented Set 1 during the pre-intervention condition, Set 2 during the second probe condition, and Set 3 during the final probe condition. A sample of the metaphor probe is shown in Figure 8 below.
**Figure 8.** Sample of the metaphor probe. The participants were required to attend to the teacher vocal antecedent and respond by providing three metaphor responses. The participants were provided with five opportunities per set to demonstrate that extended metaphors were in repertoire.
There were two curriculum-based materials required to effectively implement the interventions in this study. The two intervention materials were the *Corrective Reading: Thinking Basics-Comprehension A Teacher Presentation Book 1* (Engelmann, Haddox, Hanner, & Osborn, 1999) and the *Corrective Reading: Thinking Basics-Comprehension A* workbook (Engelmann, Haddox, Hanner, & Osborn, 1999). The teacher presentation book was a gray, 278 paged, spiral bound text. The book consisted of 35 lessons and four Fact game lessons. The student workbook was a gray, 105 paged text. The book consisted of worksheets with textual and visual stimuli for 60 lessons, five Remediation and Review Exercises and seven Fact game lessons. The *Corrective Reading* curriculum is a Direct Instruction curriculum, which was designed to strengthen the following reading comprehension repertoires: true/false responses, statement inferences, same/different, deductions, definitions, descriptions and classification. The experimenter used the *Corrective Reading: Thinking Basics-Comprehension A* student workbook (Engelmann, Haddox, Hanner, & Osborn, 1999) in conjunction with the *Corrective Reading* teacher presentation book (Engelmann, Haddox, Hanner, & Osborn, 1999). The experimenter produced duplicate pages of the targeted lesson page within the student workbook for each participant within the group. A sample page from the *Corrective Reading* teacher presentation book is provided in Figure 9 below. A sample page from the *Corrective Reading* student workbook is provided in Figure 10 below.
Figure 9. Sample page found within the Corrective Reading curriculum (Engelmann, Haddox, Hanner & Osborn, 1999).
Figure 10. Sample page found within the *Corrective Reading* student workbook (Engelmann, Haddox, Hanner & Osborn, 1999). The participants were required to attend to the auditory directions presented by the teacher as well as the 2D print stimuli presented on the worksheets within the workbook.
*RAZ Kids* was the second intervention implemented during the intervention conditions and served as a content control for *Corrective Reading* in order compare the effects of both curricula. *RAZ Kids* is an online reading and reading comprehension curriculum. *RAZ-Kids* provides readers with a wide variety of leveled eBooks across fiction and non-fiction genres and from beginning to advanced levels of reading (i.e., Levels A-Z). The experimenters used the RAZ-Kids reading program as a common online reading comprehension curriculum ([https://www.raz-kids.com/main/Login](https://www.raz-kids.com/main/Login)) for both groups as content control. All participants were preset to level E and progressed to level F, which means that all participants read eBooks at the same first grade level during this intervention. The experimenter pre-selected Level E as the starting text levels due to the fact that level E is considered middle first grade and the all of the participants were all reading at a middle to end of first grade level according to the DRA correlation chart (See Figure 11 below). *RAZ-Kids* was set to level E to help control for the type of texts, type of vocabulary, and comprehension questions each participant contacted during instruction. Participants were provided one of the following items: an iPad (2014), a MacBook Pro laptop (2008), or a MacBook Air (2012) to login and engage with the *RAZ-Kids* curriculum. Samples of the *RAZ-Kids* curriculum are shown in Figures 12, 13, and 14. A sample of the data sheet used during all conditions in shown in Figure 15.
Figure 11. This is the K-2 DRA level correlation chart that was used to determine the appropriate middle first grade level to begin the RAZ-Kids intervention. All participants’ DRA scores ranged between middle to end of first grade, which refers to levels eight and 16.
Hey, sit down and I’ll tell you a bad news story. My name is Arthur Hankins. The first eight years of my life were nearly perfect. But then my parents told me some pretty disturbing news. It would change everything!

*Figure 12.* This is sample page from a story within the *RAZ-Kids* online reading curriculum. The participants were required to read four to five books from this curriculum during each intervention session. After reading the grade level story the participants were then required to answer five (i.e., explicit and implicit) comprehension questions related to the story.
Figure 13. This is sample comprehension question within the RAZ-Kids online reading curriculum. After reading each leveled story the participants were required to answer five (i.e., explicit and implicit) comprehension questions related to the story.
Figure 14. This is sample quiz score page within the RAZ-Kids online reading curriculum. After reading and answering the five (i.e., explicit and implicit) comprehension questions related to the story, the participants viewed the feedback to their responses on the quiz score page.
Figure 15. This is an image of the data sheet that was used to collect data during all probe and intervention conditions.
Dependent Variables

There were three dependent measures. The dependent measures were: a) number of correct metaphor responses, b) number of correct deduction responses, and c) number of correct responses emitted to derived relations from letters/numbers probe.

Derived relations from letters/numbers: The function of the derived relations probe of letters/numbers probe was to determine if the participants could demonstrate combinatorial entailment (RFT) after being trained two relations: if G=T and T=5, then 5=G. Similar to the transitive property of Stimulus Equivalence research, combinatorial entailment refers to a network of relations or a combination of two or more stimulus relations. The participants were required to demonstrate that they could learn relations between multiple stimuli, after being taught relations between three contrived letters and/or numbers. During this probe there were a total of 10 opportunities to respond. See Figure 6 for a sample of the derived relations from letters/numbers probe.

Deductions: The purpose of this probe was to test for the presence of combinatorial entailment (e.g., learning relations between two or more stimuli), after being trained relations between two stimuli or events presented in sentence form. The following is an example of one of the sentences found in the probe, if a monkey is tiny it is blue; Nick has a tiny monkey, what else do you know about it? Deduction is referring to derived relations from sentences, which is a demonstration of combinatorial entailment and the Corrective Reading curriculum identifies these as deductions. Deductions are considered an advance reading comprehension skill. See Figure 7 for a sample of the deductions probe.
Metaphors: The experimenter probed for the presence of metaphors. Metaphors can function as a type of extended tact if the speaker has the intended effect on the listener. A tact is a verbal operant that functions to make contact with a nonverbal stimulus within the environment and is reinforced by generalized reinforcement (Greer & Ross, 2008). However, in this study metaphor was not defined by the effect it had on the listener but rather as tacting the commonalities of features or non-commonalities of features between explicit stimuli. The antecedent presented during the metaphor probe prompted the speaker to say the commonality of features or non-commonality of features between two stimuli. Metaphors are also a type of derived relation (Stewart & Barnes-Holmes, 2001). As mentioned previously, according to Stewart and Barnes-Holmes (2001, p. 191) the four components involved in metaphors are, “(a) establishing two separate equivalence relations, (b) deriving an equivalence relation between these relations, (c) discriminating a formal relation via this equivalence-equivalence relation, and (d) a transformation of function on the basis of the formal relation discriminated in the third element.” An example of one of the sentences used in the probe is, “name three ways that a house is like a seashell.”

A correct response was recorded for each feature of commonality or each difference amongst the stimuli the participant was able to tact in consecutive order. The response was considered correct if the participant responded with “both are” or “they have” or “one is_______ and the other is______.” For example, if a participant vocally stated, “a house is the same as a seashell because both are considered homes” then we would consider that response as correct because the participant addressed both stimuli. An incorrect response was recorded if the participant was unable to say a commonality or
difference between the two stimuli or only emitted a response for one stimulus rather than both. For example, if a participant stated, “a house is the same as a seashell because the house is a home” but did not say that a seashell was a home, then we would consider that response as incorrect because the response did not state the commonality of both targeted stimuli. During the probe the participants were presented with five metaphors and each opportunity required a maximum of three correct responses. The experimenter recorded a plus (+) if the participant emitted a correct response and the experimenter recorded a minus (-) if the participant emitted an incorrect response.

**Independent Variables:**

*Derived Relations Curriculum Sequence. Corrective Reading* is the Direct Instruction curriculum that was implemented during both intervention conditions of this study due to the fact that the curriculum has a sequence that trains derived relations (Engelmann, Haddox, Hanner, & Osborn, 1999). The experimenter used *Corrective Reading: Thinking Basics* (Teacher Presentation) Comprehension A book, and the *Corrective Reading: Thinking Basics* (student) workbook (Engelmann, Haddox, Hanner, & Osborn, 1999) as materials to effectively implement the reading intervention. As noted previously, this curriculum provides over 30 lessons and within each lesson are multiple exercises targeting different skills related to reading comprehension. Each lesson within the curriculum provides 12-16 exercises, which teach comprehension skills involving true/false, inferences, deductions, and some/all/none. For purposes of this study, the experimenter taught the first ten lessons of *Corrective Reading* due to the fact that the first ten lessons provided ample opportunities for the participants to contact the sequence within the curriculum that appears to train derived relations, therefore, the participants
were only required to complete the first ten lessons of Corrective Reading. The curriculum rotates between listener and speaker responses. The experimenter presented 210 instructional units to both groups during the Corrective Reading intervention. One exercise/task (e.g., deductions) was considered one instructional unit. Some exercises contained multiple tasks (e.g., Task A and Task B) and each task within an exercise was also considered an instructional unit. Criterion was set to 90% accuracy within one lesson. In this study, Corrective Reading curriculum was introduced to Group 1 following all pre-intervention probes and Corrective Reading was introduced to Group 2 following all post-intervention I probes.

RAZ-Kids. RAZ-Kids was the common reading curriculum that was implemented during Intervention I condition for Group 2, and Intervention II condition for Group 1. It is an online reading curriculum within the Learning A-Z reading resources. The curriculum targets textually responding and reading comprehension aligned to the Common Core State Standards. The curriculum provides over 1,000 leveled reading books from Kindergarten (i.e., Level aa) to Fifth grade (i.e., Level Z) and reading comprehension quizzes followed each story as a post review. The quizzes provided five opportunities for the student to emit responses to implicit and explicit comprehension questions.

Data Collection

Derived relations from letters/numbers probe. During the derived relations from letters/numbers probe, the experimenters presented 30 slides, which contained a total of ten opportunities to respond. Each trial consisted of three slides and each trial within the probe presented two slides, which included a letter/number relation (e.g., Slide 1: A=5
and Slide 2: 5=H). The third slide within each trial probed for the final untaught relation. During the last slide, experimenters rotated between two antecedents, “what does A equal?” and “what is the same as A?” The participants were required to emit a vocal response within 5s following the presentation of the antecedent. When the participants did not emit a response within 5s, the response was recorded as incorrect and the experimenter proceeded to the next slide. The experimenters recorded a plus (+) when the participant emitted a correct relational response and the experimenters recorded a minus (-) when the participant emitted an incorrect response. See Figure 6 for a sample of the probe.

_Deductions probe._ During the deductions probe, the experimenters presented the participants with a nonsense rule (e.g., If a chicken is coral it has 3 legs). Subsequently, the experimenter presented three questions following each rule to probe combinatorial entailment according to RFT (e.g., Bob’s chicken is coral, what else do you know about it?). The participants were presented with a total of five deduction rules and there were three opportunities to respond following each deduction rule. A correct response was recorded if the participant was able to identify the correct relation for each question. If the participant emitted, “I don’t know” or another response aside from the correct relation the response was recorded as incorrect. Experimenters recorded a plus (+) if the participant emitted a correct response and the experimenters recorded a minus (-) if the participant emitted an incorrect response. See Figure 7 for a sample of the deduction probe.

_Metaphors._ During the metaphor probe, the experimenter probed for the presence of metaphors. The experimenters presented the participant with an antecedent, which
prompted the participant to intraverbally respond to three commonalities of features or non-commonalities between explicit stimuli (e.g., “Name three ways a fin is the same as a tail.”). The response was considered correct when the participant responded with an accurate commonality or difference. The participants were required to vocally say “both are” or “they have” or “one is ______ and the other is ______” in order to accurately communicate the commonality or difference. The content of the participant’s response needed to be accurate and functional. For example, if the participant emits a vocal response such as, “a house and a seashell are the same because they both are furry” the experimenter marked this as incorrect due to the fact that the participant did not demonstrate an accurate understanding of the commonalities of features between the house and seashell given that neither are furry. However, if the participant emitted a vocal response such as, “a house and a seashell are the same because they both provide shelter” then the experimenter considered this response as accurate. An incorrect response was recorded if the participant was unable to tact a commonality or difference between the two stimuli or only emitted a response for one stimulus (e.g., You can live in a house) rather than both (e.g., You can live in a house and creatures live in a seashell). The experimenter recorded a plus (+) if the participant emitted a correct response and the experimenter recorded a minus (-) if the participant emitted an incorrect response. See Table 4 for examples of correct and incorrect metaphor responses.
Table 4.
An example of a correct response and an incorrect response for the metaphor probe.

