A Functional Analysis of the Effects of the Induction of Naming and Observing Teacher-Modeling on Accelerated Learning of Academic Skills for Children with Autism

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ABSTRACT

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I tested the effects of the absence and presence of Naming on rate of learning when teacher modeling was part of an instructional procedure. A time-lagged multiple probe design across matched pairs of participants was implemented. Eight elementary aged children with autism, ranging in age from 4 to 7 years old, were selected because they lacked Naming at the onset of the study. The dependent variable was the number of instructional trials, or learn units, required to master 6 mathematics curricular objectives: 3 prior to the emergence of Naming, and 3 following the acquisition of Naming. Each instructional session consisted of a teacher model, in which I demonstrated how to solve 2 problems while the participant observed, followed by 20 learn units. Learn unit procedures following the teacher-model included positive reinforcement for correct responses and corrective feedback for incorrect responses. The independent variable in the study was the induction of Naming using multiple exemplar instruction (MEI) across listener and speaker responses. Following the emergence of Naming, 3 novel mathematics objectives were taught and rate of learning was measured. The participants’ rate of learning under teacher modeling conditions was compared prior to the emergence of Naming, and following the acquisition of Naming. The results of the study showed
accelerated learning for all 8 participants under teacher modeling conditions following the acquisition of the Naming capability.
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DEDICATION

To my students, who have taught me to think deeper and smile wider than I ever thought possible.
Chapter I

INTRODUCTION AND REVIEW OF THE LITERATURE

Educational and language theory researchers agree children acquire language at an incredibly fast rate such that the magnitude of a child’s vocabulary repertoire cannot be attributed to direct instruction (Crystal, 2006; Greer & Ross, 2008 Greer & Speckman, 2009; Hart & Risley, 1995; Landauer & Dumais, 1997; Kenneally, 2007; McMurray, 2007; Pereira-Delgado & Greer, 2009; Pinker, 1994; Snow, 2001). Auditory discrimination of words, or listener behavior, develops far earlier than speech production of words, or speaker behavior (Crystal, 2006). Around 18 months, a child has auditory discrimination for approximately 250 words, and their functions, but only produces around 50 words vocally. Around age two, the number of spoken words increases to around 200. At age three a dramatic increase in spoken words occurs in which children acquire three to four new words per day (Crystal, 2006; Snow, 2001). Hart and Risley (1995) refer to this dramatic increase in language as a “language explosion.” Research documenting this language explosion reported that typically developing three-year old children say 2,000, and often many more, words (Crystal, 2006; Hart & Risley, 1995; Snow, 2001).

It is evident that this language explosion is not due to systematic direct instruction from parents or educators, as found in the Hart and Risley (1995) longitudinal study. Researchers attest that children acquire language effortlessly, without any formal instruction, and generally become fluent in their native language before attending school.
So the question becomes, if children do not learn most of their vocabulary from direct instruction, but they are acquiring language from the age of three at a rapid rate, how does this phenomenon occur? There are numerous theories on how children acquire language. One such theory is that the Naming capability is a, or the, source for how children come to learn language incidentally (Greer & Keohane, 2006; Greer & Ross, 2008; Greer & Speckman, 2009; Greer & Keohane, 2009; Greer & Longano, 2010). The theory of Naming (capitalized to distinguish its special usage aside from “labeling”) was first introduced by Horne and Lowe (1996) to describe a critical verbal developmental stage. Horne and Lowe first suggested that Naming is a bi-directional capability to learn language, and that Naming leads to learning language incidentally. Horne and Lowe defined Naming as the ability to acquire the name for something (a tact, as described by Skinner, 1957) when the name was emitted by a speaker in the presence of the object (Horne & Lowe, 1996; Catania, 2007; Greer & Ross, 2008). Therefore if a child has Naming, he or she can observe another person say the name of an object, and learn to emit the word for that object as a speaker without direct instruction. In addition to learning the name for an object as a speaker, a child with Naming learns auditory discrimination of the word as a listener without direction instruction (Greer & Longano, 2010). This ability to learn a word as listener and emit it as a speaker, or vice versa, is central to the bi-directional component of Naming.

Furthermore, Horne and Lowe (1996) proposed that Naming also leads to learning language incidentally. That is, children can learn language from experiences, and no direct instruction is required. The Naming theorists’ research focused on the bidirectional
aspects of Naming, as well as derived relational responding associated with Naming (Horne, Hughes, & Lowe, 2006; Horne, Lowe & Randle, 2004; Miguel, Petursdottir, Carr & Michael, 2008). The verbal behavior development theory (VBDT) is another theory that embodies Naming as the source of learning language incidentally. The VBD theorists expanded on Horne and Lowe’s empirical research and were the first to test the theory that Naming is the source for learning language incidentally (Greer & Ross, 2008; Greer & Longano, 2010).

Both Horne and Lowe’s (1996) theory of Naming and the VBDT are extensions of Skinner’s (1957) theory of verbal behavior, as they both proposed that Naming is the joining of the speaker and listener functions. The speaker-listener relation central to Naming was founded in Skinner’s (1957) theory of verbal behavior (Greer & Longano, 2010). These two theories, in conjunction with relational frame theory (RFT), agreed that the joining of the speaker and the listener functions (Naming) is the beginning of being truly verbal (Barnes-Holmes, Barnes-Holmes & Cullinan, 1999; Greer & Longano, 2010). From the research associated with these three theories, it can be stated that Naming is central to language acquisition and development.

VBDT has expanded the Naming theory to suggest that Naming is not only a higher order verbal operant (Catania, 2007; Greer & Ross, 2008; Greer & Speckman, 2009; Greer & Longano, 2010; Hayes, Barnes-Holmes & Roche, 2001; Horne & Lowe, 1996; 1997), but also a verbal developmental cusp that is also a verbal developmental capability (Greer & Longano, 2010; Greer & Speckman, 2009). A verbal developmental cusp is a behavioral milestone in a child’s development that allows the learner to come into contact with new aspects of his or her environment, and the contingencies of reinforcement and
punishment that such contact entails (Rosales-Ruiz & Baer, 1997). A developmental cusp that also results in a new way of learning is termed a verbal developmental capability (Greer & Keohane, 2006; Greer & Longano, 2010; Greer & Ross, 2008; Greer & Speckman, 2009). Greer and Speckman (2009) described a capability as a behavioral cusp that once reached allows children to learn faster, learn multiple responses from one stimulus, and learn in *a new way that they could not before the attainment of the capability*. The VBD theorists emphasized the importance of Naming in language development; because once it is acquired children learn an exponential number of words from incidental experiences (Catania, 2007; Greer & Longano, 2010). Therefore the ability to learn language incidentally makes Naming a critical step in verbal development.

A significant number of scholars now agree social and environmental factors are critical to language acquisition in young children (Catts & Kamhi, 2005; Crystal, 2006; Hart & Risley, 1995; McMurray, 2002). The emergence of Naming appears to occur incidentally in many typically developing children, from everyday interactions with their caregivers (Catania, 2007; Gilic, 2005; Greer & O’Sullivan, 2007; Greer & Ross, 2008). However, for children with developmental language delays (such as those associated with autism spectrum disorder or children with limited language exposure), Naming may not occur without educational interventions (Hart & Risley, 1995; Greer & Speckman, 2009; Greer & Longano, 2010). Hart and Risley’s (1995) longitudinal study on language in the home, and its latter effects on educational performance, reported that children with limited language exposure as young children do not have positive educational outcomes. Hart and Risley reported that the number of words heard by children in households with professional parents was approximately eleven million per year, while the number of
words heard by children born to impoverished homes was only three million per year. Therefore limited language exposure in the home leads to a developmental and educational disadvantage. Interestingly, regardless of the number of words spoken in a child’s environment, if a child lacks Naming, he or she may not be acquiring words incidentally which leads to a developmental disadvantage regardless of language exposure. Furthermore, those children who lack Naming and are born to language-impoverished homes are at a serious disadvantage with respect to acquiring language. Hart and Risley directly link such language disadvantages to educational outcomes. Children with limited language exposure in the home, or children who have limited language acquisition due to developmental delays, are already at a significant disadvantage educationally.

The research on language acquisition and development supports the statement that children learn new words without direct instruction. However, this phenomenon only seems to occur with listener and speaker behaviors that comprise language (Crystal, 2006). Reading and writing, and essentially all other academic skills, need to be taught. Although these skills are not acquired incidentally from the environment the way language is, there may be a link between Naming and acquiring academic skills from observation. I propose that the same capability that allows children to acquire language from experiences (Naming) is also key to allowing children to learn academic skills that are not acquired incidentally. I propose that Naming is a key factor in allowing children to learn academic skills from simply observing teachers “teach” these skills. For the purposes of the present study, I defined teacher modeling as the vocal and written behavior of the teacher that involves the demonstration of each step the student should
follow to emit an accurate response. In the case of teacher modeling, it is critical that the student is observing the teacher while he/she demonstrates the process. Before returning to the review I provide a list and definition of specialized terms associated with verbal behavior development and verbal behavior analysis.

**Definition of Terms**

1. *Verbal Behavior*

   Verbal behavior refers to the function of language (Skinner, 1957). Verbal behavior is behavior, vocal or otherwise, that is reinforced and mediated by another person (Skinner, 1957; Greer & Ross, 2008). Greer (2008) defined verbal behavior as “all of the producing and mediating functions of language responses (speaking, signing, gesturing, Morse code, smoke signals, drumbeats)” (p. 364). Catania (2007) defined verbal behavior as behavior that “involves both listener behavior shaped by its effects on speaker behavior and speaker behavior shaped by its effects on listener behavior” (p. 416). Verbal behavior, both listener and speaker, is shaped and sustained by a verbal environment through reinforcement.

   Skinner proposed that the role of the speaker is to affect the environment through the mediation of a listener (1957). A speaker is one who can govern the behavior of others using verbal behavior. A listener is one who responds to another’s speaker behavior (Greer & Ross, 2008). One critical component of verbal behavior is the initial separation of the listener and speaker functions (Skinner, 1957). Research done subsequent to Skinner’s original theory on the joining of these functions has shown the interception of the listener and speaker is critical to development (Greer, 2008). A key indication of the intercept of the speaker and listener is the presence of
Naming. More recent research and theory proposes that to be truly verbal the speaker and listener must be joined (Barnes-Holmes et al., 1999; Greer & Ross, 2008; Greer & Speckman, 2009; Hayes 1994).

Skinner defined six verbal operants as the echoic, mand, tact, intraverbal, autoclitic and textual response. These are now seen as the speaker verbal operants. More recent work identified the listener components of verbal behavior such as listener literacy, phonemic awareness and the joining of the listener and speaker as say and do correspondence, self-talk conversational units and Naming.

a. *Echoic*

An echoic is a vocal verbal operant that is under the control of a vocal verbal stimulus (Greer & Ross, 2008; Skinner, 1957). Echoics have a point-to-point correspondence between the auditory components of the heard stimulus and the sound of the spoken duplicated response. An example of an echoic is an individual saying “toy” and the target speaker producing the same consonant-vowel sound-patterns for the word “toy” directly following. Therefore, an auditory stimulus controls the echoic, which is then shaped and maintained by certain contingencies of reinforcement. The echoic is distinguished from simple parroting in that the response is evoked because prior echoics have led to speaker effects on a listener. Due to the self-reinforcement that sustains the function of parroting, there are no effects on a listener.

b. *Mand*

A mand is a verbal operant, vocal or otherwise, that is reinforced by a consequence and is specified by the topography of the mand in a particular verbal
community (receiving a target stimulus, or removal of a target stimulus) (Greer & Ross, 2008; Skinner, 1957). A mand is under the control of the relevant conditions of deprivation and aversive stimulation (Skinner, 1957). The possibility that a mand will be emitted is strengthened when the target stimulus is under deprivation. The possibility of the emission of the mand is further reinforced in the presence of an individual who has reinforced the target stimulus or other stimuli under deprivation in the past. The listener reinforces the mand operant by the delivery of, or removal of, the target stimulus by a listener. The motivating operation for the mand is deprivation or aversive stimulation that can be mediated by the listener and therefore the mand is verbally controlled (Greer & Ross, 2008; Stafford, Sundberg & Braam, 1978). An example of a mand would be “toy” when a speaker is under deprivation of gaining access to a toy, resulting in the listener providing the speaker with a toy.

c. Tact

A tact is verbal operant in which a response of a given form is evoked by a particular object or event present in the environment (Skinner, 1957). The stimulus control for a tact is the presence of an item. Control can also be exerted by a prior stimulus in the physical environment, and can be altered by conditions of occasion or audience (Skinner, 1957). The reinforcement possibilities for the emission of the tact include generalized reinforcement of a social nature, extension of contact with the environment, or extension of the senses (Greer & Ross, 2008; Skinner, 1957). Deprivation of attention is a motivating operation for the emission of a tact (Gewirtz, 1969; Stafford et al., 1978; Tsiouri & Greer,
An example of a tact is saying the word “toy” when the item is present in the environment, and the response is reinforced by social attention and not by delivery of the item tacted. Recent work suggests that the tact is social in nature and as such the social reinforcement is a key component of verbal behavior since Skinner proposed that verbal behavior is social behavior (Pistoljevic, 2008; Schmelzkopf, 2010).

d. **Intraverbal**

An intraverbal is a verbal operant that shows no point-to-point correspondence with the verbal stimuli that evoke them (Greer & Ross, 2008; Skinner, 1957). The stimulus control for the intraverbal can be vocal, written or a combination of both. Intraverbals are maintained by generalized reinforcement. The intraverbal repertoire of any given adult is the result of hundreds of thousands of reinforcement opportunities under a great variety of contingencies. If you interrupt the speaker during an intraverbal response, the control may be lost (Skinner, 1957). Examples of intraverbals include counting, reciting the alphabet, responding to a social antecedent (“How are you?”), poetry, among many others (Greer & Ross, 2008; Skinner, 1957). An example of an intraverbal in the present study is “What is this called?” when holding up a picture of an item.

e. **Textual Response**

A textual response is a verbal operant under the control of non-auditory print or textual stimuli (Greer & Ross, 2008; Skinner, 1957). It consists of seeing a word, and saying the word and is one of the six components of reading. Therefore the presence of visual stimuli controls the textual response. Examples of textual
response include letters as labels or as phonemes, words, characters, Braille, and hieroglyphics. Textual responses are reinforced by educational reinforcement or hearing the word, or by some evocation of emotion/motivation. An example of a textual response is emitting the word “toy” when seeing the word printed on a page. Although the textual response is a reader function, it is only one component of reading (Greer & Ross, 2008), that is comprehension or intraverbal responses relative to the content read may or may not be present.

f. **Autoclitic**

An autoclitic is a verbal operant that modifies the function of other verbal behavior for a listener or a speaker (Greer & Ross, 2008; Luke, 2009; Skinner, 1957). It functions to quantify, qualify or specify the effects of the primary verbal operants. The control and reinforcement for an autoclitic is dependent upon the verbal behavior it is accompanied by. Examples of autoclitis include the words “I”, “see” “a” and “blue” in the sentence “I see a blue toy.”