<table>
<thead>
<tr>
<th>Example Metaphor Questions</th>
<th>Correct Responses</th>
<th>Incorrect Responses</th>
</tr>
</thead>
<tbody>
<tr>
<td><em>Name 3 ways an airplane is like a boat.</em></td>
<td>They are both vehicles.</td>
<td>A boat is a vehicle.</td>
</tr>
<tr>
<td></td>
<td>A plane can take you places and a boat can take you places.</td>
<td></td>
</tr>
<tr>
<td><em>Name 3 ways that water is different from a brick.</em></td>
<td>Water is a liquid <em>and</em> brick is a solid.</td>
<td>Water is a liquid.</td>
</tr>
</tbody>
</table>

*Corrective Reading.* During the *Corrective Reading* intervention, the experimenter recorded data on each participant’s response to learn units presented during the intervention sessions. Each lesson consisted of 79 or more learn units and 12 or more instructional units (i.e., Exercises and tasks). The experimenter used choral responding to ensure that all participants within the group responded at the same time. When the participants emitted correct responses the experimenter reinforced the participants for responding accurately and recorded a plus (+) on the data sheet. If one or more of participants emitted an incorrect response the experimenter recorded a minus (-) on the group data sheet and provided those students with a correction operation, while the other participants were prompted to record a point on their point sheet for following directions. The correction operation consisted of the experimenter re-presenting the antecedent, modeling the correct response then re-presenting the antecedent again so that the participant could emit the correct response independently. The criterion was set to 90% accuracy within one lesson. At the end of each lesson, the experimenter divided the total number of correct responses to learn units by the total number of opportunities to determine whether the participant emitted 90% correct responses or higher. If a participant emitted less than 90% accuracy during one lesson, the participant was required to recycle the targeted lesson. To recycle a lesson, the experimenter simply re-
presented the lesson to the participant during an available time period during the school day. If a participant emitted more than two incorrect responses during an instructional unit (i.e., exercise or task), the participant was required to recycle that specific exercise.

During the worksheet component of *Corrective Reading* the experimenter provided the students with their targeted lesson worksheet then read each written direction out loud. The participants were then prompted to use their pencil to record their selection responses within 10s. Subsequently, after the participants recorded their selection response, the experimenter continued to read the script to provide feedback for correct and incorrect responses. The experimenter also used a pen to mark a check on the participant’s paper if the answer was correct and the experimenter placed a circle around the problem on the worksheet if the answer was incorrect. The experimenter recorded the incorrect and correct responses on a data sheet. In addition to this, the experimenter provided the participants with point sheets at the start of each intervention session so that the students could receive positive reinforcement in the form of praise for appropriate performance and learning behaviors during the intervention sessions. The participants were prompted to count their points at the end of each session so that they could exchange the points for back-up reinforcers (e.g., prize-box & play area).

*RAZ Kids.* During the *RAZ Kids* intervention, the experimenter recorded data on each participant’s response to learn units presented during the intervention sessions. Each story within the curriculum was followed by a quiz that provided five opportunities to respond to multiple-choice questions. Each question provided four exemplars and the participant was required to select the correct answer. The experimenter vocally read the antecedent out loud then waited 10s for the participants to emit their selection response
on their devices (e.g., lap tops, iPads). When the participants emitted correct responses
the experimenter delivered praise and approvals for responding accurately and recorded a
plus (+) on the data sheet. If one or more of participants emitted an incorrect response the
experimenter recorded a minus (-) on the data sheet and provided those students with a
correction operation, while the other participants recorded points on their point sheet for
answering correctly and following directions. During the correction operation the
experimenter re-presented the antecedent, modeled the correct response, then re-
represented the antecedent again so that the participant could emit the correct response
independently. Criterion was set to 100% correct responses within one story (i.e., 5/5
learn units). At the end of each story, the experimenter viewed the total number of correct
responses on the quiz to determine whether the participant emitted 100% correct
responses or higher. If the participant emitted less than 100% accuracy on one quiz the
participant was required to recycle the quiz.

**Interobserver Agreement:**

The experimenter conducted point-by-point interobserver agreement by dividing
the number of agreements by the total number of agreements and disagreements. The
experimenter then took this number and multiplied it by 100%. The experimenter
selected observers who were CABAS® trained teachers holding a Teacher I, Teacher II
or higher rank (www.cabasschools.org); all observers either had acquired their masters
degree or were working towards completion of their masters degree in teaching as
applied behavior analysis.

Interobserver agreement (IOA) was conducted for 100% of the derived relations
from letters/numbers probe, and for over 80% of the deduction probe for all participants.
IOA was conducted for over 90% of the metaphors. See Tables 5, 6, and 7 for percentage of mean agreement and range of interobserver agreement during all pre and post-intervention probe sessions.

Table 5

The percentage of mean agreement, range of agreement and the percentage of sessions during which IOA was conducted for the metaphor pre and post intervention probes.

<table>
<thead>
<tr>
<th>Participant</th>
<th>C1</th>
<th>C2</th>
<th>C3</th>
<th>C4</th>
<th>C5</th>
<th>C6</th>
<th>C7</th>
<th>E1</th>
<th>E2</th>
<th>E3</th>
<th>E4</th>
<th>E5</th>
<th>E6</th>
<th>E7</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>Percentage of Sessions</strong></td>
<td>100</td>
<td>100</td>
<td>100%</td>
<td>100</td>
<td>100%</td>
<td>75%</td>
<td>100</td>
<td>100%</td>
<td>100</td>
<td>100</td>
<td>100</td>
<td>100</td>
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</tr>
<tr>
<td><strong>Mean Agreement</strong></td>
<td>%</td>
<td>%</td>
<td>%</td>
<td>%</td>
<td>%</td>
<td>%</td>
<td>%</td>
<td>%</td>
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<td>%</td>
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<tr>
<td><strong>Range of Agreement</strong></td>
<td>100</td>
<td>100</td>
<td>100%</td>
<td>100</td>
<td>100%</td>
<td>100</td>
<td>100%</td>
<td>90%</td>
<td>90%</td>
<td>85%</td>
<td>96%</td>
<td>91%</td>
<td>96%</td>
<td>97%</td>
</tr>
</tbody>
</table>

Table 6

The percentage of mean agreement, range of agreement and the percentage of sessions during which IOA was conducted for the derived relations from letters/numbers pre and post intervention probes.

<table>
<thead>
<tr>
<th>Participant</th>
<th>C1</th>
<th>C2</th>
<th>C3</th>
<th>C4</th>
<th>C5</th>
<th>C6</th>
<th>C7</th>
<th>E1</th>
<th>E2</th>
<th>E3</th>
<th>E4</th>
<th>E5</th>
<th>E6</th>
<th>E7</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>Percentage of Sessions</strong></td>
<td>100</td>
<td>100</td>
<td>100%</td>
<td>100</td>
<td>100%</td>
<td>100%</td>
<td>100</td>
<td>100%</td>
<td>100%</td>
<td>80-</td>
<td>83-</td>
<td>91-</td>
<td>75-</td>
<td>91-</td>
</tr>
<tr>
<td><strong>Mean Agreement</strong></td>
<td>%</td>
<td>%</td>
<td>%</td>
<td>%</td>
<td>%</td>
<td>%</td>
<td>%</td>
<td>%</td>
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<td>%</td>
<td>%</td>
<td>%</td>
<td>%</td>
<td>%</td>
</tr>
</tbody>
</table>

Table 7

The percentage of mean agreement, range of agreement, and the percentage of sessions during which IOA was conducted for the deduction pre and post intervention probes.
<table>
<thead>
<tr>
<th>Participant</th>
<th>C1</th>
<th>C2</th>
<th>C3</th>
<th>C4</th>
<th>C5</th>
<th>C6</th>
<th>C7</th>
<th>E3</th>
<th>E2</th>
<th>E3</th>
<th>E4</th>
<th>E5</th>
<th>E6</th>
<th>E7</th>
</tr>
</thead>
<tbody>
<tr>
<td>Percentage of Sessions</td>
<td>84%</td>
<td>100 %</td>
<td>100%</td>
<td>84%</td>
<td>100%</td>
<td>84%</td>
<td>100%</td>
<td>84%</td>
<td>100%</td>
<td>84%</td>
<td>100%</td>
<td>84%</td>
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<tr>
<td>Mean Agreement</td>
<td>100%</td>
<td>100%</td>
<td>100%</td>
<td>100%</td>
<td>100%</td>
<td>100%</td>
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<td>100%</td>
<td>100%</td>
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<td>100%</td>
</tr>
</tbody>
</table>

**Design**

The experimenter used an experimental group design with a simultaneous treatment and a crossover feature. The experimenter selected this design due to the fact that it controlled for instructional history, maturation of the participants, and whether the difference in results would occur in the absence of the *Corrective Reading* (Engelmann, Haddox, Hanner, & Osborn, 1999) intervention. The experiment consisted of two groups, Group 1 and Group 2. There were a total of seven students in each group (i.e., Group 1 and Group 2). Both groups consisted of matched participants, meaning that each group had participants with the same level of verbal capabilities and reading skills.

The sequence of the experiment was as follows: 1) experimenters conducted the *Corrective Reading Placements Test* for pre-experimental screening. The experimenter used results from this test to determine placement during the *Corrective Reading* intervention. All participants were placed at Comprehension A level for *Corrective Reading*. 2) The experimenter conducted pre-intervention probes to assess whether the participants had derived relations or metaphors in repertoire. The experimenter used the pre-intervention probe data to ensure that the placement for the participants in Group 1 and Group 2 was balanced in terms of participant repertoires. The experimenter matched
the participants in pairs then randomly assigned each participant to Group 1 or Group 2. 3) The experimenter began conducting Corrective Reading with Group 1 and RAZ-Kids with Group 2 simultaneously. Instructional units were matched across both groups. Once all the participants in RAZ Kids completed 210 learn units and the Corrective Reading group completed the first 10 consecutive lessons (i.e., 210 instructional units) at 90% accuracy or above, criterion was met for the intervention condition. The experimenter matched the 210 instructional units presented in the Corrective Reading group with the number of learn units presented in the RAZ-Kids group. 4) Post-intervention I probes were conducted with both groups to assess whether correct responses to derived relations and metaphors increased or emerged, for both groups. 5) The experimenter began conducting Corrective Reading with Group 2 and RAZ-Kids with Group 1 simultaneously. Instructional units were matched across both groups. Once all the participants in the RAZ Kids condition completed 210 learn units and the Corrective Reading group completed 10 consecutive lessons (i.e., 210 instructional units) at 90% accuracy or above, criterion was met for the second intervention condition. 6) Post-intervention II probes were conducted to assess whether correct responses to derived relations or metaphors increased or emerged, for both groups following the interventions. See Figure 16 for a visual display of the experimental sequence.
Figure 16. The experimental sequence for Experiment I.
Procedure

**Screening Placement Test.** Prior to conducting the pre-intervention probes for each dependent variable the experimenter presented each participant with a *Corrective Reading* Placement Test. The *Corrective Reading* (Engelmann et. al., 1999) placement packet consisted of the following placement tests: *Blackline Master for Test 1, Blackline Master for Test 2, and Blackline Master for Test 3*. Each participant was provided with a Placement packet, pencil, and eraser in order to emit written responses to each question. All three of the test worksheets consisted of written or vocal antecedents. In this study the experimenter vocally read each direction and antecedent aloud. Following each antecedent, the participants were required to emit selection responses (e.g., circling the answers). Test 1 assessed listening comprehension and vocabulary using selection responses, which were presented in a field of four targets or more. Test 2 assessed metaphors and derived relations; the experimenter read the antecedents aloud and the participants responded in vocal form.

The experimenter transcribed the participants’ responses onto the test sheets. Test 3 assessed sentence or short passage comprehension. The participants read the written antecedents independently in Test 3. Test 3 also assessed vocabulary using selection responses. If the participants met criterion on Test 1, they continued onto Test 3. However, if a participant did not pass Test 3, the participant was then required to complete Test 2, which placed him at the Comprehension A level. When the participants did not meet criterion on Test 1, the participants were required to complete Test 2 and were automatically placed at the Comprehension A level for Corrective Reading. All of
the participants were placed in Comprehension Level A of the *Corrective Reading* intervention.