2. **Listener Components**

Skinner’s (1957) *Verbal Behavior* has been criticized as only taking into account the role of the speaker, and not the role of the listener. Although the role of the speaker was explicitly addressed in the book, the role of the listener was also accounted for in many regards. Skinner accounted for the role of the listener in respect to mediation in the environment, in terms of reinforcement (for both the listener and the speaker) and the critical nature of the listener in the verbal episode. Skinner (1957) was clear that the role of the speaker is to mediate between the verbal and non-verbal environment. He did however reference that the role of the
listener in respect to mediation is to extend the senses. A common example of extension of the senses is one regarding the weather. If a speaker states that it is raining outside, the listener does not actually experience the rain, but is affected because he can now take an umbrella with him, or wear a raincoat. If he does this, he is reinforced as a listener, as he will not get wet when he goes outside. Another example of an extension of the senses through listening is the emotion that can be elicited from listening to a story.

It is important to look at the role of reinforcement for both the listener and the speaker to get a complete understanding of verbal behavior. Skinner described that the extent of reinforcement of verbal behavior depends upon the energy of the listener, in regard to the speaker (1957). In other words, the listener mediates the environment for the speaker and verbal behavior is shaped and maintained by the reinforcement provided by the listener. Skinner stated the reinforcement delivered by the listener maintains the speakers’ behavior. However, it is critical to discuss how the listener is reinforced. As described above, one source of reinforcement for the listener is the extension of the senses. In addition, the listener is reinforced differently for different verbal operants emitted by the speaker. For example, the tact works for the benefit of the listener by extending his contact with the environment. The listener may be reinforced when the listener responds to tacts emitted by others (confirming the observation of the listener). Also, the reinforcement of the listener may be educational in that it establishes and maintains a particular form of behavior in the speaker (as teachers and parents we reinforce tacts). In addition, a tact may elicit an
emotion, or evoke a behavior, in a listener without the listener seeing the object in the environment (i.e., spider = fear, dessert = salivate).

There must be an interaction between a speaker and a listener for verbal behavior to occur. This interaction is called a verbal episode (Skinner, 1957). A verbal episode is the combined behavior of the speaker and the listener in which the behaviors are separate, but interlocking. The behavior of the listener must provide the conditions to explain the behavior of the speaker. In Skinner’s *Verbal Behavior* (1957) he discussed that in order to explain verbal behavior, the listener and speaker behaviors require both a separate, and an interlocking account. He commented how verbal behavior is not complete without the behavior of the speaker and the listener. Skinner’s theory specified the distinction between the listener and speaker functions, and the need to address each separately until the responses are joined (Skinner, 1957; 1989). Subsequent research on the joining of these functions has shown the interception of the listener and speaker is critical to development (Greer, 2008).

3. **Speaker-as-own-Listener**

Skinner proposed that individuals act as both a speaker and a listener (Greer & Lodhi, 1988; Skinner, 1957). Verbal behavior development theorists (Greer & Keohane, 2006; Greer & Ross, 2008; Greer & Speckman, 2009) postulated speaker-as-own-listener functions may be a, or the, critical component(s) to understanding complex human verbal behavior. “The degree to which a speaker is able to mediate her own speaker behavior is dependent on the degree to which she listens to her own speaker behavior” (Greer & Speckman, 2009, p. 3). Skinner refers to speaker-as-own-listener as behavior beneath the skin (1957, 1989). Three speaker-as-own-listener
cusps (and in one instance a cusp that is also a capability) have been identified in the literature (Greer & Keohane, 2006, Greer & Ross, 2008; Greer & Speckman, 2009). These developmental cusps are self-talk, say-do correspondence, and Naming. These cusps identify the joining of the speaker and the listener functions beneath the skin. How the speaker and listener functions come to be joined is central to the theory of verbal behavior development (Greer & Speckman, 2009).

a. Say-Do Correspondence

Say-do correspondence refers to an individual saying what he/she is going to do, and subsequently doing it, without direct instruction (Greer & Speckman, 2009; Paniagua & Baer, 1982). Greer and Ross (2008) defined say-do correspondence as “the relation between the verbal and non-verbal behavior of an individual” (p. 300).

b. Self-Talk

Self-talk refers to an individual emitting conversational units in which he or she acts as both a speaker and a listener (Greer & Ross, 2008; Greer & Speckman, 2009). Self-talk conversational units are important developmental milestone for children (Lodhi & Greer, 1988).

c. Naming: Described in depth in number nine.

4. Operant

An operant is a behavior selected out by its consequences (Greer & Ross, 2008), or behavior that is modified by its consequences (Catania, 2007). Operant behavior is selected out and maintained by consequences that result in a repertoire of behavior as a product of interactions with the environment (Cooper, Heron & Heward, 2007).
Verbal operants include the six speaker behaviors introduced by Skinner (1957) and the listener components identified in the last two decades (Hayes et al., 2001; Greer & Speckman, 2009).

5. **Repertoire**

Greer and Ross (2008) defined a repertoire as “a class or category of operants that was learned by an individual and is likely to be emitted given the learned setting events and antecedents” (p. 300). A behavior is said to be in an individual’s repertoire when he or she emits it under natural antecedent and consequence conditions. Catania (2007) defined a repertoire as “the behavior an organism can emit” (p. 407). In simple terms, a repertoire is all of the behaviors a person can emit (Cooper et al., 2007). Repertoire also refers to “the range of learned relations that are possible when a cusp or capability is present” (Greer, 2008, p. 369).

6. **Higher Order Operant**

A higher order class of behavior, as defined by Catania (2007) is “an operant class that includes within it other classes that can themselves function as operants” (p. 392). Greer and Ross (2008) explained that higher order operants are overarching operants that occur “when previously independent responses to a stimulus, such as the independence of listener and speaker responses to a stimulus, come to jointly control both listener and speaker responding” (p. 293). Therefore Naming and generalized imitation are higher-order operants (Catania, 2007; Greer & Ross, 2008; Healy, Barnes-Holmes & Smeets, 2000; Horne & Lowe, 1996).

7. **Verbal Behavioral Developmental Cusp**

A behavioral developmental cusp is defined by Rosales-Ruiz and Baer (1997) as:
A change that (1) is often difficult, tedious, subtle, or otherwise problematic to accomplish, yet (2) if not made, means little or no further development is possible in its realm (and perhaps in several realms); but (3) once it is made, a significant set of subsequent developments suddenly becomes easy or otherwise highly probable which (4) brings the developing organism into contact with other cusps crucial to further, more complex, or more refined development on a thereby steadily expanding, steadily more interactive realm (pp. 166).

A behavioral developmental cusp allows an individual to come into contact with a new environment, and therefore new contingencies of reinforcement and punishment that he/she could not before the attainment of the cusp (Greer, 2008; Greer & Speckman, 2009). These new experiences result in a new opportunity to learn, but not necessarily a new way to learn (Greer, 2008). Examples of verbal behavioral developmental cusps include pre-verbal foundational cusps such as conditioned reinforcement for voices, capacity for sameness across the senses, or verbal stages such as listener literacy, transformation of establishing operations across mands and tacts, joint stimulus control across saying and writing, and Naming to name a few (Greer & Ross, 2008).

8. **Verbal Behavioral Developmental Capability**

A capability has all of the specifications of a cusp, but also allows an individual to learn in a new way (Greer & Speckman, 2009). Verbal developmental capabilities allow children to learn faster, learn multiple response topographies from instruction in only one response topography, and learn in ways they could not prior to the attainment of the capability (Greer & Speckman, 2009). Examples of verbal behavior developmental capabilities include generalized imitation (Catania, 2007; Greer & Ross, 2008), Naming (Catania, 2007; Greer & Ross, 2008; Hayes et al., 2001; Horne
& Lowe, 1996) and observational learning (Davie-Lackey, 2005; Gautreaux, 2005; Greer & Ross, 2008; Greer & Singer-Dudek, 2004; Greer & Singer-Dudek, 2008; Greer, Singer-Dudek & Gautreaux, 2006; Greer, Singer-Dudek, Longano & Zrinzo, 2008; Pereira-Delgado, 2005; Pereira-Delgado & Greer, 2009; Stolfi, 2005).

9. *Naming*

Naming is a construct first introduced by Horne and Lowe (1996) and was described by Miguel and Petursdottir (2009) as “a higher-order operant involving a bi-directional relation consisting of two component relations: a speaker component and a listener component. Naming occurs when just one of these components, speaker or listener, suffices to establish both relations” (p. 131). Therefore, Naming is a bi-directional higher order verbal relation in which an individual can learn something in one repertoire (listener or speaker), and emit it in the other repertoire (listener or speaker) without direct instruction (Catania, 2007; Greer & Ross, 2008; Horne & Lowe, 1996). For example, if a child is taught to point to a picture of a “golden retriever” and the child can tact the animal “golden retriever” when the picture is presented to him or her, or in the presence of a golden retriever, then the child has the bi-directional components of Naming.

Naming is also the joining of the listener and speaker responses that allows an individual to acquire *both listener and speaker behavior incidentally* (Greer, 2008). For example, if a mother is helping her child dress, and hands the child rain boots and says “Don’t forget to put your rain boots on, it’s raining” and in the future the child can tact “rain boots” without direct instruction, he or she has Naming. The listener and the speaker repertoires have been joined such that he or she can learn language
incidentally. This ability to learn language incidentally makes Naming a critical step in verbal development.

10. Learn Unit

The learn unit is a strong predictor of effective teaching (Greer & McDonough, 1999) because it is the primary indicator in evaluating whether students are receiving necessary instruction (Greer, Keohane, & Healy, 2002). The learn unit is at least two interlocking three-term contingencies between the student and the teacher comprised of a teacher-presented antecedent condition, a student response, and one or more immediate consequences provided by the teacher in the form of either positive reinforcement or correction. The learn unit includes the motivational conditions required for the student to respond. Therefore the student must be attending, and must be motivated, for a learn unit to be present. The four components of the learn unit are creation of the establishing operation, presentation of the target the discriminative stimuli, provision of an adequate opportunity to respond and the consequences that reinforce or corrections (Greer, 2002).

Learn units “involve all instruction in which a student contacts an antecedent stimulus that is under teacher control, actively responds, and receives a corrective or reinforcing consequence from a teacher, tutor, or an automated device” (Greer, 1991, p. 35). The student must emit a corrected response in the presence of all of the above; however the student is not reinforced for emitting the corrected response. In rare cases corrections are reinforced according to a particular scientific criterion. Research has reported that increasing the number of learn units presented to a student will
increase his or her correct responses (Albers & Greer, 1991; Greer, Williams, & McCorkle, 1989; Kelly, 1994; Selinske, Greer & Lodhi, 1992).

11. *Multiple Exemplar Instruction*

Multiple exemplar instruction (MEI) is utilized in two forms in research and instruction. The first application, also known as general case teaching, is used to describe a procedure in which students respond to presentations of variations in stimuli designed to evoke abstract stimulus control in which irrelevant aspects of stimuli are rotated. Cooper et al. (2007) defined multiple exemplar training as “instruction that provides the learner with practice with a variety of stimulus conditions, response variations, and response topographies to ensure the acquisition of desired stimulus controls response forms” (p. 699-700). A more precise definition for MEI as general case teaching is “student responses to presentations of abstractions in which the irrelevant aspects of a stimulus or conglomerate of stimuli are rotated across positive exemplars” (Greer & Ross, 2008, p. 296).

The other application involves joining responses that are initially independent (Greer & Ross, 2008). The multiple exemplar instruction across speaker and listener responses that instantiated Naming teaches instructional sets of multiple response topographies to single stimuli or multiple stimuli in training sets using a response rotation procedure that results in the emergence of incidental learning of novel speaker and listener for novel stimuli without direct instruction (Greer & Longano, 2010; Greer & Ross, 2008; Greer & Speckman, 2009). That is the word and object stimulus relation or multiple stimulus control is taught across both speaker and listener responses in a juxtaposed fashion for training sets of word/objects. A sample
instructional set (or several sets) is/are taught across multiple topographies, so that a learner can acquire the capability to learn novel listener and speaker responses to novel stimuli as a result of hearing the word for stimuli as the stimuli are observed. For example, if taught a matching response while hearing the word for the stimulus spoken an individual with Naming can emit the listener response (e.g., if asked to point to the stimulus the child can do so) and speaker response (e.g., the child says the word for the stimulus) without instruction. Children who lack Naming cannot do this and must be taught each word and object relation directly in both listener and speaker functions.

In order to expand current research on the Naming capability, how it may serve to explain language acquisition, and the subsequent effects on educational practices associated with such as capability, it is critical to explore several bodies of relevant research. The topics of 1) language acquisition, from a structural and behavioral perspective as well as the role of verbal behavior theories in language acquisition theory (Chomsky, 1957; Crystal, 2006; Kenneally, 2007; Pinker, 1994, 1999; Skinner, 1957), 2) Naming: Naming as a derived relation (Horne & Lowe, 1996; Horne et al., 2004; Horne et al., 2006; Horne et al., 2002; Lowe et al., 2005; Miguel et al., 2008) and Naming as a capability (Fiorile & Greer, 2007; Greer, Corwin & Buttigieg, 2010; Greer, Stolfi, Chavez-Brown, & Rivera-Valdes, 2005; Greer & Keohane, 2006; Greer & Longano, 2010; Greer & Speckman, 2009; Greer, Stolfi, & Pistoljevic, 2007; Helou-Care, 2008; Longano, 2008; Pistoljevic, 2008; Speckman-Collins, Park, & Greer, 2007), as well as 3) effective instructional procedures and the role of teacher modeling in instruction (Albers
& Greer, 1991; Brophy & Good, 1986; Greenwood et. al, 1994; Greer, 2002; Skinner, 1953; States, 2010), are relevant topics to the present study.

**Language Acquisition**

Language can be analyzed based on structure and function (Greer, 2008). Linguists have proposed theories related to the structure of language (Crystal, 2006; Chomsky, 1959; Chomsky & Place, 2000; Kenneally, 2007; MacCorquodale, 1970; Pinker, 1999), while behavior analysts have proposed theories based on the function of language as behavior (Catania, Matthews & Shimoff, 1990; Greer & Keohane, 2006; Greer & Ross, 2008; Skinner, 1957). Linguistics is a science of language, which incorporates physiological processes behind the production of speech sounds and the discrimination of hearing sounds (Crystal, 2006). A behavior analytic approach focuses only on language function, and relies on the science of linguistics to explain biological factors associated with speech production and auditory discrimination of speech.

It is clear there are many factors that play a role in language acquisition including experience, physiological factors including genetic endowment, and the environment (Greer, 2008). Much of the past controversy between some linguists and behaviorists surrounds the extent in which consequences play a role in language acquisition (Catania, 2007).

**The Structural and Linguistic Approach to Language.** In Skinner’s (1957) book, *Verbal Behavior*, he proposed that language, like all human behavior, is predicted and controlled by the environment, and the consequences therein. He did not however, state that genetic endowment did not play a role. Rather, adventitious genetic endowment that came from natural selection coupled with reinforcement contingencies in cultural
interactions led to verbal behavior (Greer, 2008; Skinner, 1957). Therefore the basis for a behavioral approach to the explanation of language lies in the particular analysis of the cultural contingencies provided in the environment.

On the opposite end of the language theory spectrum, Noam Chomsky, rebutted Skinner’s theory. Chomsky referred to Skinner’s theory as a “stimulus response model” and stated language could not be established this way, due to the rapid rate in which children learn language (Kenneally, 2007). Chomsky’s argument, which came to be known as the “poverty of the stimulus argument,” refers to the theory that a child’s verbal environment is not rich enough to support language acquisition and therefore some structural features of language are innate and will emerge regardless of environment/contingencies/consequences (Catania, 2007; Kenneally, 2007). In Chomsky’s theory, called “universal grammar,” he therefore proposed that children must be born with some biological factor (which he initially asserted was not a product of natural selection but later said was) in which there was a mental map for language acquisition already present at birth (Kenneally, 2007). Chomsky argued that this mental component allowed children to learn the correct rules of syntax without formal instruction or consequences in the environment.

Most linguistics followed Chomsky’s theory of language acquisition until the publication of a paper that later became *The Language Instinct*, an influential book written by Steven Pinker (1994). Pinker, and his mentor Paul Bloom were two linguists who supported Chomsky’s theory that language was born out of some innate mental capacity. However, Pinker and Bloom postulated that Chomsky’s universal language device was born out of natural selection, a theory that Chomsky initially opposed.
Pinker, Bloom, and Chomsky agreed that children acquire language incredibly fast, beginning around age three, and make grammatical distinctions without formal instruction (Kenneally, 2007). However, Pinker and Bloom argued that our system of language, from a grammatical perspective, evolved over time due to its function. They opposed evolutionists, such as Stephen Jay Gould, who stated that the evolution of language, like the evolution of all biological factors, could be attributed merely as a “spandrel”, or random evolutionary event. Pinker and Bloom’s linguistic theory of language is in fact complementary to a behavioral view of language acquisition. Pinker and Bloom changed the perspective of many traditionally Chomsky and theorists that language came from a distinctly mental component or organ, to a theory of language evolution. After Pinker’s (1994) book, many language theorists stopped asking the question “did language evolve?” and began researching how language evolved.

**Functional Analysis of Language.** Linguistic theories of language based on structure are critical to the explanation of grammatical aspects of language, as well as the science of spoken sounds and auditory discrimination of such sounds (Crystal, 2006). However, linguistic theories do not identify the function of language, and therefore the analysis of language as behavior complements the linguistic analyses by providing a more complete analysis of language (Greer, 2008). Of course certain anatomical, physiological and neuro-physiological prerequisites are necessary to emit vocal or non-vocal verbal behavior. However, the presence of such properties allows for the verbal environment to shape and maintain verbal behavior (Catania, 2001; Greer & Keohane, 2006). Behavior analysts argue that cultural contingencies are responsible for language acquisition (Catania, 2007) coupled with the adventitious natural selection of physiological
capabilities allowed the cultural contingencies to select out language functions in any given verbal community (Greer, 2008). Researchers concerned with verbal behavior as a science, theorize cultural selection is responsible for the evolution of verbal function (Catania, 2001; Greer & Keohane, 2006). Verbal behavior theorists focus on the environmental role of language and language acquisition, while drawing on particular linguistic principles (Greer, 2008).

The foundation for the behavioral approach to language acquisition was adapted from Skinner’s writing on verbal behavior (1957). One criticism of Skinner’s initial theory was that it was not empirically tested. While the original concepts drew on an extensive body of laboratory research with non-human animals, several decades passed before research in verbal behavior of humans began in a serious fashion. However for over thirty years, a substantial amount of research has been conducted to test the function of Skinner’s identified verbal operants as well as further expand his theory. Research in stimulus equivalence (Sidman, 1971), relational frame theory (Hayes & Hayes, 1989), Naming (Horne & Lowe, 1996) and verbal behavior development theory (Greer & Keohane, 2006; Greer & Speckman, 2009), all contributed to the expansion of Skinner’s theory of verbal behavior, and therefore on the function of human language.

**Empirical Research as an Expansion of Skinner’s Theory of Verbal Behavior**

**Stimulus Equivalence.** Stimulus equivalence sought to add to Skinner’s (1957) theory of verbal behavior, and ultimately a behavioral approach to language acquisition, by identifying important emergent relations that are relevant to human language. Although the emergent relations specified by Sidman (1971) are relevant to language, they were not proposed as an explanation of language. Stimulus equivalence is a finding
about a particular kind of emergent behavior that identified equivalence among stimulus-stimulus relations and refers to similar responses under the control of two or more stimuli (Sidman, 1971). This theory focused on stimulus classes that do not share similar physical topographies, however do share similar behavioral functions, such as a picture and a printed word (Miguel & Petursdottir, 2009).

Sidman (1971) conducted the first experiment that led to the theory of stimulus equivalence. In this experiment, a male participant diagnosed with mental retardation was taught to match spoken words to printed words. A post-experimental probe was conducted to test for matching printed words to pictures, and reading printed words aloud without any direct training. The results of Sidman’s study showed the participant emitted correct reading comprehension responses (matching words to pictures) without being directly taught. Thus, the participant emitted untrained responses.

The experiment led to more research by Sidman and others involving extensive demonstration of the phenomenon. Sidman and Tailby (1982) used a conditional-discrimination procedure to test for the emergence of untaught equivalence relations in an experiment conducted with eight participants. The results of the experiment led to the three defining characteristics of stimulus equivalence: 1) reflexivity 2) symmetry and 3) transitivity. In the case of all three characteristics, the emergence of the untrained response occurs without any instruction, or reinforcement. Reflexivity (A=A) occurs when a stimulus is matched to an identical replication of itself. For example, if a child matches a picture of a car to another picture of a car without any training or reinforcement, reflexivity has occurred. Symmetry (A=B, B=A) is the reversibility of two stimuli. For example, if a child is taught to match the word “car” with the picture “car”,...
the child can then match the picture “car” to the word “car” without instruction. Transitivity (A=B and B=C, then A=C) occurs when two stimulus-stimulus relations are taught, and a third, untrained relation emerges. For example, if a child is taught to match the spoken word “car” with a printed word “car”, and the child is taught to match the spoken word “car” with a picture of a car, and the child can then match the printed word “car” with a picture of a car without instruction, transitivity has occurred.

This work constituted the identification of components involved in the emergence of equivalent relations. However, the theory of stimulus equivalence was a description of stimulus-stimulus equivocal relations that was not empirically tied to human language. Therefore the behavior that emerges as a result of stimulus equivalence may not be verbal.

Relational Frame Theory (RFT). RFT is a theory developed by Hayes and Hayes (1989) as a comprehensive explanation of human language and cognition (the process of thought, or behavior beneath the skin). The theory is an extension of Skinner’s theory of verbal behavior, as well as an extension of stimulus equivalence, in which language was the defining component (Hayes et al., 2001). Proponents of the theory only acknowledge behavior to be verbal if both the speaker and the listener within the skin participate in the verbal interaction, also called a frame (Barnes-Holmes et al., 2004; Hayes et al., 2001). Hayes et al. (2001) theorized that emergent verbal behavior frames resulted from histories of multiple exemplar experiences; hence, the phenomenon was potentially traceable to the environment. While the capacity to do so may be uniquely human, doing so results from cultural contingencies (i.e. the environment).
RFT requires an understanding of 1) what constitutes a frame, 2) relational responding, and 3) derived relational responding. Hayes et al. (2001) defined a frame as any response involving a stimulus event. Within the frame, there may be several stimuli. It is important to note that emotions and thoughts are treated as stimuli in RFT. Relational responding is the discriminations people make between and among stimuli in a frame. There are relationships between stimuli that may be causal (one stimulus caused a response or another stimulus), equivalence between stimuli (one stimulus may be the same as another, even when physically different), or a hierarchal relationship between stimuli (one stimulus may be a smaller or larger piece of another stimulus) (Blackledge, 2003). Derived relational responding is built on the concept that a person can discriminate the relationships between stimuli without ever having direct contact with one or more stimuli in the frame (Barnes-Holmes et al., 2004; Barnes-Holmes et al., 2004).

Blackledge (2003) gives an example to describe the basic components of RFT: the frame, relational responding, and derived relational responding. I adapted the example to describe the basic components of the theory: A person is in a wooded area and sees a snake which results in the person experiencing accelerated heart rate, and further results in the person running away. The person, the wooded area, the snake, and the accelerated heart rate are the stimuli that compromise the frame. The relationship between the snake and the action of running away is an example of relational responding (causal relational responding to be specific). Now imagine these events did not directly happen, but instead a person read a story about a snake in a wooded area, and in the story the snake bit the character in the story. Even without the person ever having an experience with a snake,
the presence of a wooded area may evoke accelerated heart rate, and may even elicit an emotion of fear. These responses are examples of derived relational responding.

There are two basic types of derived relational responding, called relational frames, in RFT. These frames are mutual entailment and combinatorial entailment (Barnes-Holmes et al., 2004; Hayes, et al., 2001; Hayes, et al., 1994). Mutual entailment is a bidirectional relation in which a relational frame develops between two verbal events. For example, if A=B, then B=A or if A > B, then B < A. In other words, if the statement “Tom is taller than Mary” is made, one can derive that “Mary is shorter than Tom” without any training or reinforcement. Combinatorial entailment is the development of a relational frame between three or more verbal elements. For example, if A<B, and B<C, than A<C. A more concrete example would be “Kathy is taller than Mery, and Mery is taller than Kate”, and one derives that “Kathy is taller than Kate.” Research has shown that children as young as one and a half do not derive mutual or combinatorial relations (Lipkin, Hayes & Hayes, 1993). This research supports the theory that derived relations are learned through multiple experiences and examples, based on differential reinforcement (Moore, 2008). Therefore, children must acquire this aspect of language (Blackledge, 2003).

Transformation of stimulus function is another key component in RFT. Blackledge (2003) described how “making relational responses between stimuli results in transformation of stimulus function for all the stimuli involved” (p. 427). In other words, the functions of the stimuli within a frame can change based on the other stimuli in the frame. In reference to Blackledge’s (2003) snake and wooded area example, if a person perceived a wooded area to be beautiful prior to being informed there are snakes in
wooded areas, the wooded area’s function may change from beautiful to frightening based on the presence of the snake stimulus.

**Verbal Behavior Development Theory (VBDT).** A new empirical account of verbal behavior development, VBDT, is based on the foundations of verbal behavior as set forth by Skinner (1957), as well as current research showing functional analyses of verbal behavior (Greer, 2008; Greer & Ross, 2008). The findings are consistent with RFT research as well as the extensions of Skinner’s work by Horne and Lowe (1996) on the Naming capability, although the latter two accounts differ regarding relational responding. VBDT is an empirically induced theory that has identified environmental experiences and interventions which 1) identify if an individual is missing verbal developmental cusps and capabilities and, 2) outline how to induce such cusps and capabilities in children who were missing them (Greer, 2008; Greer & Keohane, 2006; Greer & Ross, 2008; Greer & Speckman, 2009). VBDT research began when parents and educators observed a halt in development, especially in children with developmental delays. VBDT theorists began conducting experiments that lead to the identification of critical verbal developmental cusps and capabilities. As the research expanded, VBDT researchers tested interventions to induce missing cusps and capabilities, allowing children to continue to develop verbally (not only vocally). The verbal developmental sequence outlines the basic stages of development. The research associated with this sequence along with the research on developmental cusps/ capabilities and how to induce them provides empirical support for how children come to learn language (Greer, 2008; Greer & Keohane, 2006; Greer & Ross, 2008).
**Verbal Developmental Sequence.** The VBDT proposed a verbal developmental sequence that begins before birth, and progresses to include the role of verbal behavior in academic functioning (Greer & Ross, 2008; Greer & Speckman, 2009). Conditioning reinforcement begins in utero when the mother’s voice is paired with nutrients (Decasper & Spence, 1986). This pairing continues after birth when nourishment continues to be paired with the mother’s voice, and as vision accrues, with the mother’s face (Donahoe & Palmer, 2004). Simultaneously, production responses of the child are reinforcing (movement of arms and legs and a swimming movement). As reinforcement is paired with the child’s observations of the mother’s face (which are often imitated), and the child’s production responses, the acquisition of the correspondence between production and observation becomes a conditioned reinforcer.

As the mother’s voice becomes a conditioned reinforcer, the child begins to parrot, by producing vocal responses, which first manifest as babbling. When a child successfully echoes a word, and receives reinforcement from the echoic, parroting leads to the emission of echoics, the first of the speaker operants. Around this stage, generalized imitation, or see-do also emerges. The correspondence between seeing and doing, as well as hearing and saying are higher order operants which set the foundations for the acquisition of many critical cusps and capabilities (Greer & Keohane, 2009).