**Derived relations from letters/numbers:** Prior to the intervention the experimenter probed for the presence of derived relations involving letters/numbers. Similar to the probes found in Howarth, Dudek, and Greer (2015), this probe directly trained two relations then probed for the untaught relation. The derived relations from letters/numbers probe was presented using the PowerPoint® for Mac (2011) application. The participant was required to sit directly in front of the screen in order to view each relation presented on each slide. Each slide within the probe presented an arbitrary relation using contrived letters/numbers (e.g., A=5 and 5=H). There were three slides grouped together to display the relations. The first two slides taught two relations (e.g., B=7 and B=P) and the last slide presented for each relational trial probed the final untaught relation (e.g., “what does 7=” or “what is the same as P?”). The experimenter rotated between two forms of antecedents, “what is the same as ____?” and “what does ____ equal?” There were a total of ten opportunities to respond. During all probe trials; the experimenter did not consequate any correct or incorrect responses. The participants received reinforcement in the form of gestures (e.g., thumbs up) and vocal praise for emitting appropriate self-management behaviors.

**Metaphors:** Prior to the intervention and following the interventions the experimenter probed for the presence of metaphors. The experimenter only probed one set of five questions during each condition. The experimenters presented the participant with a spoken antecedent, which prompted the participant to describe three commonalities of features or non-commonalities between explicit stimuli (e.g., “Name
three ways a house is the same as a seashell.”). During instruction, the experimenter delivered scripted vocal antecedents and the antecedent prompted the participants to provide three responses per each opportunity. However, if the participant emitted less than three correct responses, the experimenter recorded minuses for the incorrect or missing responses and did not remind the student to emit a total of three responses. During all probe trials the experimenter did not consequate any correct or incorrect responses. The participants received reinforcement in the form of gestures and vocal praise (e.g., “Excellent job sitting nicely!”) for appropriate self-management behavior. The experimenter used a standard data sheet (see Figure 14) and pen to record responses emitted by the participants. The experimenter collected data during the sessions by recording a plus (+) for all correct responses and a minus (-) for all incorrect responses.

**Deductions:** During probe conditions, the experimenter probed for deduction. Similar to derived relations from letters/numbers, this probe sought to determine whether the participants could learn relations between two stimuli after hearing the teacher present a short sentence containing all three stimuli being related. These probes were similar to the probes found in Howarth, Dudek, and Greer (2015), due to the fact that this probe directly presented two relations then probed for the untaught relation. This probe sought to identify whether the participants could derive relations or draw conclusions between stimuli or events. For each deduction trial, the experimenter vocally presented a sentence rule (e.g., “If a chicken is coral it has three legs”), which encompassed all three relations while the participant was attending. The experimenter then presented three questions, which probed for combinatorial entailment (e.g., “if Bob has a chicken that is coral, what else do you know about it?”). An example of one of the sentences and questions is below,
“If a chicken is coral it has 3 legs”

1. Bob’s chicken is coral, what else do you know about it?

2. Sue’s chicken has 3 legs, what else do you know about it?

3. Phil has something coral with three legs, what is it?

During each set within this probe, each participant was provided with a total of five deduction sentences. Following each deduction sentence, there were three opportunities to respond. During all probe trials the experimenter did not consequate any correct or incorrect responses. The participants received reinforcement in the form of gestures and vocal praise (e.g., high five) for appropriate self-management behavior. The experimenter used a standard data sheet and pen to record responses emitted by the participants. The experimenter collected data during the sessions by recording a plus (+) for all correct responses and a minus (-) for all incorrect responses.

**RAZ-Kids intervention:** During the RAZ-Kids intervention, the experimenter matched the learn units (Albers & Greer, 1991) in RAZ-Kids to the instructional units presented in Corrective Reading. Prior to beginning this intervention, the experimenter set up an account for each participant by following the account set-up guidelines presented on the website. The participants were provided with an iPad or Mac book and required to log into their RAZ-Kids account. Once all participants in the group were logged in they were required to read a leveled book together as a group. All participants were required to begin the RAZ-Kids intervention on level E due to the fact that level E was considered mid-year first grade reading level. Each session began with the participants textually responding to the selected level story aloud.
The experimenter selected one leveled text for the entire group to read simultaneously. Each participant was required to textually respond to one sentence from the selected leveled story in vocal form while the other participants silently attended to the sentence being read. The experimenter consequated each sentence read correctly by either providing corrections for sentences read with one or more errors or praising participants who read the sentence without any errors. The correction operation for sentences read incorrectly consisted of the experimenter modeling the correct way to read the words that were read incorrectly then requiring the participant re-read the sentence accurately. The experimenter did not provide praise following incorrect responses. When the participant read the sentence correctly, the experimenter praised the student for responding accurately (e.g., “nice job”). Following each story, the participants were presented with a short quiz.

After reading the story the students were directed to click on the quiz sign. Once the participants were on the quiz page, they were permitted to begin taking the quiz independently. Each quiz provided five opportunities to respond. Each time a participant emitted a correct response the experimenter provided reinforcement by praising the student and permitting the student to move onto the next question. Each time the participant emitted an incorrect response the program and experimenter provided a correction by re-presenting the question to the participant, providing the correct response, re-presenting the antecedent again and having the participant emit the correct response independently. There were a total of 210 learn units presented during the entire RAZ-Kids intervention and a total of 210 instructional units presented during the Corrective Reading intervention. The experimenter recorded data on the number of correct and
incorrect responses emitted for each text at each level. Criterion was set to 100% correct responses on each quiz (i.e., 5/5 correct responses). At the end of each story, the experimenter viewed the total number of correct responses the participant emitted to determine whether the participant emitted 100% (i.e., 5/5 correct responses) accuracy. If the participant emitted less than 100% accuracy on a quiz the participant was required to recycle the quiz after receiving feedback.

**Corrective Reading:** Prior to beginning of the *Corrective Reading* (Engelmann, Haddox, Hanner, & Osborn, 1999) intervention participants were given opportunities to practice chorally responding on signal during group and class-wide settings due to the nature of the *Corrective Reading* curriculum, which requires participants to chorally respond. During the intervention the teacher instructed the group using choral responding. Choral responding involves the teacher presenting an antecedent to the group, the group attending to the antecedent, the teacher presenting a signal-to-respond to the group (e.g., clicker, finger-snap) and the group responding simultaneously on signal in vocal form.

During the intervention both groups were presented with the first ten lessons of *Corrective Reading*. As mentioned previously, it appeared that ten lessons provided ample opportunities for the participants to contact relational responding via the curriculum. Each lesson within *Corrective Reading* consists of eight or more exercises and each exercise consisted of four to eight learn units (Albers & Greer, 1991). The experimenter counted each exercise as an instructional unit because each exercise taught a specific comprehension skill. The experimenter took data on each of the participants’
responses to learn units (Albers & Greer, 1991), which were presented within each exercise also called an instructional unit.

A learn unit is a fundamental measure of pedagogy and is interlocking operants between the teacher and student, which involves teacher and student interactions (Greer & McDonough, 1999). In brief, the learn unit consists of an attending learner, the presence of a teacher or a target discriminative stimulus for teacher behavior, an unambiguous antecedent, student response to the teacher target discriminative stimulus, and a consequence for student response to the teacher behavior or discriminative stimulus (Albers & Greer, 1991; Greer & McDonough, 1999). However, for purposes of this study, instructional unit simply refers to the skill (i.e., exercise and tasks) being taught within each lesson. An instructional unit referred to each exercise, which targeted a specific comprehension skill (e.g., True/False) and each task within each exercise was also considered an instructional unit.

The instructional unit within Corrective Reading consisted of multiple individual learn units. As mentioned above, each task and exercise was considered an instructional unit. For example, if Exercise 1 of Lesson 3 targeted the comprehension skill “Some, All, None” and consisted of 3 tasks, that exercise would be considered to have three instructional units. Equally important, this same exercise could consist of more than six learn units, however the exercise itself would only be considered to have three instructional units. The experimenter matched the instructional units in Corrective Reading with the learn units presented in the RAZ-Kids curriculum. The experimenter presented 210 instructional units in Corrective Reading and 210 learn units in RAZ Kids. The instructors presented approximately a total of 210 instructional units in lessons one
through ten of Corrective Reading however, in order to keep the instructional units to 210 the experimenter only presented the first 21 instructional units in lessons three, four, and the first 20 instructional units in Lesson five even though there was a total of 24 instructional units in lessons three, four, and five. This allowed there to be a total of 210 instructional units presented during Corrective Reading. See Table 8 below for a visual display of the total number of instructional units and total number of derived relation learn units within each Corrective Reading lesson.

The participants were required to complete the first 10 lessons in Corrective Reading comprehension level A. The experimenter recorded data on each participants’ responses to the learn units within all instructional units. The criterion for each lesson was 90% x 1 or above. The data collected on each learn unit within each instructional learn unit allowed the experimenter to analyze whether the participant passed each Lesson with a score of 90% or higher. If the student emitted fewer than 90% correct responses, the student was required to recycle the specific instructional unit while the other students were praised for performance behaviors and/or prompted to count their points. Notably, all students in this study emitted 90% or above during each exercise. If a participant emitted all correct responses during each learn unit within each instructional unit a plus (+) was recorded, however when the participant emitted an incorrect response to one of the learn units within an instructional learn unit, the experimenter recorded a minus (-) for that learn unit and the student received a correction for that specific learn unit immediately following the incorrect response while the other students received points and praise for responding correctly and for performance behaviors (e.g., sitting nicely).
The correction operation consisted of the teacher re-presenting the antecedent, stating the correct answer then presenting the antecedent again and the student emitting the correct response independently. The student received feedback following each incorrect response to ensure that the student was learning from the corrective feedback pertaining to the skill being taught. Each lesson within Corrective Reading consisted of one workbook exercise, which required each student to attend to a specific worksheet page within the workbook. The workbook exercises required the participants to emit selection responses (e.g., circle the correct letter) when presented with positive and negative exemplars of the answer to the questions.

Table 8

This table shows the total number of instructional units (i.e., exercises/tasks) presented within each Lesson and the total number of derived relation learn units presented within each lesson of the Corrective Reading intervention.

<table>
<thead>
<tr>
<th>Corrective Reading Lesson</th>
<th>1</th>
<th>2</th>
<th>3</th>
<th>4</th>
<th>5</th>
<th>6</th>
<th>7</th>
<th>8</th>
<th>9</th>
<th>10</th>
</tr>
</thead>
<tbody>
<tr>
<td>Number Of Instructional Units (Exercises/Tasks)</td>
<td>19</td>
<td>23</td>
<td>24</td>
<td>24</td>
<td>24</td>
<td>20</td>
<td>21</td>
<td>18</td>
<td>18</td>
<td>20</td>
</tr>
<tr>
<td>Number Of Deduction Learn Units</td>
<td>2</td>
<td>2</td>
<td>2</td>
<td>3</td>
<td>3</td>
<td>4</td>
<td>4</td>
<td>3</td>
<td>4</td>
<td>3</td>
</tr>
<tr>
<td>Number Of Statement Inference Learn Units</td>
<td>1</td>
<td>2</td>
<td>2</td>
<td>2</td>
<td>2</td>
<td>2</td>
<td>2</td>
<td>2</td>
<td>2</td>
<td>2</td>
</tr>
<tr>
<td>Total Derived Relation Learn units (Deductions/Inferences)</td>
<td>3</td>
<td>4</td>
<td>4</td>
<td>5</td>
<td>5</td>
<td>6</td>
<td>6</td>
<td>5</td>
<td>6</td>
<td>5</td>
</tr>
</tbody>
</table>
Results

Group-Design Results

Across one or more of the dependent variables there were increases in correct responses for all the participants following the curriculum, which has the sequence to train derived relations (i.e., Corrective Reading). All participants in Group 1 showed gains across all three measures after receiving instruction from the curriculum, which has the sequence to train derived relations. All of the participants in Group 2 emitted significantly higher number of correct responses for deductions following the curriculum, which has the sequence to train derived relations compared to the number of correct responses emitted following the popular reading intervention (i.e., RAZ-Kids). Group 2 maintained low scores following the RAZ-Kids intervention and showed increases in correct responding post the curriculum, which has the sequence to train derived relations. See Figures 17, 18, and 19 below for a visual graphic display of the results from Group 1 and Group 2.
Figure 17. The number of correct deduction responses emitted by each participant in Group 1 and Group 2 during the deductions probes. All participants were probed using the original set (Set 1) and novel sets (Set 2 & Set 3) after each condition. Each set consisted of 15 probe trials.
Figure 18. The number of correct metaphor responses emitted during the probe. All participants were probed using a novel set after each condition. Each set required a maximum of 15 responses.
Figure 19. The number of correct responses emitted during the derived relations from letters/numbers probe. All participants were probed using the original set after each condition.
Single-subject Analysis

There was improvement for majority of the participants following the Corrective Reading condition. Figures 20-26 show the pre and post probe results graphed in pairs of individuals. The paired graphs show the results for the derived relations from letters/numbers probe, metaphor probe and the derived relation sentence probe. Each participant from Group 1 was paired with a participant from Group 2 based on cusps/capabilities and reading levels. Participants E1 and C1 are displayed in Figure 20. Participants E2 and C2 are displayed in Figure 21. Participants E3 and C3 are displayed in Figure 22. Participants E4 and C4 are displayed in Figure 23. Participants E5 and C5 are displayed in Figure 24. Participants E6 and C6 are displayed in Figure 25. Participants E7 and C7 are displayed in Figure 26.