Listener operants continue to develop, such as basic listener literacy in which children can hear and do. Simultaneously, but independently, speaker operants begin to emerge and expand, such as mands and tacts. At this point in development, listener functions and speaker functions are independent of each other. The joining of the speaker and the listener functions begin with say-do correspondence and self-talk conversational
units. The joining of the speaker and the listener functions is not fully complete until a child acquires Naming. At this point in development, a child’s language repertoire significantly expands. In addition, children are able to learn language, as well as reader and writer functions, in a way they could not prior to the integration of the speaker and listener responses beneath the skin. The acquisition of Naming sets the foundation for many advanced cusps and capabilities including reading comprehension, transformation of stimulus function across saying and writing, and affecting the behavior of another through reading and writing (Greer & Ross, 2008).

This developmental sequence appears to occur naturally and incidentally in typically developing children but is clearly tied to the contingencies that they experience (Greer & Longano, 2010). For an extensive review of the identified cusps, capabilities, and procedure to induce them, see Greer and Ross (2008) and Greer and Keohane (2005).

**Naming**

The presence of Naming as a verbal developmental capability may be the key factor in incidental language acquisition that has been shown to occur naturally in typically developing children. Research on Naming has been conducted by two groups of theorists, with much agreement between them on the importance of the presence or absence of Naming on language development and acquisition. Naming theorists (Horne & Lowe, 1996) have conducted extensive research on Naming as bidirectional relation and an untaught derived relation. VBD theorists (Greer & Keohane, 2006; Greer & Longano, 2010; Greer & Ross, 2008; Greer & Speckman, 2009) have conducted research on Naming as a verbal developmental capability. Relational frame theorists (Hayes, Barnes-Holmes & Roche, 2001) also agree with the Naming theorists and VBD theorists...
that Naming is a central factor to becoming truly verbal, as it joins the listener and speaker functions.

**Naming as a Derived Relation.** It has been proposed that Naming facilitates derived relational responding (Hayes et al., 2001; Miguel & Petursdottir, 2009). Several studies showed that Naming was a necessary prerequisite for a child to emit untaught sorting and categorization responses after tact instruction (Horne et al., 2004; Horne et al., 2006; Horne et al., 2002; Lowe et al., 2005; Miguel et al., 2008). In these studies, children were taught either the speaker or the listener responses for two sets of stimuli. After the training (either listener or speaker, but not both) a categorization and sorting test was conducted to determine if untaught relations emerged. The results of these studies showed that children who failed to acquire the speaker functions (tacts) from listener training were unable to correctly sort and categorize. However, children who did learn to tact from listener training were able to do so. The results showed that only children who could emit correct responses after learning the stimuli in only one response showed the bi-directionality central to Naming. Therefore children with Naming were able to emit untaught derived relations while children without Naming were unable to do so.

**Naming as a Verbal Developmental Capability.** Several experiments conducted by VBD theorists found that after Naming was induced, children could acquire novel speaker and listener responses for novel stimuli from attending to the stimuli as they heard the words for the stimuli spoken. Prior to the induction of Naming, the participants required direct instruction in each response separately (Fiorile & Greer, 2007; Greer et al., 2005; Greer et al., 2007; Helou-Care, 2008; Longano, 2008; Pistoljevic, 2008;
Speckman-Collins, Park, & Greer, 2007). In this research, multiple exemplar instruction (MEI) across listener and speaker responses, intensive tact instruction, auditory matching, and stimulus-stimulus pairing were interventions that have been shown to induce Naming.

**MEI to Induce Naming.** MEI has been the most widely replicated protocol to induce Naming. MEI across speaker and listener responses that instantiates Naming teaches multiple response topographies to single or multiple stimuli (heard word and observed stimulus in this case) in training sets using a response rotation procedure that results in the emergence of incidental learning of novel speaker and listener responses without direct instruction (Greer & Longano, 2010; Greer & Ross, 2008; Greer & Speckman, 2009). A sample instructional set is taught across multiple topographies (MEI), so that a learner can acquire the capability to learn novel listener and speaker responses to novel stimuli as a result of hearing the word for stimuli as the stimuli are observed. The test, or pre-experimental/post-experimental probe, involves teaching a set of stimuli in a match topography (in which the child hears the names for the stimuli while matching them), and then testing for the untaught listener and speaker responses. For example, after teaching a match response while hearing the word for the stimulus spoken, an individual with Naming can emit the listener response (i.e., if asked to point to the stimulus the child can do so) and speaker response (i.e., the child says the word for the stimulus without a vocal antecedent, a tact, or says the word for the stimulus after a vocal antecedent, an impure tact or intraverbal) without direct instruction. Children who lack Naming cannot do this and must be taught each word and object relation directly in both listener and speaker functions. The capability to do so resides in the environmental
history of contact with the basic principles that formed the relations, such that a Naming experience occasions the emergent behavior.

Studies conducted by Greer et al. (2005) and Gilic (2005) showed that multiple exemplar instruction was an effective intervention to induce the Naming capability for pre-school aged children who lacked Naming. Greer et al. (2005) taught three children to match the stimuli while hearing the experimenter say the word for the stimuli as they matched. Upon mastery of the match-to-sample (MTS) procedure, the untaught point, tact and intraverbal responses were tested to see if they emerged. Following pre-experimental probe sessions, MEI was implemented to mastery, and the untaught point, tact and intraverbal responses were tested again, this time without hearing the words for the stimuli during the MTS procedure. The results of the study showed that untaught listener and speaker responses emerged for all three participants following the MEI intervention. Gilic (2005) tested the same procedure in two experiments with two-year old children. The results of that study showed that the untaught listener and speaker responses also emerged for those children after implementation of MEI. Feliciano (2006) used MEI to induce the listener half of Naming in six elementary school aged children, who did not have vocal verbal behavior. Feliciano reported that simply rotating a MTS procedure in which the participants heard the word for the stimuli when taught to match and point resulted in non-vocal children acquiring the capability to emit the listener half of Naming for novel stimuli.

Fiorile (2005), Greer et al. (2007) and Pistoljevic (2008) compared multiple and single exemplar instruction (SEI) on the acquisition of Naming in three separate studies. The results of the studies taken together showed that MEI was effective in inducing one
or both components of Naming while SEI was not. In all three studies, MEI was implemented in the same fashion as described above. SEI consisted of teaching participants a set of stimuli in each response separately. Post-experimental probes showed that MEI resulted in Naming while SEI did not for all participants across the three studies.

**Intensive Tact Instruction to Induce Naming.** In the second experiment of the Pistoljevic (2008) study, she tested the effects of the Intensive Tact protocol on the acquisition of Naming for preschool children with developmental delays. The Intensive Tact procedure consisted of presenting one to two hundred additional tact learn units to the participants every day, in addition to their regular curricular instruction. Pistoljevic (2008) used a time lagged, or as some have termed the design a “non-concurrent”, multiple probe design across three participants. The results of this experiment showed the participants acquired Naming and also increased the participants’ emissions of verbal operants in non-instructional sessions as a result of the Intensive Tact intervention.

**Auditory Matching to Induce Naming.** A study by Speckman-Collins et al. (2007) tested the effects of auditory matching on the emergence of the listener component of Naming alone. The participants were two preschool students diagnosed with autism, who were just beginning to emit echoics and tacts. The dependent variable in the study was the point to (selection) response for two pictures placed in front of the participant, the echoic response for the presentation of one picture, and the tact response for the presentation of one picture. The intervention in the study was auditory matching, which consisted of three BIG Mac® buttons placed in front of the student. One button had the target sound, one had a negative exemplar sound, and the third (in front of the
experiment) was the target sound. The experimenter pressed the button in front of him/herself, and then the two buttons in front of the participant. The participant was required to match the target sound from the experimenter’s button with the correct match in front of him/her. The participants learned to match progressively more difficult auditory stimuli eventually resulting in matching spoken words. The results of the study showed that auditory matching resulted in the emergence of the listener component of Naming for two children with autism.

**Stimulus-stimulus Pairing to Induce Naming.** Longano (2009) conducted three experiments utilizing delayed multiple probe designs across participants to test the effects of the echoic and a second order classical conditioning procedure as the source of reinforcement for Naming. In the first experiment, three of four participants acquired Naming after an echoic component was added to MEI across listener and speaker responses. In the second experiment, the participant who did not acquire Naming from emitting echoics acquired Naming after stimulus-stimulus pairing conditioned the echoic as a reinforcer. In the third experiment, three participants who did not have Naming and who had not received the echoic stimulus-stimulus pairing or MEI with an echoic component, acquired Naming after a second-order classical conditioning procedure was used to pair visual stimuli with vocal responses. Naming was acquired as measured by experimental probes like those used in all of the Naming experiments but in addition it also emerged in post-experimental probes of incidental comments the experimenter made about stimuli in the environment. Longano (2009) proposed that the results of the study suggested that stimulus-stimulus pairing is the source of reinforcement for Naming in that
it may be the underlying cusp that makes MEI, auditory matching, and the intensive tact effective.

**Initial Reinforcement for Naming.** There are many inquiries about Naming that researchers continue to make, such as the source of initial reinforcement for the Naming capability. Horne and Lowe (1996) proposed the source of reinforcement for Naming is the echoic. Longano (2009) found that ensuring the emission of the echoic in training sessions did induce Naming for participants for whom the MEI was not successful. However, her subsequent studies suggested that the echoic needed to be conditioned as a reinforcer presumably in some cases, suggesting that the foundation was the stimulus-stimulus pairing procedure which resulted in conditioning of the echoic as the reinforcer. Greer and Longano (2010) proposed the immediate reinforcement for Naming is the echoic, however the initial source is based on conditioning experiences that (most likely) typically occurs incidentally in infancy, as described in the verbal developmental sequence.

**Educational Implications of Naming.** Inquiry into the development of verbal behavior within children’s lifespan suggests that effective instruction may need to take into account the cusps and capabilities that students have in repertoire (Greer & Speckman, 2009). This focus is consistent with other research that reports strong interactions between development and types of instruction (Connor et al., 2009). Naming theorists, relational frame theorists and verbal behavior development theorists agree that Naming is a critical component of language acquisition (Greer & Keohane, 2006; Greer & Ross, 2008; Greer & Speckman, 2009; Hayes et al., 2001; Horne & Lowe, 1996; Miguel & Petursdottir, 2009). Verbal behavior development theorists also proposed that
Naming has significant educational implications, as the joining of the speaker and the listener functions is a necessary developmental stage to learning in new ways. Naming may not only be critical to language development, but it also may be critical to the acquisition of advanced reader and writer functions.

The impact that the acquisition of Naming has on the educational (and social) development of children continues to be expanded as more research is conducted. For example, when print control joins Naming, reading comprehension becomes possible (Helou-Care, 2008; Lee-Park, 2005; Reilly-Lawson, 2008). Lee-Park (2005) conducted a study in which children were unable to match pictures to printed words. MEI across pictures and textual responses was conducted. Following MEI, print joined Naming and the participants matched words to pictures resulting in the acquisition of reading comprehension.

Reilly-Lawson (2008) tested the effects of multiple exemplar phonemic instruction on joining Naming to reading and writing, and transformation of stimulus function across reading and writing for elementary aged children with developmental delays. The dependent variables in the study were untaught reading comprehension responses, textual responses and written spelling responses for unknown French words and three-dimensional contrived stimuli. The independent variable in the study was multiple exemplar instruction across point, textual and written response for phonemic blends. The results of the study showed Naming joined reading and writing, and transformation of stimulus function across reading and writing emerged. The results suggested phonemic control is the source of the derived relation between Naming and reading and writing.
Helou-Care (2008) tested the effects of Naming on reading comprehension for middle school students with emotional and behavioral disorders. All of the participants lacked Naming and showed difficulty with reading comprehension skills, however were fluent at textual responding. The dependent variables in the study were reading comprehension questions about the content of a story, as well as about the meaning of contrived words within the story. The independent variable in the study was the induction of Naming utilizing MEI. The results of the study showed that following the induction of Naming, the participants’ correct responses to reading comprehension questions, as well inferring the meaning of contrived vocabulary words within a story, significantly increased.

The studies by Lee-Park (2005), Reilly-Lawson (2008) and Helou-Care (2008) showed the effects of Naming on untaught reading and writing responses. Naming experiences may also have an educational impact, if certain advanced capabilities are in a child’s repertoire. Greer and Longano (2010) give an example of the effect of a Naming experience is as follows: A child goes to the zoo and sees an elephant. He has many emotional experiences during his zoo visit (excitement, or perhaps fear). In school the following week, he sees a new word. If the child can phonetically sound out words, he can sound out the word “elephant”. Immediately, the child knows what an elephant is without being taught directly (reading comprehension), due to his Naming experience. He probably can visualize an elephant (described by Skinner (1957) as conditioned seeing), and perhaps an emotion is evoked. This immediate comprehension of the word is due to Naming (Greer & Keohane, 2009; Greer & Longano, 2010). Furthermore, when transformation across saying and writing is in repertoire (i.e., the joining of saying and
writing phonemes), the child may even be able to spell the word “elephant” without direct instruction (Greer & Du, 2010; Greer, Yuan & Gautreaux, 2007).

Research on the educational implications of Naming for reading, writing and math functions continue to expand the case that Naming is not only critical to language development, but also to educational success (Greer et al., 2010; Helou-Care, 2008; Lee-Park, 2005; Reilly-Lawson, 2008). Testing for the presence of Naming, and subsequently inducing Naming, may be critical to educational outcomes. Hart and Risley (1995) have shown that children who are not exposed to language (due to poverty or non-English speaking homes) are at a significant disadvantage to their upper-middle class peers. In a study by Greer and O’Sullivan (2006) out of fifty-six first graders tested, the majority of students without Naming were English language learners (ELL), or from economically disenfranchised families. These findings build the case for the need for Naming to be induced for children who often do not acquire it naturally (children with language disabilities such as ASD, children who are ELL, or from low socio-economic status).

**Effective Instruction**

Effective instruction was defined by Fredrick and Hummel (2004) as “instruction that enables students to demonstrate, maintain, and generalize competency on pre-specified learning outcomes faster than students would be able to accomplish this either on their own or with less effective instruction” (p. 10). The number of student-level variables (factors that teachers cannot control) that impact learning are infinite, therefore effective instruction requires a broad definition: the actions of a teacher that result in student learning. Teacher-level variables include aspects of education that can be controlled. Marzano (2000) groups teacher-level variables into three categories:
curriculum, instruction, and classroom management. Slavin (1994) gives an analogy to
describe the importance of each category in relation to one another. If curriculum design
was the means to student achievement, then educators could achieve this by identifying
the best lecturer on a topic, videotape the lecturer, and presenting it to all students. Slavin
(1994) goes on to describe the ineffectiveness of such a model, as the video teacher does
not know the students’ level of performance, nor can she adapt the curriculum based on
evaluation and analysis of such performance. Furthermore, the video teacher cannot
provide motivation to students, or manage their behaviors. An effective educational
system must incorporate all three components. For the purposes of this review, the focus
will be on the instructional component of an educational system. It is important to note
that sequentially organized curricula and classroom management systems must also be in
place.