Summary of Results

As shown in the above Figures the results show that Group 1 emitted a higher number of correct responses during the derived relations from letters/numbers probe following the Corrective Reading intervention and maintained high correct responses following the RAZ Kids intervention. In Group 2, Participants C1, C2, C3, and C7 also emitted a higher number of correct responses following the Corrective Reading intervention compared to the correct number of responses emitted following the RAZ Kids intervention for derived relations from letters/numbers probe. This rules out the notion that any popular reading curriculum, such as RAZ Kids can increase correct responding for derived relations. During the deductions probe, Group 1 emitted a higher number of correct responses following the Corrective Reading intervention and maintained high correct responses following the RAZ Kids intervention. Similarly, Group
2 emitted a higher number of correct responses following the *Corrective Reading* intervention compared to the correct number of responses emitted following the *RAZ Kids* intervention for deductions. The findings shown the deductions probes confirm that *Corrective Reading* was successful in training derived relations. During the metaphors probe, Group 1 emitted a higher number of correct responses following the *Corrective Reading* intervention, however following the *RAZ Kids* intervention the high number of correct responses decreased. For Group 2 during the metaphor probes Participant C1 and C5 showed some gains following the *RAZ Kids* intervention while all other participants did not show significant gains following the *RAZ Kids*. However, following the *Corrective Reading* intervention Participants C2, C3, and C7 showed a slight increase in correct responses; all other participants in Group 2 did not demonstrate higher numbers of correct responding following the *Corrective Reading* intervention with metaphors.
Figure 20. The number of accurate responses emitted by paired participants, E1 and C1 during the derived relations from letters/numbers probes, metaphor probes and the deductions probes. Participant E is from Group 1 and participant C is from Group 2. The horizontal black line represents the maximum number of responses (10) for the derived relations from letters/numbers probe.
Figure 21. The number of accurate responses emitted by paired participants, E2 and C2 during the derived relations from letters/numbers probes, metaphor probes and the deductions probes. Participant E is from Group 1 and participant C is from Group 2. The horizontal black line represents the maximum number of responses (10) for the derived relations from letters/numbers probe.
Figure 22. The number of accurate responses emitted by paired participants, E3 and C3 during the derived relations from letters/numbers probes, metaphor probes and the deductions probes. Participant E is from Group 1 and participant C is from Group 2. The horizontal black line represents the maximum number of responses (10) for the derived relations from letters/numbers probe.
Figure 23. The number of accurate responses emitted by paired participants, E4 and C4 during the derived relations from letters/numbers probes, metaphor probes and the deductions probes. Participant E is from Group 1 and participant C is from Group 2. The horizontal black line represents the maximum number of responses (10) for the derived relations from letters/numbers probe.
Figure 24. The number of accurate responses emitted by paired participants, E5 and C5 during the derived relations from letters/numbers probes, metaphor probes and the deductions probes. Participant E is from Group 1 and participant C is from Group 2. The horizontal black line represents the maximum number of responses (10) for the derived relations from letters/numbers probe.
Figure 25. The number of accurate responses emitted by paired participants, E6 and C6 during the derived relations from letters/numbers probes, metaphor probes and the deductions probes. Participant E is from Group 1 and participant C is from the Group 2. The horizontal black line represents the maximum number of responses (10) for the derived relations from letters/numbers probe.
Figure 26. The number of accurate responses emitted by paired participants, E7 and C7 during the derived relations from letters/numbers probes, metaphor probes and the deductions probes. Participant E is from Group 1 and participant C is from Group 2. The horizontal black line represents the maximum number of responses (10) for the derived relations from letters/numbers probe.
Figure 27. Corrective Reading acquisition graph displaying the number of correct responses emitted for each participant in Group 1 during the intervention. The criterion was set to 90% correct responses within each lesson. If a participant emitted less than 90% accuracy upon completion of a lesson, the participant was required to recycle the lesson. The y-axis scale begins at 80%.
Figure 28. Corrective Reading acquisition graph displaying the number of correct responses emitted for each participant in Group 2 during the intervention. The criterion was set to 90% correct responses within each lesson. If a participant emitted less than 90% accuracy upon completion of a lesson, the participant was required to recycle the lesson. The y-axis scale begins at 80%.
Figure 29. Group 1’s RAZ Kids intervention graph displaying the number of quiz recycles required for every 5 stories read by each participant. Each session consisted of the participants reading 5 stories. The criterion was set to 100% correct responses per story (i.e., 5/5). If a participant emitted less than 100% accuracy upon completion of a quiz, the participant was required to recycle the quiz.
Figure 30. Group 2’s RAZ Kids intervention graph displaying the number of quiz recycles required for every 5 stories read by each participant. Each session consisted of the participants reading 5 stories. The criterion was set to 100% correct responses per story (i.e., 5/5). If a participant emitted less than 100% accuracy upon completion of a quiz, the participant was required to recycle the quiz.
Discussion

The research question for Experiment I was to determine if the curriculum sequence of *Corrective Reading* or *RAZ Kids* could train derived relations, which in turn would cause an increase in the number of correct comprehension (i.e., derived relations and metaphors) responses. The present results show a functional relation between the sequence of the curriculum and higher numbers of correct responses emitted for derived relations and metaphor questions. The results also show that there was no functional relation between *RAZ Kids* and an increase in numbers of correct comprehension responses. The implementation of the first 10 lessons of *Corrective Reading* was successful in training derived relations in first grade learners, while the *RAZ Kids* curriculum did not show significant increases in comprehension responses following the post-intervention probes.

Deductions

The deductions probe sought to assess the presence of combinatorial entailment through the auditory presentation of sentences. The results showed that all seven participants in Group 1 emitted a higher number of correct responses following the *Corrective Reading* intervention. Markedly, Participant E4 was the only participant who demonstrated 80% correct responding for deductions during the pre-intervention condition and maintained high scores following the *Corrective Reading* and *RAZ Kids* interventions. Group 1 maintained and increased in correct responding following the *RAZ Kids* intervention. This could suggest that proper abstraction took place due to the fact that novel exemplars of deduction questions resulted in stimulus control. The results also suggest that the sequence of *Corrective Reading* trained combinatorial entailment given
that correct responding increased for deduction questions. The trained deductions responses showed strength when probed later, even after the group received exposure to an entirely different reading curriculum (i.e., RAZ Kids). The deductions responses showed strength in the occurrence of other deduction responses that displayed similar properties as the initially trained deduction responses (Skinner, 1957).

Consistent with Group 1’s data for deductions, the results showed that all of the participants in Group 2 emitted a higher number of correct responses following the Corrective Reading intervention compared to the number of correct responses emitted during the pre-intervention probe and following the RAZ Kids intervention. Participant C6 was the only participant with an IEP (i.e., Autism diagnosis) at the onset of the study and he did not demonstrate abstraction of deductions after mastering instruction in Corrective Reading. Participant C6 was also bilingual; he emitted the least number of correct responses for deductions following the Corrective Reading and RAZ Kids interventions. Participant C6 was more fluent in his native language (i.e., Chinese) due to the fact that he communicated in his native language with his family outside of school. According to Skinner (1957) it is possible that the deduction response (i.e., combinatorial entailment) was not conditioned in the presence of derived relations antecedents found in Corrective Reading, therefore it did not show strength in the presence of other deductions, which showed similar properties of the initially trained deductions. Though Participant C6 did not qualify for English Language Learner services, he may have lacked a significant number of English tacts in his fluent repertoire, therefore preventing deductions from being conditioned in the presence of deduction learn units presented during Corrective Reading. Also, Participant C6 did not have Naming in repertoire at the
start of the study and may have lacked phonemic control, which is a source of derived relations between joining Naming and reading (Reilly-Lawson, 2008) and can be considered a prerequisite to the advanced comprehension skills targeted in this study. Participant C7 was the only participant who showed an increase in correct responding for deductions following RAZ Kids intervention. Participant C7 may have contacted some reinforcement for deduction responses during instruction in other English Language Arts (ELA) areas throughout the school day.

**Derived Relations from Letters/Numbers**

Similar to Steele and Hayes (1991) who used letters/numbers to probe for mutual and combinatorial entailment following an arbitrary matching-to-sample training, this derived relations from letters/numbers probe used letters and numbers to assess the presence of combinatorial entailment after training the mutual entailment component through the visual-auditory presentation of the letters and numbers. The results for this probe showed that the majority of the participants in Group 1 emitted a higher number of correct responses following the curriculum, which trains derived relations and maintained high correct responding following the RAZ Kids intervention. One exception, Participant 6E did not emit any correct derived relations from letters/numbers responses following the Corrective Reading intervention, however he did emit correct responses following the RAZ Kids intervention. Comparatively, Participant 6E demonstrated combinatorial entailment following the deductions probe but not during the letters/number probe. Therefore it is possible that for Participant 6E, the sequence found within Corrective Reading initially only provided a reinforcement history for combinatorial entailment with sentences (i.e., deductions), however combinatorial entailment with contrived
letter/number relations did not abstract until the third exposure to the probe. Participant E5 did not demonstrate a large increase in correct responding following both interventions however; he did demonstrate combinatorial mutual entailment during the deductions probe. Similar to Participant E6, combinatorial entailment may not have abstracted from sentences to contrived letters-numbers for Participant E5.

The results for the derived relation from letters/numbers probe showed that the majority of the participants in Group 2 emitted a higher number of correct responses following the Corrective Reading intervention when compared to the numbers of correct responses emitted following the RAZ Kids intervention. Participant 6C and Participant C3 did not show an increase in correct responding following Corrective Reading. According to Hayes and Hayes (1989), relations are based on an individual’s reinforcement history with arbitrary and non-arbitrary relations. It is possible that Participant C6 and C3 lacked reinforcement history with arbitrary relations though they did contact reinforcement for non-arbitrary relations (i.e., deductions) during the Corrective Reading intervention.

Metaphors

The metaphors probe sought to assess whether the participants could tact the similarities or differences between dimensions of two or more stimuli that were not directly related. The results showed that all seven participants in Group 1 emitted significantly higher numbers of correct responses following the Corrective Reading intervention. Interestingly, all of the participants did not maintain high correct responses following the RAZ Kids intervention. The participants only received 10 lessons of the curriculum which has the sequence to train derived relations and the low number of metaphors responses may be due to lack of a reinforcement history in which metaphorical
responses were conditioned (Skinner, 1967). Skinner (1957) stated that metaphors are a type of extension that occurs because of the control exercised by specific dimensions of a stimulus and it is possible that lack of a reinforcement history means lack of control exercised by specific dimensions of stimuli.

Similar to Group 1, the majority of the participants in Group 2 increased in correct responses following the Corrective Reading intervention. The majority of the participants emitted a higher number of correct responses following the Corrective Reading intervention compared to the number of correct responses emitted following the RAZ Kids intervention, with the exception of Participants 4C and 6C. Participants C1, C4, and C5 showed an increase in correct responding following RAZ Kids and this may be due to the fact that the participants may have contacted reinforcement for metaphorical responses during other instructional settings.

It appears that Participant C4 may have already had a reinforcement history for metaphorical responses in repertoire during the pre-intervention probe condition. He continued to emit 5 or more accurate responses following the RAZ Kids and Corrective Reading interventions. Participant C2 did not show significant increase in correct responding following Corrective Reading and this may be due to the fact that Participant C2 was a free and reduced lunch learner from an economically disenfranchised community and therefore lacked language interaction experiences (Hart & Risely, 1995). According to Hart and Risely (1995), learners who lack a reinforcement history with language interaction experiences in their homes are found to have received far fewer language interaction experiences compared to their grade-level peers prior to the start of grade school. Participant C6 did not emit any correct responses following both
intervention conditions. It is possible that Participant C6’s metaphorical responses may not have been conditioned during Corrective Reading due to the fact that the participant may have significantly lacked prior instructional history with reinforcement for metaphorical responses and required many more opportunities to be reinforced for responding to metaphors antecedents. Contrary to Participant C6’s peer participants (i.e., English speakers) Participant C6 was bilingual and his original verbal community may not have provided reinforcement for metaphorical responses to strengthen control over dimensions of stimuli. Some participants in Group 2 did not show significant increases in correct responding following the Corrective Reading intervention; they may have lacked reinforcement history by their verbal community in establishing two separate equivalence relations between stimuli and deriving an equivalence relation between those relations. The verbal community of these participants may not have provided these learners with adequate reinforcement history for metaphorical responses. These participants may have benefited from more lessons of the curriculum, which has the sequence to train derived relations to strengthen their reinforcement history for metaphorical responding.

Rationale for Experiment II

Overall, the results for Experiment I showed that the sequence of Corrective Reading was successful in increasing the number of correct comprehension responses emitted by first graders. Also, the results from Experiment I strengthened the idea that relational responding is a necessary repertoire to have in order for there to be success with advanced comprehension involving metaphors and deductions. The rationale for Experiment II was to replicate the findings in Experiment I. Similar to Experiment I, Experiment II sought to determine whether the sequence of the Corrective Reading
curriculum alone could increase correct responding in the same comprehension repertoires, deductions, derived relations from letters/numbers, and metaphors with first grade students. An additional dependent variable was assessed, implicit and explicit reading comprehension questions. Experiment II also targeted first graders, however all the participants in Experiment II were monolingual English speakers, three of the four demonstrated full Naming at the onset of the study, and were already reading at the end-of-the-year reading level for first grade.

Given that the students in Experiment II were all advanced first grade readers, could these participants increase in correct derived relations responses just as the participants in Experiment I though the participants are only presented with five lessons of Corrective Reading? In respect to this, Experiment II provided the participants with five lessons in order to determine if the sequence in Corrective Reading could train derived relations though the participants’ only come in contact with five lessons (i.e., 60 exercises) instead of ten. All in all, Experiment II differed from Experiment I due to the fact that there was an additional dependent variable (i.e., implicit and explicit reading comprehension responses), five lessons of Corrective Reading was implemented instead of ten, only one intervention (i.e., Corrective Reading) were run instead of two, and Experiment II was a single case design with two first-grade dyads.
CHAPTER III

EXPERIMENT II

All components of Experiment II were the same as in Experiment I, with the following exceptions: different participants, one intervention (i.e., Corrective Reading) conducted rather than two, the addition of the QRI implicit/explicit comprehension questions, and the design was a single case design.

Participants

Four participants from a first grade inclusion classroom participated in this study. All of the participants were typically developing first grade students without Individualized Educational Plans (IEP). There were three females and one male. All four participants were seven years of age at the start of the study. All participants were selected from a general education, inclusion first grade classroom within a public school. The classroom was comprised of 15 students in total. The classroom consisted of one lead teacher and one paraprofessional. Some features of this classroom included but were not limited to: large group instruction, choral responding, and a class-wide behavior management system.

At the onset of the study, all participants were assessed for the presence of naming and observational learning to determine whether these verbal developmental capabilities were in repertoire or not. The results from these assessments provided the experimenter with data pertaining to the participants’ existing cusps/capabilities and how the participants could learn (Greer & Ross, 2008). The experimenter assessed these cusps due to the fact that the presence of these capabilities are beneficial for learners to have in order to learn in new ways and learn successfully in the general education setting (Greer
& Speckman, 2009). At the onset of the study three of the four participants had full naming, Participant A had the listener half of Naming, and all four participants had observational learning in repertoire. All of the participants functioned at Listener/Speaker and Reader/Writer levels of verbal behavior (see Table 9 for detailed demographics and participant information). The following repertoires were required in order to be a participant in this study: read-do (follow written instructions), Grade one reading level, and conditioned reinforcement for observing books. The experimenter selected four participants due to low numbers of correct responses across all of the following dependent variables: derived relations from letters/numbers probe, deductions probe, and the metaphor probe.
Table 9

*Description of Participants at the onset of Experiment II by qualification for free/reduced lunch, gender, Individualized Education Plan, Naming capability, Observational Learning capability, and Grade level equivalent reading level.*

<table>
<thead>
<tr>
<th>Participants</th>
<th>Qualification for Free/Reduced Lunch</th>
<th>Gender</th>
<th>IEP</th>
<th>Full Naming</th>
<th>Observational Learning</th>
<th>Reading Rate (WPM)</th>
<th>Grade Level Equivalent Reading Level</th>
</tr>
</thead>
<tbody>
<tr>
<td>A:</td>
<td>N</td>
<td>M</td>
<td>N</td>
<td>N</td>
<td>Y</td>
<td>90</td>
<td>Grade 1: E</td>
</tr>
<tr>
<td>B:</td>
<td>N</td>
<td>F</td>
<td>N</td>
<td>Y</td>
<td>Y</td>
<td>90</td>
<td>Grade 1: E</td>
</tr>
<tr>
<td>C:</td>
<td>N</td>
<td>F</td>
<td>N</td>
<td>Y</td>
<td>Y</td>
<td>90</td>
<td>Grade 1: E</td>
</tr>
<tr>
<td>D:</td>
<td>N</td>
<td>F</td>
<td>N</td>
<td>Y</td>
<td>Y</td>
<td>90</td>
<td>Grade 1: E</td>
</tr>
</tbody>
</table>

Note. A Y denotes a Yes, which means that the participant had the characteristic in repertoire according to information provided by the school district and Verbal Behavior Development Assessment procedures (Greer & Ross, 2008). An N denotes a No, which means that the participant did not have the characteristic in repertoire according to information provided by the school district and Verbal Behavior Development Assessment procedures (Greer & Ross, 2008).

a IEP refers to Individualized Education Plan.
b Full Naming refers to incidental language acquisition and is demonstrated when a learner acquires the tact as a listener for a stimulus after receiving reinforcement or correction on matching the visual stimulus while attending to the auditory name and later emits the name for the stimulus as a speaker.
c Observational Learning refers to a learner who demonstrates the capability of acquiring new skills after observing a peer receive instruction in the form of reinforcement or correction.
d An E refers to “end of year” reading level

**Setting**

The experiment took place in a general education first grade classroom. The classroom was located in a Kindergarten through fifth grade Elementary School. The experiment was conducted in the corner of the classroom at a U-shaped table, while the other students were engaged in small group instruction.

**Materials**

The materials used in Experiment II were the same as the materials used in Experiment I. However, in Experiment II the experimenter only used the first five lessons of *Corrective Reading* and there was the addition of the *Qualitative Reading Inventory*
(5th Ed), QRI-5 (Leslie & Caldwell, 2010). The QRI was an additional reading comprehension measurement. The QRI-5 is a standardized reading assessment used to examine readers’ textual responses (i.e., decoding) to grade level texts, reading fluency of grade level passages, vocabulary, and accurate comprehension responses. The assessment was conducted during pre-intervention and post-intervention conditions. The materials used were the QRI-5 assessment sheet, which were 8” x 11” worksheets consisting of the Level 1 (i.e., 1st grade level) story read by the participant and the Level 1 QRI questionnaire packet, which consisted of comprehension questions and scoring sheet. The experimenter used the test materials from the Level 1 stories due to the fact that the Level 1 was equivalent to a first grade reading level and all participants were either on or above a first grade reading level. Elementary grade Level 1 stories were used to assess the participants’ reading and comprehension responses during pre-and post-intervention probes. The following stories were used, *Mouse in the House*, *The Bear and the Rabbit*, and *Marva Finds a Friend* (Leslie & Caldwell, 2010). Samples of the QRI assessment sheets are shown in Figures 31 and 32.
Figure 31. Sample of a Level 1 QRI-5 assessment sheet completed by the participants during all probe conditions. Participants were required to read the leveled stories then emit written responses to the comprehension questions.
COMPREHENSION:

Mouse in a House - Level One - Narrative

1. Where did the mouse live in the house?
   Explicit: in a wall.

2. What did the old man decide to do?
   Explicit: sell the house.

3. What did the mouse do when people came to visit the house?
   Explicit: run up and down the inside of the walls.

4. How many floors did the house have?
   Implicit: two.

5. Why didn't some people want to buy the house?
   Implicit: they didn't want a mouse in their house.

6. Why did the last family buy the house even though it had a mouse?
   Explicit: it was the right size for them.

<table>
<thead>
<tr>
<th>Total Reading</th>
<th>Comprehension</th>
<th>Reading Level</th>
</tr>
</thead>
<tbody>
<tr>
<td>Independent</td>
<td>Independent</td>
<td>Independent</td>
</tr>
<tr>
<td>Independent</td>
<td>Instructional</td>
<td>Instructional</td>
</tr>
<tr>
<td>Independent</td>
<td>Frustration</td>
<td>Frustration</td>
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<tr>
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<tr>
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<tr>
<td>Frustration</td>
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<td>Frustration</td>
</tr>
<tr>
<td>Frustration</td>
<td>Instructional</td>
<td>Frustration</td>
</tr>
</tbody>
</table>

Number Correct Explicit: ______
Number Correct Implicit: ______
Total ______
  Independent: 6 correct
  Instructional: 4-5 correct
  Frustration: 0-3 correct

Figure 32. Sample of a Level 1 QRI-5 comprehension assessment sheet completed by the participants in written form during all probe conditions. The experimenter used the answer key on the worksheet to score number of correct/incorrect written responses.
The participants were required to read the Level 1 story and respond in written form to the five explicit and implicit comprehension questions. The participants were not able to refer back to the story during the comprehension probe. Following completion of the comprehension responses, the experimenter reviewed the responses and scored the responses using the answer key.

**Dependent Variables:**

The dependent variables in Experiment II were identical to the three dependent measures in Experiment I, however a fourth additional dependent measure was included. The additional dependent measure was implicit and explicit comprehension questions from the QRI-5 (Leslie & Caldwell, 2010). As mentioned previously, the QRI-5 is a standardized reading assessment used to examine readers’ textual responses, reading rate of grade level passages, vocabulary, and comprehension responses. The QRI-5 is a common reading assessment used in grade level schools from K-12. The experimenter used the reading *comprehension* questions from the QRI to assess for mutual entailment (i.e., explicit comprehension) and combinatorial entailment (i.e., implicit comprehension). For example, Level 1 story *Mouse in a House*, included four explicit comprehension questions and two implicit comprehension questions. The following is an example of one of the explicit questions presented in the *Mouse and the House* narrative, “Where did the mouse live in the house?” The answer to this question is explicitly stated in the text. This form of question demonstrates mutual entailment due to the fact that it assess for a bidirectional relationship between two stimuli and the first relation (A=B) relation is directly presented in the text. In this example the first relation taught was, mouse lives (i.e., A) in a wall (i.e., B). The reader simply has to demonstrate that he can
respond accurately to this explicit question in both directions (i.e., A=B and B=A). The following is an example of one of the implicit questions presented in the *Mouse in the House* narrative, “How many floors did the house have?” Responding accurately to this question demonstrates combinatorial entailment because the answer to this question is not explicitly stated in the text and must be inferred (i.e., A=B, B=C therefore A=C). The assessment provided the participants with a total of six questions following each story; majority of the stories contained four explicit questions and two implicit questions.

**Independent variable:**

The experimenter implemented five lessons of the same independent variable found in Experiment I, *Corrective Reading* (Engelmann, Haddox, Hanner, & Osborn, 1999).

**Data collection:**

Data collection for the following dependent measures, derived relations from letters/numbers, deductions, and metaphors were the same as Experiment I. Data collection for *Corrective Reading* was the same as Experiment I.