**Early Research on Effective Instruction.** In the 1960s and early 1970s,
educational research emphasized the importance of curriculum over the importance of the
teacher. Studies such as the Coleman report (Coleman et al., 1966) and Popham’s (1971)
study reported that teachers did not have significant effects on student achievement.
These studies suggested that regardless of training, the right curriculum was the key
factor in student learning. In the mid to late 1970s, the use of direct observational
methods to study teachers became commonplace in educational research (Brophy &
Good, 1986). In addition, large-scale government funding of educational research, such
as Project Follow Through (Stallings, 1975; Stallings & Kaskowitz, 1979) led to more
accurate information regarding the role of the teacher in education. The findings from
Project Follow Through, in conjunction with other studies of that era, reported that the
teacher played a critical role in increasing student outcomes. The study also reported that increasing student opportunities to learn by increasing time spent on academic subjects, increasing students’ opportunities to respond, and teacher feedback lead to higher student achievement.

Opportunity to respond is built on Skinner’s (1953, 1968) definition of teaching, which involves arranging the contingencies of reinforcement to occasion learning (Greenwood, Hart, Walker & Risley, 1994). The three-term contingency, consisting of an antecedent, student response and a consequence, is also a foundational aspect of Skinner’s (1953, 1968) definition of teaching, as well as a foundational aspect of opportunity to respond. Opportunity to respond is defined as “the interaction between a) teacher formulated instruction and b) its success in establishing the academic responding…the subject matter goals of instruction” (Greenwood, Delquadri & Hall, 1984, p. 64). Therefore opportunity to respond requires teachers to provide the antecedent and consequence to behaviors by 1) analyzing the environment to account for antecedent events that lead to student responding 2) providing presentations and questioning to lead to student responding and 3) providing consequation of student responding in the form of reinforcement or correction (Greenwood et al., 1994).

Increasing student opportunities to respond, when done effectively, is synonymous with “increasing engaged academic time” or “active learning”. When increased opportunities to respond are paired with teacher feedback, the components of effective instruction are in place. In the years since Project Follow Through, substantial research has been conducted on methods that involve increasing students’ opportunities to respond, with an emphasis on teacher feedback. Peer tutoring (Greenwood, Delquadri
& Carta, 1988, Greenwood et al., 1989), response cards (Gardner, Heward, & Grossi, 1994), Precision Teaching (West & Young, 1992; West, Young & Spooner, 1990), Direct Instruction (Binder & Watkins, 1990), and computer-based programming (Kulik, 1994) are some of the well-researched educational methods to increase students opportunities to respond, and include the key components of effective instruction.

**Beyond Opportunities to Respond.** In the past two and a half decades, research based on Skinner’s (1953, 1968) definition of teaching, and the principles of verbal behavior (Skinner, 1957) have added to the prior research on what comprises effective instruction. Research shows that teacher assessment and subsequent feedback have significant implications for student learning (States, 2010).

The learn unit and components of the learn unit have been tested in several experiments that consistently report that it is a key measure of instructional effectiveness (Albers & Greer, 1991; Bahadorian, Tam, Greer, & Rousseau, 2006; Diamond, 1992; Emurian, et al; Greer, 1994; Greer, McCorkle & Williams, 1989; Greer & McDonough, 1999; Hogin, 1996; Ingham & Greer, 1992; Singer & Greer, 1997). Researchers have also reported that greater numbers of learn units presented to learners result in higher numbers of correct responses and higher numbers of objectives mastered (Albers & Greer, 1991; Greer, 2002; Greer, McCorkle & Williams, 1989; Selinske, Greer & Lodhi, 1991). These findings provide a more complete treatment of what constitutes effective teacher behavior that results in the global findings on the importance of “good” teachers in providing active responding, feedback, and direct measurement. In effect, the learn unit constitutes key components of good teaching (Greer & Keohane, 2006 Greer et al., 2002; Goe, Bell, & Little, 2008).
Unfortunately, many teachers do not provide this kind of effective instruction (Greer, 2002). Nevertheless, some students learn to some degree in spite of the paucity of learn unit presentations, while others fail to do so. Moreover, secondary students and college students must learn from lecture presentations where there are few if any learn units (Bahadourian et al, 2006; Keller, 1968). This disparity suggests that some learners come to the table with the prerequisite capabilities to learn, at least to some degree, from instructional presentations that do not meet the conditions of learn units. Some evidence suggests that there may be verbal developmental cusps and capabilities that allow students to learn from different types of contact with instructional contingencies, including those missing the key components of the learn unit.

**The Presence or Absence of Verbal Cusps and Capabilities.** Recent research has shown that the presence or absence of verbal developmental cusps and capabilities not only affect a student’s verbal and educational development, but also may affect how children learn (Greer & Speckman, 2009). The presence of verbal developmental capabilities allow children to learn in a way they could not prior to the attainment of the capability, and therefore their learning is accelerated (Greer & Keohane, 2009). However it is up to the teacher to 1) assess the presence or absence of verbal developmental capabilities and 2) change instruction based on the students repertoire. The present study seeks to test how instruction should be changed based on the presence or absence of verbal developmental capabilities.

**Teacher Modeling as Part of Instruction**

Research has shown that increasing student opportunities to learn by providing more learn unit presentations, which include the components of effective instruction,
results in student achievement (Albers & Greer, 1991; Greer, 2002; Greer et al., 1989; Selinske et al., 1991). Practitioners and researchers continue to seek answers to questions about what other components of instruction produce significant learning outcomes. One component of instruction that is present in many educational models is the use of teacher modeling. In order to look at the effects of teacher modeling on student achievement the role of the teacher in terms of teacher guidance and the role of teacher modeling should be discussed.

**How Much Guidance Should Teachers Provide?** Several models of education, such as discovery learning (Anthony, 1973; Bruner, 1961), problem based learning (Barrows & Tambly, 1980; Schmidt, 1983), inquiry learning (Papert, 1980; Rutherford, 1964), experiential learning (Boud, Keogh & Walker, 1985; Kolb & Fry, 1975) and constructivist learning (Jonassen, 1991; Steffe & Gale, 1995) propose minimal teacher guidance as an approach to education. These approaches postulate that children should discover their own solutions to problems when provided only with a learning goal and minimal information.

Kirschner, Sweller, and Clark (2006) summarize the findings supporting that minimally guided education is significantly less effective than an educational model that includes direct instructional guidance. They defined direct instructional guidance as “providing information that fully explains the concepts and procedures that students are required to learn” (p. 75). Klahr and Nigam (2004) conducted a study in which they compared the learning outcomes of a discovery-learning model versus a direct instructional guidance model. The results of the study showed that students in the direct
instructional guidance model not only learned more content, but also were able to generalize the content they learned to new contexts.

**Teacher Guidance through Modeling.** A vast number of researchers report models based on principles of direct instruction and explicit teaching lead to higher student outcomes (Hall, 2002; Rosenshine, 1986). These educational models focus on a high level of teacher guidance, which includes a large portion of instruction consisting of teacher strategy instruction, which involves teacher demonstration of skills and problem solving techniques. Although not explicitly termed “teacher modeling,” Brophy and Good (1986) report the presence of this component as key aspect of effective teaching. They report that effective teaching consists of 1) teacher presentation of information 2) teacher questioning and 3) teacher feedback. Brophy and Good (1986) report that the initial presentation of information can maximize student achievement. They suggest that presentation of information is especially effective when it is done in a rapid fashion, with some redundancy (repetition of key skills or concepts) and interspersed with student practice. Brophy and Good (1986) state that listening to vocal presentations by a teacher positively affect student achievement. The combination of vocal teacher presentations with teacher feedback and assessment comprise the key aspects of effective teaching (Brophy & Good, 1986).

In addition to the research supporting direct and explicit instruction, empirical evidence is found that more learning occurs in the presence of teacher modeling than in the absence of the procedure (Kirschner et al., 2006; Tuovinen & Sweller, 1999). A sample these studies, along with the target population, subject area and brief commentary is provided in Table 1.
Table 1

*Research on Teacher Modeling*

<table>
<thead>
<tr>
<th>Research</th>
<th>Population</th>
<th>Subject Area</th>
<th>Comments</th>
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<tbody>
<tr>
<td>Baroody (1987)</td>
<td>Typically developing</td>
<td>Math: Counting</td>
<td>Children were asked to complete addition problems, and their strategies were observed. All but 3 out of 17 students required modeling of “concrete counting”, a strategy to add basic numbers, prior to solving problems correctly.</td>
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<td></td>
<td>kindergarteners</td>
<td></td>
<td></td>
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<tr>
<td>Swanson (1999)</td>
<td>Learning Disabled</td>
<td>Any</td>
<td>In a meta-analysis of 180 interventions, the components of effective instruction were reported, which included teacher modeling of problem solving tasks.</td>
</tr>
<tr>
<td>Swanson, Hoskyn &amp; Lee</td>
<td>Learning Disabled</td>
<td>Any</td>
<td>In a meta-analysis of 913 studies, the components of effective instruction were reported, which included explicit instruction, and the teacher playing a more active role.</td>
</tr>
<tr>
<td>(1999)</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Baker, Gersten &amp; Lee (2002)</td>
<td>Low achieving or at risk</td>
<td>Math</td>
<td>In a meta-analysis of 15 studies, the components of effective math instruction were reported, which</td>
</tr>
<tr>
<td>Study</td>
<td>Grade</td>
<td>Methodology</td>
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<tr>
<td>Methe &amp; Hintze (2003)</td>
<td>Typically developing 3rd grade children</td>
<td>Tested teacher modeling of silent sustained reading in which the teacher provided a short vocal script, and then modeled reading silently. Utilizing a reversal design, the results showed a functional relationship between teacher modeling conditions and the increase in silent sustained reading for the participants in the study.</td>
<td></td>
</tr>
<tr>
<td>Worthy &amp; Broaddus (2002)</td>
<td>Reading Fluency</td>
<td>Reported teacher modeling increased fluency. Teacher read aloud and students followed along with the print and then echoed. Benefits of modeling fluency include increased rate and accuracy as well as phrasing/expression.</td>
<td></td>
</tr>
</tbody>
</table>

Other bodies of research report findings on teacher modeling, however the principle behind the role of the teacher is different from direct instruction and explicit instruction. In direct and explicit instruction models, a skill or problem-solving task is being taught using a strategy. The strategy is modeled, scaffolded as necessary, and feedback is provided (Hall, 2002). Other bodies of research use an alternate approach to
teacher modeling. Instead of modeling a strategy with an example, the model is based on cognitive processes alone. Teacher modeling based on cognitive processes involves a teacher explicitly explaining his/her thought process about how to come to a conclusion. For example, if a teacher were teaching how to find the main idea in a story, he/she would vocally state his/her strategic thinking about how one goes about finding a main idea in a story. Duffy et al. (1986) termed this “direction explanation”. The initial studies showed that students had a greater awareness of how to reason strategically about reading comprehension tasks, however they did not test the application of the skill. In addition, some of the key components of effective instruction previously identified, such as teacher feedback, are missing.

Other research shows similar faults in teacher modeling. Mercer, Miller and Jordan (1996) propose teaching the steps of a problem solving strategy in math instruction, and only demonstrating the strategy explicitly if students do not do the strategy taught correctly initially. Therefore these researchers focus on teaching the strategy as opposed to the skill/algorithm, and expect students will be able to apply the strategy to any problem.

In essence, educational models based on cognitive strategies teach ways of thinking, as opposed to an algorithm. Although it appears the research based on teaching and modeling algorithms yield more positive results, it is subject specific. There are no algorithms to teach reading comprehension, or aesthetic writing skills, therefore the research in these subject areas are dominated by cognitive strategy instruction (Lloyd, Kameanui, & Chard, 1997).
The Role of Teacher Modeling. In a regular education class, a large portion of teacher-directed instruction can be termed “teacher modeling.” In most classes comprised of typically developing children, a teacher provides a lesson in which he/she explains and/or demonstrates what the students are to do, and how they are to do it. In an effective classroom, other components of instruction also come into play, such as providing students with opportunities to respond, questioning, student practice, and providing feedback based on student responses. As noted above, a substantial amount of research has been conducted in direct instruction, explicit instruction, and various forms of strategy instruction, all of which consist of some aspect of teacher modeling. These studies have been conducted with both typically developing children, and children with learning disabilities.

Some researchers propose more specific elements of instruction, and essentially teacher modeling, to increase student achievement. Rosenshine (1986) recommended presenting material in small steps, providing clear and explicit instruction, followed by student practice and systematic feedback. Rosenshine (1986) proposed presenting instruction in small steps is more effective than presenting a whole lesson. Fuchs and Fuchs (2001) recommend students memorize and vocally repeat the steps explicitly taught to them while performing a task.

Recently, the research on teacher modeling has been expanded to measure the effects for children with autism, as well as with typically developing children (Greer et al., 2010). More importantly, this research showed that the presence or absence of the verbal developmental capability Naming may directly affect if a child can learn from observing a teacher modeling a skill.


**Rationale**

The present study sought to expand the research on how the Naming capability might allow children to learn from observing a teacher model academic skills, learn faster, and to learn in ways they could not prior to the attainment of the verbal developmental capability. The ability to acquire language incidentally may be linked to the ability to learn from observing a teacher modeling how to produce an accurate response. In a prior study (Greer et al., 2010), we tested the presence or absence of Naming (Experiment I) and the induction of Naming (Experiment II) on the rates of learning under two instructional conditions. In Experiment I we used a counterbalanced reversal design across matched pairs of nine participants, ranging in age from five to seven. Seven of the nine participants had diagnoses of autism. Two instructional procedures were rotated and compared across the nine participants. One instructional procedure was a learn unit condition that did not provide an antecedent model demonstration of correct responses to instructional tasks. We refer to this condition as a “standard learn unit condition,” in which the experimenter taught a mathematics skill to the participant by delivering learn units. In this condition, the experimenter presented a worksheet consisting of problems on a particular skill, and delivered reinforcement for correct responses and provided corrective feedback for incorrect responses.