During the QRI-5 assessment probe, the participants were required to independently read the Level 1 story provided to them. The experimenter provided each participant with a copy of the targeted Level 1 story being assessed. The experimenter provided the participants with a version of the comprehension sheet that did not include an answer key. The participants were required to write their name at the top of the page then proceed with reading the story independently. Prior to beginning to read the story, the participants were told to raise their hand if they encountered an unfamiliar word which they could not decode so that they could receive assistance from the experimenter. None of the participants required assistance during the reading portion of the assessment.
During the comprehension portion of the QRI probe, the experimenter placed the printed story out of view (e.g., in a folder, under paper) so that the participants answered each question without referring to the story. The participants were required to independently read each question and emit their response in written form using a pencil. Once the participants completed the written portion of the QRI-5 assessment they were required to hand the paper in to the experimenter. The experimenter scored the participants’ responses by reading the question and using the answer key provided for instructors to score. The participant received a plus if the answer was identical to the answer provided in the answer key or if the answer was accurate despite the use of different terms than the terms found in the answer key. The student received a minus (-) if the answer differed significantly from the answer provided in the answer key or if the answer was functionally inaccurate. For example, in question number two of *Mouse In a House-* Level 1 story the following question is proposed, “what did the old man decide to do?” The answer key states, “sell the house.” If the participant writes, “sell the house” or something similar such as, “have someone buy the house,” “market the house” or “put it up for sale” the experimenter considered the answer correct. However, if the participant wrote a response that did not match the answer key or that was functionally incorrect such as, “give the house away for free” or “exchange the house for another house,” then the answer was considered incorrect. A second experimenter collected data and scored the comprehension sheets independently for inter-scorer agreement purposes (ISA).
Design:

The design for Experiment II was a multiple probe design across two dyads. The sequence of the experiment was as follows: (1) A pre-experimental screening to identify the participants’ level of comprehension for the Corrective Reading intervention, (2) Both dyads received pre-intervention probes targeting all four dependent measures, (3) Dyad 1 received Corrective Reading intervention, (4) Post-probes for Dyad 1, (5) A second pre-intervention probe for Dyad 2, (6) Dyad 2 received Corrective Reading intervention, (7) Post-probes for Dyad 2, and (8) A second post-probe was conducted for Dyad 1. See Figure 33 for a visual sequence of the experimental design.
Figure 33. A sequence of the experimental design for Experiment II.
Interobserver Agreement (IOA) and Inter-scorer Agreement (ISA):

For all participants, IOA was conducted for 100% of the letters/numbers probes, metaphor probes, and deduction probes with 100% agreement. See Tables 10-12 for details pertaining to IOA for each participant.

The Experimenter conducted inter-scorer agreement using the permanent products collected from the QRI comprehension probes. ISA was conducted for 100% of the QRI-5 comprehension probes with 100% agreement. See Table 13 for detailed information pertaining to ISA for each participant.

Table 10

The percentage of mean agreement and the percentage of sessions during which IOA was conducted for all metaphor probes.

<table>
<thead>
<tr>
<th>Metaphors: Participants</th>
<th>Percentage of Sessions</th>
<th>Mean Agreement</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>Participant A</td>
<td>Participant B</td>
</tr>
<tr>
<td></td>
<td>100%</td>
<td>100%</td>
</tr>
<tr>
<td></td>
<td>100%</td>
<td>100%</td>
</tr>
</tbody>
</table>

Table 11

The percentage of mean agreement and the percentage of sessions during which IOA was conducted for all deduction probes.

<table>
<thead>
<tr>
<th>Deductions: Participants</th>
<th>Percentage of Sessions</th>
<th>Mean Agreement</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>Participant A</td>
<td>Participant B</td>
</tr>
<tr>
<td></td>
<td>100%</td>
<td>100%</td>
</tr>
<tr>
<td></td>
<td>100%</td>
<td>100%</td>
</tr>
</tbody>
</table>
Table 12

The percentage of mean agreement and the percentage of sessions during which IOA was conducted for all derived relations from letters/numbers probes.

<table>
<thead>
<tr>
<th>Letters/Numbers:</th>
<th>Participants</th>
<th>Percentage of Sessions</th>
<th>Mean Agreement</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>Participant A</td>
<td>100%</td>
<td>100%</td>
</tr>
<tr>
<td></td>
<td>Participant B</td>
<td>100%</td>
<td>100%</td>
</tr>
<tr>
<td></td>
<td>Participant C</td>
<td>100%</td>
<td>100%</td>
</tr>
<tr>
<td></td>
<td>Participant D</td>
<td>100%</td>
<td>100%</td>
</tr>
</tbody>
</table>

Table 13

The percentage of mean agreement and the percentage of quizzes scored during which ISA was conducted for all QRI comprehension probes.

<table>
<thead>
<tr>
<th>QRI Comprehension:</th>
<th>Participants</th>
<th>Percentage of Permanent Products Scored</th>
<th>Mean Agreement</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>Participant A</td>
<td>100%</td>
<td>100%</td>
</tr>
<tr>
<td></td>
<td>Participant B</td>
<td>100%</td>
<td>100%</td>
</tr>
<tr>
<td></td>
<td>Participant C</td>
<td>100%</td>
<td>100%</td>
</tr>
<tr>
<td></td>
<td>Participant D</td>
<td>100%</td>
<td>100%</td>
</tr>
</tbody>
</table>

Procedure

The procedure for Experiment II was the same as the procedure for Experiment I with some minor changes. The experiment began with the implementation of the Corrective Reading pre-screening assessments. Based on the scores from the placement test, all four participants were placed on comprehension level A of Corrective Reading. Then the experimenter probed across all four dependent variables, derived relations from letters/numbers, metaphors, deductions, and the QRI comprehension questions. During Experiment II the experimenter only implemented the curriculum, which has the sequence to train derived relations. Also during Experiment II, the experimenter conducted five lessons of the curriculum rather than ten.
During the QRI probe the experimenter presented each participant with a pencil and one copy of a Level 1 story packet selected from the QRI book. As mentioned previously, level 1 in the QRI provided first grade reading level stories. The Level 1 packet consisted of three pages. The first page consisted of concept-questions and the written story. The second page consisted of scoring guides for retell responses, rate and accuracy of textually responding. The third page consisted of the comprehension questions. The participants were not required to complete the concept-questions component on the first page of the packet. The participants were told to read the narrative on the first page then turn to the third page and answer the six comprehension questions in written form. Once the participants were done writing the responses to the comprehension questions, the experimenter probed the participants on retell responses using the scoring sheet on page two. During the retell component the experimenter and the participant sat at a distance from the other participants to prevent the other participants from hearing the responses. During this probe, if any of the participants completed the packet prior to the other participants being done, they were given grade level books to read while the other participants completed the packet.

**Results**

Identical to the findings in Experiment I, there were increases in correct responses for all the participants following *Corrective Reading* for at least two or more of the dependent variables. There were minimal gains for derived relations from letters/numbers across both dyads. For the metaphors and deductions probes, both dyads emitted significantly higher number of correct responses following the *Corrective Reading* intervention. For the derived relations from letters/numbers probe, all participants but
Participant C showed increases in correct responding following the Corrective Reading intervention. For Dyad 1, the gains on the QRI comprehension responses were more significant compared to the results for Dyad 2.

*Figure 34.* The number of correct responses emitted during the deductions probe. All participants were probed using a novel set after each condition.
Figure 35. The number of correct responses emitted during the metaphor probe. All participants were probed using a novel set after each condition.
- Figure 36. The number of correct responses emitted during the derived relations from letters/numbers probe. All participants were probed using the original set after each condition.
Figure 37. The number of correct responses emitted during the QRI comprehension questions. All participants were probed using a novel story with a post quiz after each condition.
Figure 38. The number of correct responses emitted during the Corrective Reading intervention for Participants A and B (Dyad 1). Criterion was set to 90% within one lesson. If a participant emitted less than 90% correct responses within one lesson, the participant was required to recycle the entire lesson until 90% or above was achieved.
Figure 39. The number of correct responses emitted during the Corrective Reading intervention for Participants C and D (Dyad 2). Criterion was set to 90% within one lesson. If a participant emitted less than 90% correct responses within one lesson, the participant was required to recycle the entire lesson until 90% or above was achieved. The dark bar represents the recycle for Lesson 1.
Discussion

The results of Experiment II showed that 1) Five lessons of Corrective Reading was enough to provide the multiple exemplar experience needed to train derived relations with typically developing learners, 2) the number of correct metaphors and deductions responses increased following Corrective Reading instruction, and 3) even though the sequence found within Corrective Reading instruction increased correct responses with deductions (i.e., derived relations from sentences) the correct responses did not consistently increase with derived relations from letters/numbers.

Participant D showed the most gains in correct responding with derived relations from letters/numbers following Corrective Reading compared to the other participants. This may be due to the fact that Corrective Reading does not train derived relations using contrived letter/number combinations but rather it trains derived relations in the form of deductions and inferences.

The results from Experiment II are consistent with the findings from Experiment 1 and consistent with the previous findings from Howarth, Dudek, and Greer (2015). Howarth et al. (2015) showed that teaching symmetrical relations provided an experience that induced derived relations. Experiment 1 of this study demonstrated that 10 lessons of Corrective Reading provided a multiple exemplar experience that was effective in increasing derived relation responses, however Experiment 2 built upon this by showing that 5 lessons of Corrective Reading was also effective in providing the experience necessary to increase correct responding to derived relations comprehension questions. During Experiment 2, the experimenter was able to run the intervention at a more fluent pace due to the fact that there were only two participants in each group and therefore
there were fewer participants who needed corrections during each lesson. Dyad 2 emitted a higher number of correct responses to deductions following Corrective Reading compared to Dyad 1. This may be due to the fact that Dyad 2 recycled Lesson 1 and therefore received a total of 6 lessons compared to Dyad 1. Dyad 1 did not require any recycles and therefore only received 5 lessons.
CHAPTER IV

GENERAL DISCUSSION

Summary of Findings

In this study, two experiments were conducted to test that advanced reading comprehension involves relational responding and that relational responding can be taught directly when initially not present in a learner’s repertoire. Based on the findings from both experiments, I suggest that relational responding is a necessary repertoire for advanced reading comprehension to take place (e.g., deductions, inferences and metaphors). The findings from these two experiments confirm that the Corrective Reading curriculum trains derived relations and can increase correct responding for metaphors and derived relations in first grade learners (i.e., early readers). The implementation of Direct Instruction curricula that have a sequence which trains derived relations can teach beginning readers to respond accurately to advanced comprehension questions prior to comprehension becoming a problem later on.

The findings are consistent with research studies that found that reading comprehension responses or derived relations responses improved following the appropriate multiple exemplar experiences (da Silva, de Souza, & de Rose, 2006; Helou-Care, 2008; Howarth, Dudek, & Greer, 2005; Meincke, Keohane, Gifaldi, & Greer, 2003; Park, 2005; Wiehe, 2014). Meincke, Keohane, Gifaldi and Greer (2003) provided a multiple exemplar experience that allowed novel metaphorical responses to emerge. Helou-Care (2008) found that comprehension improved after the induction of Naming through MEI. Howarth et al., (2015) found that correct responding to emergent relations probes increased following the implementation of a multiple exemplar training set,
therefore suggesting that bi-directional/symmetrical relations as well as verbal operants were essential in order for derived relations to emerge. Park (2005) used a multiple exemplar instruction intervention to improve reading comprehension in early readers. Park’s (2005) intervention involved auditory-visual matching and visual-visual matching.

Metaphors

Metaphors are common and frequently used across all genres of texts (Cunningham, 1976). The findings from both experiments showed that the sequence found in Corrective Reading was effective in increasing correct metaphoric responses, which is a necessary repertoire to have in order to be successful at comprehending all genres of texts. Wiehe (2014) found that multiple exemplar instruction across emotional function of reader and writer responses resulted in the emergence of an emotional function on listeners. Cunningham (1976) examined the influence of metaphors on reading comprehension and found that students (i.e., 190 sixth graders) performed better on comprehension of non-metaphorical passages compared to comprehension performance of the metaphorical passages. As mentioned previously, metaphors and derived relations are a type of extended tact found in aesthetic writing (Greer & Ross, 2008). Stewart and Barnes-Holmes’ (2001) interpretation of metaphors is an extension of Skinner’s (1957), who described metaphors as a type of extension that occurs because of the control exercised by specific dimensions of a stimulus.

Since metaphorical responses are a reflection of the speaker’s reinforcement history, it is important to take into account the community to which the reader is attached. For example a student from a low socio-economic community may not have acquired enough language interactions in order for certain metaphorical responses to be
conditioned (Hart & Risely, 1995). Based on the findings in this study, the participants who qualified for free and reduced lunch (i.e., Participant 2C, 3C, and 7C) emitted fewer correct responses during the metaphor probe compared to most of their non-free and reduced lunch peers. In order to comprehend a metaphor the listener (i.e., reader) has to identify and compare the common properties between two target stimuli presented in a text and learners with extensive language interaction backgrounds may better demonstrate comprehension with metaphors. Corrective Reading provided experiences that increased the vocabulary and tact repertoire of the learners through exercises which reinforced skills such as, same-all-none, classifications (e.g., buildings, vehicles, and appliances), and true-false. These exercises teach learners to identify the commonalities and non-commonalities between two stimuli or events. Based on the findings from both experiments, learners who lack language interactions experiences may benefit from receiving Corrective Reading instruction, due to the fact that the instruction can increase their tact repertoire further allowing them to accurately produce and comprehend metaphors. Equally important, the findings from Experiment 1 also show that for accurate metaphorical responses to maintain, the learners must be provided with enough exposure to the Corrective Reading curriculum.