The second instructional procedure consisted of an additional antecedent in which the experimenter demonstrated how to solve two exemplars of a problem while the participant observed prior to the presentation of learn units. We referred to this condition as a “model demonstration” condition. After the participant observed the experimenter, he/she solved novel exemplars of similar types of problems and the experimenter
provided immediate feedback consisting of reinforcement for correct responses and corrective feedback for incorrect responses. Experiment I showed that, of the nine participants, six of them who had the Naming capability in repertoire at the onset of the study learned two to four times faster when presented with a model demonstration antecedent as part of the instructional procedure. In other words, the six participants with Naming learned two to four times faster when a model exemplar was presented as compared to when a model was not presented. The model demonstration did not have a positive or negative effect on the rate of learning for the three participants who lacked Naming. The results of Experiment I suggested that Naming might be a necessary prerequisite for a child to benefit from a demonstration presentation by teachers or teaching devices. The presence of Naming might be correlated with benefitting from demonstrations as part of the instructional process. Most interestingly children without Naming did not benefit from the instructional model. To further test that possibility, we conducted Experiment II that involved a functional analysis of the onset of Naming and its effects on benefitting from exemplar presentations.

Experiment II consisted of two stages. In the first stage, we used a delayed-multiple probe design to induce the Naming capability using multiple exemplar instruction across listener and speaker responses with the three participants who did not have Naming. Prior to the intervention, a set of novel stimuli were taught in a match-to-sample instructional procedure in which the participants heard the name for the stimuli as they learned to match them. Following MTS instruction, probes were conducted to measure the participants’ responses to untaught point, tact and intraverbal (impure tact) responses. In other words, we tested if the students were able to learn the names for the
stimuli as a listener (match), and then emit another listener response (point), and/or a speaker response (tact and impure tact/intraverbal) solely as a function of hearing another say the word for a stimulus as the child and the person saying the word jointly observed the stimulus. None of the participants showed they had the Naming capability in repertoire, and an intervention to induce Naming was implemented. Prior research has shown MEI across listener and speaker responses was effective in joining the listener and speaker responses to induce Naming (Feliciano, 2006; Fiorile & Greer, 2007; Gilic, 2005; Greer, Nirgudkar & Park, 2003; Greer, et al., 2005). MEI was used to teach training sets of stimuli across four responses. Match (in which the participants heard the experimenter say the word for the stimuli), point (also a listener response), tact (speaker response) and intraverbal (a speaker response with an antecedent) responses were rotated and taught to mastery. Upon mastery of MEI, post probes were conducted to measure the acquisition of Naming. The untaught point, tact and intraverbal responses for the stimuli used in the pre MEI probes were measured again, this time without MTS instruction involving hearing the words for the stimuli. If the participants emitted 80% or higher correct responding on the probe sessions, a novel set of stimuli was introduced to further test for the presence of Naming. The introduction of the novel set consisted of match-to-sample instruction while hearing the words for the stimuli until mastery of MTS for the new set of stimuli. Subsequently we conducted probes in the untaught point, tact and intraverbal response. If the participants met criterion of 80% accuracy for the untaught responses, they moved on to stage two of Experiment II. If the participants did not meet criterion on the post probe or novel probe, additional sets of stimuli were taught using MEI until Naming was
induced. Upon achieving criterion for Naming, the participants each moved on to stage two of Experiment II.

Stage two of Experiment II was an exact replication of Experiment I utilizing a counterbalanced reversal design across three participants. Four novel curriculum objectives were used to compare rate of learning across the instructional conditions. The results of Experiment II showed that once Naming was in repertoire, the three participants acquired mastery of the objectives two to four times faster when a model demonstration were part of the instructional procedure. We proposed that a child requires the Naming capability in order to benefit from teacher modeling as a part of an instructional procedure. We also proposed the ability to learn language incidentally and the ability to learn from teaching modeling may be linked. We surmised that if children have the Naming capability, they would benefit from teacher modeling (or teacher demonstrations) of the objectives being taught, and if they lacked Naming the exemplar demonstrations were not useful. If this were to be the case, the participant’s rate of learning would accelerate as a result of the onset of the Naming capability. Thus, Naming might provide learning benefits in classroom instruction.

**Research Goals and Questions**

The prior study (Greer et al., 2010) laid the foundation for research linking the benefits of observing a teacher modeling a response to the Naming capability. The present study sought to expand the findings of the prior study by systematically testing the effects of a learner observing a teacher model a response in the absence of Naming, and subsequently in the presence of Naming, for children with autism. The present study seeks to further answer the research question “Is the presence of the Naming capability
critical to allowing children to learn from observing a teacher modeling?” The educational implications of the answer to such a question are significant in that they may identify the necessary prerequisites for students to benefit from teacher modeling, a practice that is standard in most general education classrooms (Pereira-Delgado & Greer, 2009), as well as providing evidence on new ways to teach children to maximize learning. The goal of the study was to answer the following research questions: 1) Do children need to have the Naming capability to learn academic skills from observing; and 2) If this is the case, then does Naming allow children to learn in a new way and learn faster in the classroom setting?

The present study sought to further test the link between Naming and learning from a teacher-model by 1) measuring the rate of acquisition of curricular objectives when teacher modeling is part of the instructional procedure prior to the acquisition of Naming, 2) inducing the Naming capability followed by, 3) measuring the rate of acquisition of curricular objectives when teacher modeling is part of the instructional procedure once Naming is present. This study reports a functional analysis of the effects of Naming on acquisition of skills when teacher modeling is part of an instructional procedure. This study differs from the prior study, Greer et al. (2010) in that 1) only participants without Naming were selected for the study, 2) the standard learn unit condition was omitted such that teacher modeling could be systematically compared prior to and following the acquisition of Naming, and 3) only children with special education diagnoses were selected. In addition, the procedure previously termed “model demonstration learn unit” was further defined and re-named “teacher-model”. In addition to the previous modifications, the limitations of the prior study were addressed. The
limitations of the prior study revolved around the use of different curricular objectives for some participants, as well as the number of learn units delivered prior to determination of mastery. To address these limitations, the curricular objectives selected for the present study were on focused topics that the participants had no prior exposure to. In addition, the number of learn units presented and the systematic delivery of the antecedent teacher-model was more consistent in the present study. The design of the study was improved by selecting participants who did not have Naming in repertoire, and testing the effects of the teacher-model prior to and following the emergence of Naming.
Chapter II

METHOD

Participants

Eight participants were selected from a suburban elementary school for grades kindergarten through grade two. The participants were selected from a special education self-contained classroom within the school that applied the CABAS® (Comprehensive Application to Behavior Analysis to Schooling) model of schooling based solely on the use of scientific teaching procedures. Participants were selected based on their individual verbal repertoires at the onset of the study; each participant demonstrated that he had not acquired the Naming capability, as measured by probe trials prior to the study. All participants entered this self-contained classroom with a primary diagnosis of autism (i.e., a few participants were diagnosed with multiple disabilities.) The participants’ diagnoses were based on assessments and observations conducted during their special education eligibility evaluations. I assessed the participants’ present levels of educational performance, levels of verbal behavior and present/absent cusps and capabilities using CABAS® developed assessments (Greer & McCorkle, 2003). Please refer to Table 2, for a detailed summary of participant demographics; Table 3, for an overview of the verbal behavior cusps and capabilities that were present in each participants’ repertoire; and, Table 4, for a brief outline of academic performance.
Table 2

*Participants’ Grade, Age, Diagnosis and Verbal Behavior Description at the Onset of the Study*

<table>
<thead>
<tr>
<th>Participant</th>
<th>Age</th>
<th>Gender</th>
<th>Diagnosis</th>
<th>Level of Verbal Behavior</th>
</tr>
</thead>
<tbody>
<tr>
<td>1</td>
<td>5.9</td>
<td>Male</td>
<td>Multiple Disabilities</td>
<td>Listener, Speaker, Reader</td>
</tr>
<tr>
<td>2</td>
<td>5.10</td>
<td>Male</td>
<td>Autism</td>
<td>Listener and Speaker</td>
</tr>
<tr>
<td>3</td>
<td>4.10</td>
<td>Male</td>
<td>Autism</td>
<td>Listener, Speaker and Reader</td>
</tr>
<tr>
<td>4</td>
<td>5.10</td>
<td>Male</td>
<td>Autism</td>
<td>Listener and Speaker</td>
</tr>
<tr>
<td>5</td>
<td>5.11</td>
<td>Male</td>
<td>Autism</td>
<td>Listener and Speaker</td>
</tr>
<tr>
<td>6</td>
<td>5.11</td>
<td>Male</td>
<td>Multiple Disabilities</td>
<td>Listener and Speaker</td>
</tr>
<tr>
<td>7</td>
<td>6.1</td>
<td>Male</td>
<td>Autism</td>
<td>Listener, Speaker, Reader</td>
</tr>
<tr>
<td>8</td>
<td>7.6</td>
<td>Male</td>
<td>Autism</td>
<td>Listener and Speaker</td>
</tr>
</tbody>
</table>
Table 3

*Participants’ Cusps and Capabilities at the Onset of the Study*

<table>
<thead>
<tr>
<th>Participant</th>
<th>Generalized Imitation</th>
<th>Listener Half of Naming</th>
<th>Speaker Half of Naming</th>
<th>Listener Literacy</th>
<th>Independent Mands and Tacts</th>
<th>Conversational Units</th>
</tr>
</thead>
<tbody>
<tr>
<td>1</td>
<td>Yes</td>
<td>No</td>
<td>No</td>
<td>Yes</td>
<td>Yes</td>
<td>Yes</td>
</tr>
<tr>
<td>2</td>
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<td>No</td>
<td>Yes</td>
<td>Yes</td>
<td>Yes</td>
</tr>
<tr>
<td>3</td>
<td>Yes</td>
<td>Yes</td>
<td>No</td>
<td>Yes</td>
<td>Yes</td>
<td>Yes</td>
</tr>
<tr>
<td>4</td>
<td>Yes</td>
<td>No</td>
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<td>Yes</td>
<td>Yes</td>
<td>Yes</td>
</tr>
<tr>
<td>5</td>
<td>Yes</td>
<td>No</td>
<td>No</td>
<td>Yes</td>
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</tr>
<tr>
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<td>Yes</td>
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<td>Yes</td>
</tr>
<tr>
<td>7</td>
<td>Yes</td>
<td>No</td>
<td>No</td>
<td>Yes</td>
<td>Yes</td>
<td>Yes</td>
</tr>
<tr>
<td>8</td>
<td>Yes</td>
<td>No</td>
<td>No</td>
<td>Yes</td>
<td>Yes</td>
<td>No</td>
</tr>
</tbody>
</table>

Table 4

*Participants’ Academic Performance at the Onset of the Study*

<table>
<thead>
<tr>
<th>Participant</th>
<th>Identifies Letter Names</th>
<th>Identifies Letter Sounds</th>
<th>Reads K Level Words</th>
<th>Matches Words to Pictures</th>
<th>Answers Basic “Wh” Questions about Text</th>
<th>Counts to 20</th>
<th>Identifies Numbers through 20</th>
<th>Writes Letters</th>
<th>Writes Numbers</th>
<th>Writes K Level Words</th>
</tr>
</thead>
<tbody>
<tr>
<td>1</td>
<td>Yes</td>
<td>Yes</td>
<td>Yes</td>
<td>Yes</td>
<td>Yes</td>
<td>Yes</td>
<td>Yes</td>
<td>Yes</td>
<td>Yes</td>
<td>Yes</td>
</tr>
<tr>
<td>2</td>
<td>Yes</td>
<td>No</td>
<td>No</td>
<td>No</td>
<td>Yes</td>
<td>Yes</td>
<td>No</td>
<td>No</td>
<td>No</td>
<td>No</td>
</tr>
<tr>
<td>3</td>
<td>Yes</td>
<td>Yes</td>
<td>Yes</td>
<td>Yes</td>
<td>Yes</td>
<td>Yes</td>
<td>Yes</td>
<td>Yes</td>
<td>Yes</td>
<td>Yes</td>
</tr>
<tr>
<td>4</td>
<td>Yes</td>
<td>No</td>
<td>No</td>
<td>No</td>
<td>Yes</td>
<td>Yes</td>
<td>Yes</td>
<td>No</td>
<td>No</td>
<td>No</td>
</tr>
<tr>
<td>5</td>
<td>Yes</td>
<td>No</td>
<td>No</td>
<td>No</td>
<td>Yes</td>
<td>Yes</td>
<td>Yes</td>
<td>No</td>
<td>No</td>
<td>No</td>
</tr>
<tr>
<td>6</td>
<td>Yes</td>
<td>No</td>
<td>No</td>
<td>No</td>
<td>Yes</td>
<td>Yes</td>
<td>Yes</td>
<td>No</td>
<td>No</td>
<td>No</td>
</tr>
<tr>
<td>7</td>
<td>Yes</td>
<td>Yes</td>
<td>Yes</td>
<td>No</td>
<td>Yes</td>
<td>Yes</td>
<td>Yes</td>
<td>Yes</td>
<td>Yes</td>
<td>No</td>
</tr>
<tr>
<td>8</td>
<td>Yes</td>
<td>No</td>
<td>No</td>
<td>No</td>
<td>Yes</td>
<td>Yes</td>
<td>No</td>
<td>No</td>
<td>No</td>
<td>No</td>
</tr>
</tbody>
</table>
Setting

The study was conducted in the participants’ self-contained (i.e., serving students with special education diagnoses) elementary school classroom located in a suburban school for children in grades kindergarten through grade two. The classroom was comprised of eleven children, 7 assistant behavior specialists (teacher assistants with experience in implementing instruction using the principles of applied behavior analysis) and one lead teacher (the experimenter). The classroom followed applied behavior analytic teaching procedures derived from research in the principles of behavior, and their application in education. Within such classrooms, the acquisition of developmentally foundational verbal capabilities is a primary objective. The instructors delivered comprehensive instruction across academic, communicative, social/behavioral and self-management repertoires in order to prepare the students, both academically and developmentally, with the competencies required for success in the inclusive classroom. Throughout the school day, the teacher and assistant behavior specialists delivered instruction based on the students’ individualized curriculum.

Each experimental session relevant to the study required 10-15 minutes of time with the experimenter. The participants were engaged in the regular curricular instruction and school activities with the teacher or assistant behavior specialists during all other times of the school day. All students in the classroom who were not selected for the study continued their regular instruction and school activities.

The classroom included a large table for group instructional sessions, along with smaller tables for individualized instruction. For the purposes of the study, the experimenter selected individual students, one by one, to participate in the probe and
instructional sessions at the larger group table, while the assistant behavior specialists each delivered instruction to individuals or student dyads at the smaller instructional tables. During all curricular instruction sessions (dependent variable), the experimenter sat next to the participant, while a second independent observer (an assistant behavior specialist in the classroom) sat adjacent to or across from the participant to conduct observations for interobserver agreement. During Naming probe and intervention sessions (independent variable), the experimenter sat across from the participant, while a second independent observer sat adjacent to the participant.

In addition to the large and small instructional tables, the classroom also contained a carpeted section, designated as the “free play” area, which was located next to the instructional area. The play area was comprised of toys, puzzles, books, and a computer. The instructors delivered points to the students throughout the school day as part of a token economy, along with opportunities for students to exchange those point balances for free time. The token economy was implemented during the participants’ regular school day, as well as during sessions relevant to the study.

**Materials**

The materials relevant to this study included: 1) various sets of two-dimensional stimuli used during the experimental Naming probe and intervention sessions (Refer to Table 5); 2) teacher-created materials pertaining to instructional objectives outlined in the math curriculum (Refer to the Appendix); and, 3) additional, miscellaneous teacher materials (e.g., black pens, data sheets, graphs) and student materials (e.g., pencils, erasers, dry erase boards, dry erase markers, dry erase erasers, crayons/colored pencils).
The teacher-created materials to teach curricular objectives included worksheets for place value, fractions, tally marks and multiplication and division concepts skills. See the Appendix for examples of worksheets pertaining to these skills. Some participants did not have refined fine motor skills in repertoire, making it difficult for them to write their response in the spaces provided on the worksheets. When this issue became apparent, dry erase boards were used for some participant responses such that they could write in a larger space.

Table 5

*Naming Probe and Intervention Stimuli*

<table>
<thead>
<tr>
<th>Set</th>
<th>Participants</th>
<th>Stimuli</th>
</tr>
</thead>
<tbody>
<tr>
<td>Initial probe- cars</td>
<td>Participants 1, 3, 5, 7, 8</td>
<td>Ferrari, Mustang, Hummer, Rolls Royce, Punch Buggy</td>
</tr>
<tr>
<td>Initial probe- flowers</td>
<td>Participant 4, 6</td>
<td>Lily, dogwood, iris, carnation, tulip</td>
</tr>
<tr>
<td>Initial probe- trees</td>
<td>Participant 2</td>
<td>Willow, dogwood, birch, pine, maple</td>
</tr>
<tr>
<td>Novel pre probe- Phoenician symbols</td>
<td>Participant 4</td>
<td>Samekh, daleth, qoph, mem, yodh</td>
</tr>
<tr>
<td>MEI- gemstones</td>
<td>Participant 1, 2, 3, 4, 5, 6, 7, 8</td>
<td>Ruby, emerald, sapphire, amber, amethyst</td>
</tr>
<tr>
<td>MEI- occupations</td>
<td>Participant 1</td>
<td>Pharmacist, server, surgeon, florist, gardener</td>
</tr>
<tr>
<td>MEI- occupations</td>
<td>Participant 2, 4, 5</td>
<td>Cheerleader, news reporter, referee, dog walker, taxi driver</td>
</tr>
<tr>
<td>MEI- occupations</td>
<td>Participant 2</td>
<td>Beekeeper, surgeon, construction worker,</td>
</tr>
<tr>
<td>MEI- occupations</td>
<td>Participant 4, 5</td>
<td>Beekeeper, pilot, judge, sheriff, artist</td>
</tr>
<tr>
<td>------------------</td>
<td>------------------</td>
<td>------------------------------------------</td>
</tr>
<tr>
<td>MEI occupations</td>
<td>Participant 7</td>
<td>Judge, sheriff, news reporter, gardener, artist</td>
</tr>
<tr>
<td>MEI- tools</td>
<td>Participant 4, 7, 8</td>
<td>Drill, wrench, chisel, screwdriver, pliers</td>
</tr>
<tr>
<td>MEI – Phoenician symbols</td>
<td>Participant 7</td>
<td>Samekh, daleth, qoph, mem, yodh</td>
</tr>
<tr>
<td>MEI- Contrived symbols</td>
<td>Participant 7</td>
<td>Blapper, kimchow, truddy, follay, weewam</td>
</tr>
<tr>
<td>Novel probe- trees</td>
<td>Participants 1, 3, 6, 7</td>
<td>Willow, dogwood, birch, pine, maple</td>
</tr>
<tr>
<td>Novel probe- cars</td>
<td>Participant 2</td>
<td>Ferrari, Mustang, Hummer, Rolls Royce, Punch Buggy</td>
</tr>
<tr>
<td>Novel probe- flowers</td>
<td>Participant 2, 5, 8, 7</td>
<td>Lily, tulip, carnation, iris, snapdragon</td>
</tr>
<tr>
<td>Novel probe- contrived 1</td>
<td>Participant 4</td>
<td>Trud, loplee, flog, weewam, kimchow</td>
</tr>
<tr>
<td>Novel probe- contrived 2</td>
<td>Participant 4</td>
<td>Riggy, follay, glip, nopow, blapper</td>
</tr>
<tr>
<td>Novel probe- contrived 3</td>
<td>Participant 4</td>
<td>Shig, mum, janik, alup, perdy</td>
</tr>
<tr>
<td>Novel probe- flowers (2)</td>
<td>Participant 7, 8</td>
<td>Azalea, forget-me-not, poppy, dogwood, mayflower</td>
</tr>
<tr>
<td>Novel probe- fish</td>
<td>Participant 7</td>
<td>Eel, trout, blowfish, catfish, angelfish</td>
</tr>
</tbody>
</table>
**Procedures**

**Dependent Variable**

The dependent variable was the rate at which participants acquired math curricular objectives during instructional sessions, which consisted of two antecedent teacher-models, followed by twenty learn units. The experimenter measured the number of learn units required for each participant to achieve mastery criteria for the operationally defined curricular objectives by obtaining a calculation of learn units-to-criteria prior to and following acquisition of the Naming capability. The experimenter totaled the sum of learn units delivered across three curricular objectives and divided that number by three, which resulted in mean rate of learning for each participant. A mean learn units-to-criteria was calculated for the three objectives taught prior to the induction of Naming, and calculated for the three objectives taught following the induction of Naming. Subsequently, the experimenter compared the participants pre-Naming acquisition learn units-to-criteria with their own post-Naming acquisition learn units-to-criteria. The mean learn units-to-criteria calculated provided the experimenter with a measure in which to compare rate of learning prior to the induction of Naming, and following the emergence of Naming.

The experimenter chose topics from the state and national mathematics standards after determining that participants’ instructional histories did not include exposure to those topics. As such, the target curricular objectives comprised concepts such as, place value, fractions, tally marks, and multiplication/division. Outlined in Table 6 are the curricular objectives taught to each participant, prior to the acquisition of Naming, and following the onset of Naming.
Table 6

Curricular Objectives Taught Prior to the Acquisition of Naming, and Following the Onset of Naming, for Each Participant

<table>
<thead>
<tr>
<th>Participant</th>
<th>Curriculum Objectives Taught Prior to Emergence of Naming</th>
<th>Curriculum Objectives Taught Following the Emergence of Naming</th>
</tr>
</thead>
<tbody>
<tr>
<td>Participant 1</td>
<td>1. Place Value: Identify the tens and ones using pictures of base ten blocks</td>
<td>1. Multiplication Concepts: multiplying numbers (1-5) by drawing pictures to solve the problem</td>
</tr>
<tr>
<td></td>
<td>2. Tally Marks: count the tally marks (through 19) and write the number</td>
<td>2. Writes Fractions: write the fraction based on the number of shaded parts (2-10 equal parts)</td>
</tr>
<tr>
<td></td>
<td>Fractions: color the shape to represent the fraction given (shapes consisting of 2-4 equal parts)</td>
<td>3. Place Value: identify which place the underlined digit is in and write O for ones, T for tens and H for hundreds</td>
</tr>
<tr>
<td>Participant 2</td>
<td>1. Fractions: color the shape to represent the fraction given (shapes consisting of 2-4 equal parts)</td>
<td>1. Writes Fractions: write the fraction based on the number of shaded parts (2-10 equal parts)</td>
</tr>
<tr>
<td></td>
<td>2. Place Value: Identify the tens and ones using pictures of base ten blocks</td>
<td>2. Place Value: identify which place the underlined digit is in and write O for ones, T for tens and H for hundreds</td>
</tr>
<tr>
<td></td>
<td>3. Tally Marks: count the tally marks (through 19) and write the number</td>
<td>3. Multiplication Concepts: multiplying numbers (1-5) by drawing pictures to solve the problem</td>
</tr>
<tr>
<td>Participant 3</td>
<td>1. Fractions: color the shape to represent the fraction given (shapes consisting of 2-4 equal parts)</td>
<td>1. Writes Fractions: write the fraction based on the number of shaded parts (2-10 equal parts)</td>
</tr>
</tbody>
</table>
2. Multiplication Concepts: multiplying numbers (1-5) by drawing pictures to solve the problem
3. Place Value: identify which place the underlined digit is in and write O for ones, T for tens and H for hundreds

Participant 4
1. Fractions: color the shape to represent the fraction given (shapes consisting of 2-4 equal parts)
2. Tally Marks: count the tally marks (through 19) and write the number
3. Place Value: Identify the tens and ones using pictures of base ten blocks

Participant 5
1. Place Value: identify which place the underlined digit is in and write O for ones, T for tens and H for hundreds
2. Fractions: color the shape to represent the fraction given (shapes consisting of 2-4 equal parts)
3. Tally Marks: count the tally marks (through 19) and write

2. Division Concepts: solve a division problem (numbers up to 12) by drawing pictures
3. Write in Standard Form: write a number in standard form when given the value of the hundreds, tens and/or ones place

1. Writes Fractions: write the fraction based on the number of shaded parts (2-10 equal parts)
2. Place Value: identify which place the underlined digit is in and write O for ones, T for tens and H for hundreds
3. Multiplication Concepts: multiplying numbers (1-5) by drawing pictures to solve the problem

1. Multiplication Concepts: multiplying numbers (1-5) by drawing pictures to solve the problem
2. Writes Fractions: write the fraction based on the number of shaded parts (2-10 equal parts)
3. Place Value: Identify the tens and ones using pictures of base ten blocks
the number

Participant 6 1. Tally Marks: count the tally marks (through 19) and write the number
2. Fractions: color the shape to represent the fraction given (shapes consisting of 2-4 equal parts)
3. Place Value: Identify the tens and ones using pictures of base ten blocks

1. Multiplication Concepts: multiplying numbers (1-5) by drawing pictures to solve the problem
2. Place Value: identify which place the underlined digit is in and write O for ones, T for tens and H for hundreds
3. Writes Fractions: write the fraction based on the number of shaded parts (2-10 equal parts)

Participant 7 1. Tally Marks: count the tally marks (through 19) and write the number
2. Fractions: color the shape to represent the fraction given (shapes consisting of 2-4 equal parts)
3. Place Value: identify which place the underlined digit is in and write O for ones, T for tens and H for hundreds

1. Multiplication Concepts: multiplying numbers (1-5) by drawing pictures to solve the problem
2. Writes Fractions: write the fraction based on the number of shaded parts (2-10 equal parts)
3. Place Value: identify and write the value of the underlined digit

Participant 8 1. Place Value: identify which place the underlined digit is in and write O for ones, T for tens and H for hundreds
2. Multiplication Concepts: multiplying numbers (1-5) by drawing pictures to solve the problem

1. Writes Fractions: write the fraction based on the number of shaded parts (2-10 equal parts)
2. Place Value: identify and write the value of the underlined digit
3. Division Concepts: solve a division problem (numbers up to
The experimenter administered a pre-test prior to the first instructional session to ensure that target skills were not in the participants’ repertoires. The pre-test included opportunities to respond to five example problems, in the absence of both the teacher’s delivery of an antecedent model, and feedback following responses, after the experimenter read the directions vocally to the participant. The experimenter determined that a skill was missing from repertoire if the participant responded incorrectly to the five probe trials, or did not respond at all; after establishing that a skill was missing, the experimenter selected and taught the corresponding curricular objectives. Conversely, if the participant responded correctly to one or more of the example problems during a probe session, the experimenter considered that skill in repertoire, and continued to test further skills to identify one not in repertoire.

Following the pre-test, instructional sessions were implemented, which included the delivery of two teacher-models, followed by 20 learn unit presentations (for each session). The experimenter conducted instructional sessions corresponding to each curricular objective until the participant achieved mastery (Refer to Table 6 for an outline of the sequence of objectives taught). Criterion for mastery was set at 90% accuracy across two consecutive sessions or 100% accuracy during a single session. The problems corresponding to each objective were varied using multiple exemplars, which functioned to provide each student with novel targets across sessions, including probe sessions.
During instructional sessions, following the presentation of two teacher-models, learn units were delivered immediately following each response. For correct responses, a plus was recorded and praise was delivered. Examples of vocal praise included “That’s right!”, “Super work”, “You did it!”. For incorrect responses, a minus was recorded, and corrective feedback was given. An example of corrective feedback for a place value problem is:

*Antecedent:* (written problem) \[765\]

*Incorrect Response:* Participant writes: “T” for tens place

*Corrective Feedback:* Experimenter demonstrates: “Watch me. The 5 is in the ones place, the 6 is in the tens place, and the 7 is in the hundreds place. I am going to write an H because the 7 is in the hundreds place. What place is the 7 in?”

Participant responds: “The hundreds place.”