Deductions & Derived Relations from Letters/Numbers

Da Silva, de Souza, and de Rose (2006) found that visual-visual match-to-sample trials and auditory-visual matching experiences increased correct responses on equivalence relations probes. Similar to Sidman and Tailby (1982), da Silva et al. (2006) used contrived letters/numbers to test for transitivity (i.e., combinatorial entailment). The findings from Experiment 1 show that the sequence found within Corrective Reading was
effective in training combinatorial mutual entailment, which in turn increased correct responses to deductions and derived relations from letters/numbers. The curriculum provides 50 derived relations instructional units within the first ten lessons and it appears that the relational responding experience provided from the ten lessons made it possible for the participants to respond accurately to other exemplars of derived relations whether with sentences or contrived letters/numbers. In Experiment II, both dyads demonstrated significant improvement on deductions following the five lessons of Corrective Reading. However, there was only one participant (i.e., Participant D) who showed gains on derived relations from letters/number immediately following the Corrective Reading intervention. Participants A, B, and C did not show immediate gains in correct responding with derived relations from letters/numbers after five lessons of the Corrective Reading intervention. This may be due to the fact that unlike da Silva, de Souza and de Rose (2006), the sequence found within Corrective Reading did not train derived relations using contrived symbol or letter/number combinations, rather it trained derived relations using short sentences (e.g., “All fish swim. Sharks are fish, so sharks-swell”). Derived relations in sentence format better reflect what derived relations look like in reading comprehension. Since the Corrective Reading curriculum only provided a reinforcement history using derived relations in sentence form, it is possible that the three participants in Experiment II may have needed more opportunities to respond to derived relations learn units (i.e., more lessons) in order for relational responding to emerge for contrived letter/number relations as well. Derived relations may need to be taught using different types of stimuli (e.g., sentences, symbols, letters, numbers, pictures) in order for abstraction to take place.
Reader-As-Own Listener and Reading comprehension

A learner’s performance in reading comprehension is a function of the experiences that the learner encountered within his environment. Reading comprehension occurs when a learner hears his own textual responses and responds to the text the way the writer intended for the reader to respond (Greer & Ross, 2008). In order for successful reading to take place, the following components are required: listener, speaker, and speaker-as-own listener repertoires (Greer & Ross, 2008). When a learner first acquires the skill of reading he is seeing and saying the printed words while simultaneously hearing himself as a speaker. Also, while the reader is textually responding to the words, he is attending to the auditory properties of the speech sounds, which in turn represents an object, person, or event (e.g., student can read c-a-t and point to picture of cat). The reader’s verbal community reinforces certain consonant-vowel combinations that correspond with stimuli or events within the reader’s environment. Successful correspondence between reading and doing occurs when the reader is able to hear himself when textually responding to the words. Not only must the reader hear himself but he must also respond accordingly to his speaker sounds as a listener (Greer & Ross, 2008).

Furthermore, implicit reading comprehension (i.e., involving derived relations) also involves listener, speaker, and listener as-own speaker repertoires, however not only does the listener have to attend to his own textually responding, he must also attend to his own speaker behavior deriving relations during the reading process (i.e., combinatorial entailment). For example, if a reader textually responds to a story about a girl going to a theme park with her family, he is attending to his behavior beneath the skin deriving
certain relations that are not explicitly stated in the text (e.g., the girl may be happy because going to parks is fun or the girl must be outdoors because most theme parks take place outdoors).

The curriculum sequence found in Corrective Reading reinforces the appropriate listener and speaker-as-own listener repertoires during comprehension instruction. According to the findings from Experiment II, Corrective Reading improved implicit and explicit reading comprehension for three of the four participants. Participants A, B, and C emitted less than 90% correct responses during the pre-intervention probes for first grade level implicit and explicit reading comprehension questions. Following the Corrective Reading intervention, all three participants increased in correct responding compared to scores performed during pre-intervention conditions. Participant D demonstrated that accurate responding to first grade implicit and explicit reading comprehension skills were already in repertoire during the second pre-intervention probe.

The Curriculum Sequence of Corrective Reading and Direct Instruction

The curriculum sequence found within Corrective Reading (Engelmann, Haddox, Hanner, & Osborn, 1999) was effective in improving comprehension (i.e., derived relations) in early readers because it provided thorough details regarding the multiple exemplar instructional exchange that should take place to train derived relations, which in turn provided a reinforcement history in which relational responding was reinforced. The implementation of Corrective Reading or other Direct Instruction (DI) curricula (e.g., Funnix Reading, Horizons, Reading Mastery, REWARDS) requires that the instructors follow the specifications outlined by the curriculum (e.g., scripted lessons). In general, the teaching procedures for each skill and concept in DI curricula are specified, which
therefore decreases the likelihood of teacher errors and increases the chances of successful student performance (Engelmann & Carnine, 1982).

The sequence found in Corrective Reading provided a systematic form of instruction in which the skills sequentially advanced as the learners demonstrated mastery of each objective. As seen in both experiments, this type of systematic instruction produces academic achievement for learners due to the fact that it addresses all necessary prerequisite skills before moving on to more complex skills (Slocam, 2004). Corrective Reading was successful in improving correct reading comprehension responses due to the curriculum content and organization of the subject content. DI curricula teach generalizable strategies (Engelmann & Carnine, 1982). The sequence found within Corrective Reading not only has organized lessons that introduces every academic skill within a sequential order but it also decreases the amount of support the learners would need in order to master a learning objective.

**Educational Implications**

The implications from the findings of both experiments contribute greatly to educational literature pertaining to reading and listening comprehension. Listening is a critical part of the reading process (Greer & Ross, 2008; Greer & Speckman, 2009). Whether a learner is listening to his-own-self read a text or listening to another individual read a text, the leaner is attending to the auditory components of the speech sounds and he is discriminatively responding to these auditory sounds (Greer & Ross, 2008). Corrective Reading provides multiple exemplar experiences that join the listener and speaker repertoires within one’s own skin. If a child does not attend to the phonemic auditory components of reading then the child is not a “textual responder as listener,”
which in turn may result in difficulty responding to explicit (i.e., mutual entailment) comprehension questions (Greer & Speckman, 2009). Instructors should teach decoding skills to fluency for those learners who lack a “textual responder as listener” repertoire. Instructors should also implement Corrective Reading to improve those learners’ reader-as-own-listener skills (Greer & Speckman, 2009). In order for comprehension to take place during the reading process not only must the learner listen to his-own-self read but the learner also must derive relations between stimuli presented in the text and his own experiences. For example, if a story states that “Sally twisted her ankle during recess and was sent home early” the reader must derive that Sally must be upset because a twisted ankle is painful and painful experiences cause people to be upset. A learner must derive relations in order to respond accurately to inference and deduction comprehension questions.

It is beneficial for educators to understand the process that takes place during reading or listening comprehension so that they can provide their learners with the experiences they need in order to comprehend. When a learner is responding accurately to explicit information directly sated in the text, he is demonstrating mutual entailment (i.e., A=B then B=A), according to Relational Frame Theory (RFT) (Barnes-Holmes, Barnes-Holmes, Smeets, Cullinan, & Leader, 2004). Also, when a learner is responding accurately to implicit information not directly sated in the text, he is demonstrating combinatorial entailment (i.e., A=B, B=C then A=C), according to RFT (Barnes-Holmes, et al., 2004). Once students become fluent readers (e.g., second grade) they are required to respond to more advanced compression questions in which the response has to be inferred; this is a demonstration of combinatorial entailment. For example, the following
standardized reading comprehension assessments are used nationwide and probe for implicit comprehension responses (i.e., derived relations) when the readers become more fluent: Developmental Reading Assessment (DRA), Dynamic Indicators of Basic Early Literacy Skills (DIBELS), Qualitative Reading Inventory (QRI), Readers Workshop assessments, and Reading A-Z benchmarks, to list a few.

Based on the findings from both experiments, instructors should find it advantageous to instruct their early readers (e.g., K-2 or higher) using Corrective Reading (i.e., Comprehension A) in order to build or improve the comprehension performance of their learners. Corrective Reading instruction targets listening comprehension skills and only requires vocal responses and selection responses using pictures. This makes it easy to implement for learners who are not yet fluently decoding. Paris and Paris (2007) found that first graders who could and could not fluently decode were able to improve in accurate retell responses, accurate responses to implicit pictorial information, and improve organizing main story elements after receiving “narrative thinking” instruction. The findings from Experiment II showed that written comprehension responses improved following the implementation of the curriculum with the sequence that trains derived relations (i.e., Corrective Reading). Though Corrective Reading mainly provided instruction addressing vocal responses rather than written responses, written comprehension improved.

Corrective Reading also provides vocabulary instruction, which in turn builds the tact repertoire (i.e., spoken word and picture/object associations) for students who lack language experiences. Listening as own comprehending results in accurate comprehension when the verbalizations are in the readers’ tact repertoire (Greer &
Keohane, 2006). All in all, teachers should consider using DI curricula such as *Corrective Reading* to improve student performance in reading comprehension.

**Limitations**

In Experiment I, there were a few limitations worthy of being noted. One limitation includes the fact that Participant 6C may have been missing some prerequisites skills necessary to successfully participate in this study. Participant 6C was bilingual (i.e., more fluent in his non-English language), lacked full Naming, and lacked enough English language experiences required in order to contact the relational experiences provided from the *Corrective Reading* curriculum. It is possible that the combination of these issues for Participant 6C may have kept him from appropriately attending to the relational repertoires taught in *Corrective Reading*. It is possible that more exposure to the sequence of *Corrective Reading* could have solved this problem.

Another limitation for Experiment I is that it appears that Set III of the Metaphors probe may have included some more challenging metaphor exemplars when compared to the metaphor exemplars found in Set-I and Set-II. The level of difficulty in response may have increased slightly, therefore causing the number of correct responses to decrease for Group 1 following *RAZ Kids* and causing the number of correct responses to remain low for Group 2 following *Corrective Reading*. Probing the original Metaphor sets during each condition may have helped control for this limitation or so could have changing the questions in Set III so that the questions were equally as difficult as the questions presented in Set II and I.
In Experiment I, the participants may have benefited from additional lessons of *Corrective Reading*. The experimenter presented 10 lessons due to lack of time with the participants given the end of the school year approaching. However, there are a total of 30 lessons in *Corrective Reading* (i.e., Comprehension A) and it is possible that there may have been higher numbers of correct responding if more than 10 lessons were conducted. Each lesson within *Corrective Reading* provides two or more deduction and inference exercises amongst other skills (e.g., true/false, definitions); therefore more lessons equal more opportunities to respond to derived relations instruction. Finally, the participants in Experiment I were matched in pairs then assigned into either Group 1 or Group 2 based on reading level (e.g., DRA) and number of correct responses emitted during the pre-intervention probes. Despite this, it appears that across all dependent measures and during the pre-intervention baseline conditions, one group emitted a slightly higher number of correct responses compared to the other.

In Experiment II, pertaining to the strength of the design the number of participants can be considered a limitation due to the fact that the experimenter only used two dyads (i.e., four participants) rather than instructing 3 or more dyads. Also, in Experiment II there was a lack of additional pre-intervention probes for participants whose correct responding increased during the second pre-intervention probe. It would have strengthened the study if the experimenter conducted additional probes after a participant showed an increase in correct responding prior to receiving the intervention in order to confirm that the targeted skill was not yet mastered.

Another limitation in Experiment II is the level of the comprehension assessments used to measure performance of reading comprehension. The experimenter used Level 1
passages, which is equivalent to first grade level reading passages, however all four participants demonstrated to have some level comprehension skills already in repertoire due to the fact that they emitted at least 50% or more correct responding during pre-intervention conditions. It would have been beneficial to assess their comprehension using higher grade-leveled passages, such as grade Level 2 passages (i.e., if assessing first graders), in order to ensure that none of the required comprehension responses were in repertoire prior to the intervention.

**Future Research**

The results from this present study demonstrated that *Corrective Reading* improves students’ reading and listening comprehension performance by providing the learners with the necessary experiences needed in order to derive relations. In both experiments I assessed the first grade participants’ performances using first grade level comprehension content. However, future research should consider examining the effects of DI curricula that have a sequence, which trains derived relations on comprehension skills that are above the targeted learners’ grade level. DI reading comprehension curricula such as *Corrective Reading* typically function as remedial reading curricula for struggling readers, below grade-level, however researchers should consider using curricula such as these with on grade level for readers to assess their comprehension with higher, grade level content. For example, future researchers can assess first graders’ comprehension using 2nd grade comprehension assessments and compare the difference in correct responding before and after *Corrective Reading*. This would allow us to determine whether curricula such as *Corrective Reading* is effective in improving above
grade-level performance in early elementary readers (i.e., grades K-2). Future studies should also consider adding more participants to strengthen the present findings and using participants across the K-2 elementary grade levels.

As learners advance in reading levels, they are required to respond to comprehension antecedents in written form (e.g., essays). It is important that students acquire writing skills that target both technical and aesthetic outcomes in order to effectively influence the behavior of readers (Greer, 2002). According to Greer and Ross (2008) in aesthetic writing, the writer produces writings in order to affect the emotions of the reader, who also functions as a listener. Future researchers should consider examining the effects of Corrective Reading on aesthetic written comprehension responses.

Future research should consider examining the effects of other Direct Instruction (DI) curricula on the emergence of derived relations and its impact on reading repertoires (e.g., textually responding and comprehension). Flores and Ganz (2009) found a functional relation between DI instruction and improvement in reading comprehension (i.e., picture analogies, deductions, and opposites) with learners who have developmental disabilities. The curriculum sequence of DI has also been effective in improving comprehension skills involving statement inferences, fact usage, and analogies with at-risk students who have reading delays (Flores & Ganz, 2007). All DI curricula provide a systematic form of instruction, which teaches all prerequisite skills to mastery before building more complex skills. It would be beneficial to determine which DI curricula also provide experiences that train derived relations (Slocam, 2004).
Conclusion

Development in reading comprehension is not a function of age but rather a function of experiences (Greer & Ross, 2008). It is critical that educators provide their learners with the necessary experiences required in order to comprehend when reading a story or listening to a story read aloud. Based on the findings from both experiments we see that one can determine if a learner can comprehend by simply observing if the learner reliably demonstrates derived relations. Reading comprehension and listening comprehension are derived relational responding and occur based on a learner’s history of differential reinforcement. During the process of reading, a learner responds to the stimuli presented in the story (e.g., little girl) as a function of the corresponding relational contexts (e.g., girl is at a park) included in the learner’s instructional history (e.g., the girl is most likely playing). When a student reads about a little girl going to a park and infers that the following are also possible: the little girl is happy, the little girl is playing, the little girl is with an adult, the weather is nice, or the little girl is active, he is doing so because he is responding to the information (i.e., stimuli) as a function of the corresponding relational contexts in his own instructional history.

There are specific experiences which educators could provide their leaners in order to induce derived relational responding and those experiences are multiple exemplar experiences for derived stimulus relations and tact instruction (Greer & Ross, 2008). Direct Instruction curricula that have a sequence, which train derived relations provide multiple exemplar experiences for derived stimulus relations and build the tact repertoire (i.e., vocabulary repertoire). Greer and Ross (2008) discussed the procedures required in order to promote a rapid expansion of tacts in a learner’s repertoire. Intensive
tact instruction is one of the procedures used in order to teach academic literacy and communication skills (i.e., spontaneous speech) (Pistoljevic & Greer, 2006; Schauffler & Greer, 2006).

Howarth, Dudek, and Greer (2015) found that the tact repertoire played a critical role in inducing derived relational responding in children with cognitive and language delays. Students with language disabilities or students who simply are from a community in which there is limited language interaction experiences would benefit from receiving instruction that could potentially build their tact repertoire, furthermore allowing them to respond appropriately to stimuli in their environment (Hart & Risely, 1995). Lo (2016) found that what a child learns is solely dependent on their environmental experiences with stimuli and that the stimuli select out the child’s observing responses. Cao (2016) provided echoic training experiences, which induced naming in Chinese with contrived and non-contrived stimuli, further demonstrating that a child’s language experiences impacts how and what the child can learn.

Skinner (1957) stated that if essential stimulus control is not present in a learner’s repertoire then it is the role of the verbal community to provide the experiences, which effectively sharpen stimulus control. The findings from both experiments demonstrate that advance reading comprehension responses (i.e., deductions, inferences) involve derived relations and that a curriculum sequence which trains derived relations can provide the experiences necessary to improve advanced reading comprehension in learners who are in the early stages of reading (i.e., 1st graders). Reading comprehension is relational responding and is either implicitly learned through certain types of experiences or can be directly taught. The results from this study strengthen the behavior...
analytical research, which demonstrates that environmental experiences in language development play a significant role in the success of a learner.


Flores, M., & Ganz, J. (2007). Effectiveness of direct instruction for teaching statement inferences, use of facts, and analogies to students with developmental disabilities
and reading delays. *Focus on Autism and Other Developmental Disabilities*, 22, 244-251.


Greer, R. D., & Speckman, J. (2009). The integration of speaker and listener responses: A


Lodhi, S., & Greer, R.D. (1989). The speaker as listener. *Journal of Experimental Analysis of Behavior, 5*


Appendix A
The deductions probe presented in Experiment I.

Deductions

Set 1:
1. If a chicken is coral it has 3 legs.
   a. Bob’s chicken is coral, what else do you know about it? 3 LEGS
   b. Sue’s chicken has three legs, what else do you know about it? CORAL
   c. Phil has something coral with three legs, what is it? CHICKEN

2. If a house is made with bricks it has 5 rooms.
   a. Ned’s house has 5 rooms, what else do you know about it? BRICK
   b. Sue’s house is made with bricks, what else do you know about it? 5 ROOMS
   c. Bill has something with 5 rooms made with bricks, what is it? HOUSE

3. If a moss is lavender it is a seedling:
   a. Nick has a lavender moss, what else do you know about it? SEEDLING
   b. Sam’s moss is a seedling, what else do you know about it? LAVENDAR
   c. Len has a seedling that is lavender, what is it? MOSS

4. If a snake is a carnivore it eats only animals.
   a. Sue has a snake that is a carnivore, what else do you know about it? EATS ANIMALS
   b. Tim has a snake that only eats animal, what else do you know about it? CARNIVORE
   c. I have something that is a carnivore and only eats animals. What is it? SNAKE

5. If a happy song is played in C major, it is a standard song.
   a. Sally played a happy, standard song, what else do you know about it? C MAJOR
   b. Frank listens to happy songs played in C major, what else do you know about it? STANDARD
   c. Mike played a standard song in C major. What was it? HAPPY

Set 2:
1. If a bear is enormous it has multiple arms.
   a. Ned the bear has multiple arms, what else do you know about it? ENORMOUS
   b. Sid is enormous and is a bear, what else do you know about it? MULTIPLE ARMS
   c. Henry is enormous and has multiple arms, what is he? BEAR

2. If a wall is made with cement it is poisonous.
   a. Nick’s wall is poisonous, what else do you know about it? CEMENT
   b. This wall is made with cement, what else do you know about it? POISONOUS

Set 3:
1. If a blog is purple it sings.
   a. This blog sings, what else do you know about it? PURPLE
   b. Liz has a purple blog, what else do you know about it? SINGS
   c. Phil has something purple that sings, what is it? BLOG

2. If a bucket is cold it has milk in it.
   a. Ned’s bucket has milk in it, what else do you know about it? COLD
   b. Sue’s has a cold bucket, what else do you know about it? MILK
   c. Bill has cold milk in something, what is it? BUCKET

3. If a bear is gold it can speak French:
   a. Adrien has a gold bear, what else do you know about it? FRENCH
   b. Luke has a bear that can speak French, what else do you know about it? GOLD
   c. Ken has something that is gold and speaks French, what is it? BEAR

4. If a rabbit were a reptile it would eat flies.
   a. Jill has a rabbit that is a reptile, what else do you know about it? EATS FLIES
   b. Frank has a rabbit that eats flies, what else do you know about it? REPTILE
   c. I have something that is a reptile and only eats flies. What is it? RABBIT

5. If a baby masticates, it has teeth.
a. Baby Henry masticates food, what else do you know about it? TEETH
b. Lily the baby has teeth, what else do you know about it? MASTICATES
c. I know something that has teeth and masticates. What is it? BABY
Appendix B
The deductions probe presented in Experiment II.

<table>
<thead>
<tr>
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<tbody>
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</tr>
</tbody>
</table>

| 3. If a bird is a dinosaur it is an Anzu: |
| a. Richard’s bird is an Anzu, what else do you know about it? DINOSAUR |
| b. The Anzu is a dinosaur, what else do you know about it? BIRD |
| c. Len is a dinosaur that is a bird, what is it? ANZU |
| 4. If a galaxy has stars it is burgundy. |
| a. I saw a burgundy galaxy, what else do you know about it? STARS |
| b. Tina sees stars in a burgundy place, what else do you know about it? GALAXY |
| c. There are stars in a galaxy. What else do you know? BURGUNDY |
| 5. If terminate is a word it means to end. |
| a. To end means to terminate, what else do you know about that? WORD |
| b. Penny knows the word that means to end, what else do you know about it? TERMINATE |
| c. Terminate is an interesting word. What else do you know? TO END |

| **Set 3:** |
| 1. If a blog is purple it sings. |
| a. This blog sings, what else do you know about it? PURPLE |
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b. Lily the baby has teeth, what else do you know about it? MASTICATES
c. I know something that has teeth and masticates, what is it? BABY

Set 4:

1. If a monkey is tiny it is blue.
   a. I have something tiny and blue, what else do you know about it? MONKEY
   b. Nick has a tiny monkey, what else do you know about it? BLUE
   c. I have a blue monkey, what else do you know about it? TINY

2. If a tree is tall, it’s a Red Wood.
   a. I have a tall tree, what else do you know about it? RED WOOD
   b. Lance has a Red Wood that is tall, what else do you know about it? TREE
   c. I have a tree that is a Red Wood, what else do you know about it? TALL

3. If a boat is slim it’s made with metal.
   a. Ned has something slim made with metal, what else do you know about it? BOAT
   b. I have a slim boat, what else do you know about it? METAL
   c. Vannah has a boat made with metal, what is it? SLIM

4. If a road is empty, it is closed.
   a. I see something closed and empty, what else do you know about it? ROAD
   b. Gavin sees an empty road, what else do you know about it? CLOSED
   c. I see a road that is closed, what is it? EMPTY

5. If the lamb is purple, it is sick.
   a. Mitch has something purple that is sick, what else do you know about it? LAMB
   b. I have a purple lamb, what else do you know about it? SICK
   c. Hector has a sick lamb, what else do you know about it? PURPLE
Appendix C

Picture of the derived relations from letters/numbers probe presented in Experiment II and I.
Appendix D
The metaphors probe presented in Experiment I.

Metaphors:

SET 1:
1. Name three ways that a house is like a seashell.
2. Name three ways that a car is different from a computer.
3. Name three ways a sock is the same as soil.
4. Name three ways that a dog is different from a boy.
5. Name three ways an airplane is like a boat.

SET 2:
6. Name three ways that water is different from a brick.
7. Name three ways a hammer is the same as a rake.
8. Name three ways a snake is different from a woman.
9. Name three ways box is the same as purse.
10. Name three ways a sandwich is different from soup.

SET 3:
11. Name three ways a tail is the same as a fin.
12. Name three ways a vehicle is different from a kite.
13. Name three ways a rabbit is like a tree.
14. Name three ways that ice tea is different from milk.
15. Name three ways an animal is the same as a toy.
Appendix E
The metaphors probe presented in Experiment II. Set 3 is different from Set 3 in Experiment I.

Metaphors:

SET 1:
1. Name three ways that a house is like a seashell.
2. Name three ways that a car is different from a computer.
3. Name three ways a sock is the same as dirt.
4. Name three ways that a dog is different from a boy.
5. Name three ways an airplane is like a boat.

SET 2:
6. Name three ways that water is different from a brick.
7. Name three ways a hammer is the same as a rake.
8. Name three ways a snake is different from a woman.
9. Name three ways box is the same as purse.
10. Name three ways a sandwich is different from soup.

SET 3:
11. Name three ways a school is like a store.
12. Name three ways a pencil is different from a fork.
13. Name three ways a stove is the same as a fireplace.
14. Name three ways that a chair is different from a table.
15. Name three ways a tomato is like an apple.