Table 7 shows an example sequence of curricular instruction delivered prior to the induction of Naming. This procedure was replicated with three novel objectives following the emergence of Naming.
Table 7  

Example Sequence of Three Curricular Objectives Taught Prior to the Emergence of Naming

<table>
<thead>
<tr>
<th>Pre-test on coloring a shape to represent a printed fraction showed skill was not in repertoire</th>
</tr>
</thead>
<tbody>
<tr>
<td>Instructional sessions on coloring a shape to represent a fraction repeated until mastery. Each session consisted of:</td>
</tr>
<tr>
<td>1. Two teacher-models delivered on how to read a printed fraction, and color a shape to represent the fraction.</td>
</tr>
<tr>
<td>2. Twenty learn units delivered on coloring a shape to represent a fraction</td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th>Pre-test on identifying the number of tally marks and writing the number of tally marks showed skill was not in repertoire</th>
</tr>
</thead>
<tbody>
<tr>
<td>Instructional sessions on identifying the number of tally marks and writing the number of tally marks repeated until mastery. Each session consisted of:</td>
</tr>
<tr>
<td>1. Two teacher-models delivered on how to identify and write the number of tally marks</td>
</tr>
<tr>
<td>2. Twenty learn units delivered on identifying and writing the number of tally marks</td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th>Pre-test on identifying the number of tens and ones represented as base ten blocks shows skill is not in repertoire</th>
</tr>
</thead>
<tbody>
<tr>
<td>Instructional sessions on identifying the number of tens and ones represented as base ten blocks repeated until mastery. Each session consisted of:</td>
</tr>
<tr>
<td>1. Two teacher-models delivered on how to identify the number of tens and ones represented as base ten blocks</td>
</tr>
<tr>
<td>2. Twenty learn units delivered on identifying the number of tens and ones represented as base ten blocks</td>
</tr>
</tbody>
</table>
Teacher Modeling Procedures

During the teacher-model procedure, the experimenter presented an exemplar math problem with a model of the correct response prior to each instructional session. Each model included the operations for solving the math problems, presented two times, as the student observed. The teacher continued to present two teacher-models prior to each session until the participant met criteria for the objective. The teacher used a worksheet (Refer to Appendix A) to model a correct response across two exemplars, and then removed the model worksheet. Subsequently, the experimenter presented a novel set of twenty exemplars of the problem on another worksheet, followed by the direction, “Start with number one.” Learn units were delivered, as described above.
An example of the teacher-model procedure is provided in Figure 1:

Participant is sitting adjacent to the experimenter (teacher). The experimenter says “Watch me while I complete these problems”. As participant observes, the teacher models how to complete a fraction problem: “I am going to look at this shape, and write the fraction that the shape represents. Teacher counts the number of pieces colored in. I see there are seven pieces of the shape colored in. Teacher counts total number of equal pieces of the shape. I count there are ten pieces in total. I am going to write the fraction 7/10. Teacher writes 7/10 next to the shape. This shape represents the fraction 7/10 because 7 out of the ten pieces are colored in. I am going to try another one. Teacher counts number of pieces colored in. This shape has 3 pieces colored in. Teacher counts the total number of pieces. There are four pieces in total. This shape shows the fraction 3/4. I am going to write the fraction 3/4 next to the shape. Teacher writes the fraction. Now it is going to be your turn to write fractions. Teacher removes model sheet, and presents a new sheet of shapes representing fractions to the participant. Okay, start with number one please.”

Figure 1. Example of a Teacher-model

Independent Variable

The independent variable was the instantiation of Naming. Two-dimensional stimuli were used (See Table 5 for a list of stimuli used in Naming probe and intervention
sessions) in all Naming testing and training sessions. Experimental probes were conducted prior to (pre-experimental, or pre-MEI probes) and following (post-experimental or post-MEI probes) the intervention. During the intervention to induce Naming, the experimenter trained the participants using multiple exemplar instruction (MEI) across listener and speaker topographies. The reader should note that the induction of Naming is the independent variable. In doing so, an experimental analysis of the induction of Naming was conducted.

**Naming Pre-Probe Procedures.** Prior to the initial pre-MEI probe, the experimenter trained the participants to master MTS responses (*while the participant heard the name for the stimuli as he learned to match*) using a set that contained five stimuli, each represented across four exemplars. The criterion for mastery of the MTS instruction was set at 90% accuracy across two sessions or 100% accuracy for one session. Each MTS session included 20 learn units. The experimenter presented a field of three pictures containing one target exemplar along with two negative exemplars, and provided the participant with an additional target exemplar along with the vocal antecedent, “match _____ to ____.” Praise followed correct responses, while a correction procedure followed incorrect responses. The correction procedure required the participant to repeat the correct response following the teacher’s model; the experimenter did not deliver reinforcement following incorrect responses or correction responses.

Following participant mastery of the MTS instruction, the experimenter allowed a 30-minute time lapse prior to conducting the probe sessions; during that time, the participants received regular curricular instruction. Following the 30-minute period, the experimenter conducted pre-MEI probes, which included blocked, 20-trial sessions for
each of the untaught listener (point-to) and speaker (pure tact, and impure tact/intraverbal) responses to the same set of stimuli. The listener responses required the participant to point to the target stimulus in an array of three pictures that consisted of one positive exemplar along with two rotating negative exemplars, following the teacher antecedent, “point to ______.” The pure tact responses required the participant to name the target exemplar following the instructor’s presentation (without verbal antecedent). The impure tact (or intraverbal) responses required the participant to name the target exemplar following the instructor’s presentation along with the vocal antecedent, “what is this called?” The experimenter did not deliver reinforcement or corrections during probe sessions. Criterion for the emergence of Naming was set at 80% accuracy for both listener and speakers components for one post-MEI session and one novel probe session, consistent with prior studies. See Figure 2 for a visual representation of the Naming initial probe procedures, which are replicated during the novel probe procedures.
Figure 2. Initial Pre-MEI Probe and Novel Probe Procedures
**Naming Induction Procedures.** After establishing that a participant did not have the Naming capability in repertoire, the experimenter induced Naming, using MEI across listener and speaker responses to training sets (i.e., novel stimuli). The experimenter rotated learn unit presentations across match, point, tact and intraverbal responses to the training set, for a total of eighty learn units per session, with 20 learn units devoted to each response type. Each set of stimuli was taught using MEI until the participant achieved mastery for each response topography. The criterion for mastery was set at 90% accuracy for two consecutive sessions, or 100% accuracy for one session.

Correct responses consisted of matching the target picture to its exemplar following the instructor’s antecedent, “match ______ to _____,” given an array of three stimuli that contained one positive exemplar and two negative exemplars; pointing to the target exemplar following the instructor’s antecedent, “point to _____”, given an array of three stimuli that contained one positive exemplar and two negative exemplars; providing a correct tact response following the experimenter’s presentation of the target exemplar without a verbal antecedent, and; providing a correct intraverbal/impure tact response to the target exemplar following instructor’s presentation of the picture and the vocal antecedent, “what is this called?” During the multiple exemplar instruction the response types were rotated and the stimuli were counterbalanced, such that a single stimulus was not presented consecutively across learn unit presentations. Each picture in the set was presented four times across each response type; totaling 20 learn units per target (80 learn units per instructional session). See Table 8 for an example of how stimuli were taught using MEI.

During MEI, the experimenter delivered vocal praise following correct responses
and a plus was recorded. A minus was recorded for incorrect responses. Incorrect responses included, matching or pointing to the incorrect picture, emitting an incorrect pure tact, emitting an incorrect intraverbal/impure tact, or emitting no response. The experimenter withheld reinforcement following incorrect responses, and provided a correction. During the correction procedure, the experimenter repeated the antecedent and provided a model of the correct response, to which the participant was required to respond by emitting the correct response.

Table 8

*Example of Rotation of Stimuli Taught during MEI procedure*

<table>
<thead>
<tr>
<th>Match</th>
<th>Point</th>
</tr>
</thead>
<tbody>
<tr>
<td>ruby to ruby</td>
<td>emerald</td>
</tr>
<tr>
<td>(Holds up picture of sapphire for pure tact response)</td>
<td></td>
</tr>
<tr>
<td>“What is this gemstone called?” (while holding up picture of amethyst for impure tact/intraverbal)</td>
<td></td>
</tr>
<tr>
<td>Match amber to amber</td>
<td></td>
</tr>
<tr>
<td>Point to ruby</td>
<td></td>
</tr>
<tr>
<td>(Holds up picture of emerald for pure tact response)</td>
<td></td>
</tr>
<tr>
<td>“What is this gemstone called?” (while holding up picture of sapphire for impure tact/intraverbal)</td>
<td></td>
</tr>
<tr>
<td>Match amethyst to amethyst</td>
<td></td>
</tr>
<tr>
<td>Point to amber</td>
<td></td>
</tr>
<tr>
<td>(Holds up picture of ruby for pure tact response)</td>
<td></td>
</tr>
<tr>
<td>“What is this gemstone called?” (while holding up picture of emerald for impure tact/intraverbal)</td>
<td></td>
</tr>
</tbody>
</table>
Naming Post-Probe Procedures. Following the participants’ achievement of mastery criterion on a set of MEI stimuli, the experimenter conducted a post-MEI probe. The post-MEI probe was a replication of the initial probe (same stimuli), and tested participants’ untaught point, pure tact and intraverbal/impure tact responses to the probe set in the absence of reinforcement or corrections. The MTS instruction was not repeated prior to the post-MEI probe. If the participant did not meet criterion on the post-MEI probe (80% accuracy for one session for listener and speaker responses), the experimenter repeated the intervention by conducting another MEI treatment with a novel set of stimuli. If the participant demonstrated criterion on the post-MEI probe of the initial Naming probe set, a novel set of stimuli were tested. During the novel set probe, the experimenter followed the procedures used during the initial probe with a novel set of stimuli (Refer to Figure 8). Criterion for the emergence of Naming was set at 80% accuracy for listener and speaker responses on the post-MEI probe and the novel probe.

Following the Acquisition of Naming. The experimenter compared the participants’ rates of learning prior to and following the induction of Naming, to determine if the participants learned faster after the acquisition of Naming, when teacher modeling was part of the instructional procedure (as described in the dependent variable).

Design

A time-lagged multiple probe across matched pairs of participants was implemented. First, Naming pre-experimental probes were conducted to identify which children had the Naming capability in repertoire. Eight participants who did not have Naming in repertoire were selected, and then matched based on their level of verbal behavior and academic skills. The study was time lagged across the matched pairs. The
sequence of procedures was as follows, as well as visually shown in Figures 3 and 4: 1) Naming pre-MEI probe, 2) Curricular objective instruction consisting of teacher modeling for three math objectives (which was preceded by a pre-test prior to each objective to show the skill was not in repertoire), 3) MEI across listener and speaker responses 4) Naming post-MEI probe 5) Novel Naming post probe 6) Curricular objective instruction consisting of teacher modeling for three novel math objectives (which was preceded by a pre-test prior to each objective to show the skill was not in repertoire).

The design of the study was a delayed multiple probe design (Horner & Baer, 1978) across participants. A second pre-MEI probe was administered to Participants 3-8 following Participants’ 1 and 2 acquisition of Naming to show Naming was not in repertoire for these participants. This was done to control for maturation and instructional history, and to further isolate the effects of the MEI procedure on the acquisition of Naming. Furthermore, Participants 7 and 8 received a third pre-MEI probe following Participants’ 3, 4, 5 and 6 acquisition of Naming. The repetition of pre-MEI probes was conducted in a delayed fashion to show that the participants did not acquire Naming from other variables (i.e. environmental, developmental or educational.) See Figure 4 for a visual display of the delay in the experimental design.
Pre-experimental Naming probe: participants who did not have Naming were selected

**Dependent Variable**

Three math curricular objectives taught to mastery using teacher modeling as part of the instructional session. (Pre-tests showed these skills were not in repertoire)

**Independent Variable**

MEI across listener and speaker responses using training sets was implemented to induce Naming

**Independent Variable**

Post-MEI probes and novel post probes showed Naming was present

**Dependent Variable**

Three math curricular objectives taught to mastery using teacher modeling as part of the instructional session. (Pre-tests showed these skills were not in repertoire)

*Figure 3. Experimental Design*
Figure 4. Delayed Multiple Probe Design across Participants

**Interobserver Agreement**

Data were collected by the experimenter and an independent observer to obtain interobserver agreement (IOA) for both the dependent and independent variables. IOA was calculated by dividing the number of agreements by the total number of trial-by-trial (point-to-point) agreements and disagreements and multiplying by 100% (Cooper et al., 2007). The percentage of sessions with IOA, the mean IOA for the sessions, and the range of IOA is reported in Tables 9-12 for each participant. Overall, IOA was conducted 47% of dependent variable sessions with 99% agreement (90-100%) and 51% of independent variable sessions with 99% agreement (95-100%).
IOA was conducted for the dependent variable and is reported in Tables 9 and 10. See Table 9 for IOA collected on session-by-session learning prior to the emergence of Naming. See Table 10 for IOA collected on session-by-session learning following the emergence of Naming.

Table 9

*Interobserver Agreement for Curricular Objective Instruction Prior to Naming*

<table>
<thead>
<tr>
<th>Participant</th>
<th>Percentage of Sessions IOA was Conducted</th>
<th>Mean Percentage IOA</th>
<th>Range of Percentage of IOA</th>
</tr>
</thead>
<tbody>
<tr>
<td>1</td>
<td>47</td>
<td>100</td>
<td></td>
</tr>
<tr>
<td>2</td>
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<td>4</td>
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<td>95-100</td>
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<td>50</td>
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<td>6</td>
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<td>7</td>
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</tr>
<tr>
<td>8</td>
<td>63</td>
<td>100</td>
<td></td>
</tr>
</tbody>
</table>
Table 10

*Interobserver Agreement for Curricular Objective Instruction Following the Emergence of Naming*

<table>
<thead>
<tr>
<th>Participant</th>
<th>Percentage of Sessions IOA was Conducted</th>
<th>Mean Percentage IOA</th>
<th>Range of Percentage of IOA</th>
</tr>
</thead>
<tbody>
<tr>
<td>1</td>
<td>36</td>
<td>100</td>
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</tr>
<tr>
<td>2</td>
<td>72</td>
<td>100</td>
<td></td>
</tr>
<tr>
<td>3</td>
<td>38</td>
<td>100</td>
<td></td>
</tr>
<tr>
<td>4</td>
<td>44</td>
<td>100</td>
<td></td>
</tr>
<tr>
<td>5</td>
<td>55</td>
<td>100</td>
<td></td>
</tr>
<tr>
<td>6</td>
<td>45</td>
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<td>7</td>
<td>38</td>
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</tr>
<tr>
<td>8</td>
<td>63</td>
<td>99</td>
<td>95-100</td>
</tr>
</tbody>
</table>

IOA was conducted for the independent variable and is reported in Tables 11 and 12. See Table 11 for IOA collected on Naming pre-experimental and post-experimental probe sessions. See Table 12 for IOA collected on MEI intervention sessions.
Table 11

*Interobserver Agreement for Naming Probe Sessions*

<table>
<thead>
<tr>
<th>Participant</th>
<th>Percentage of Sessions IOA was Conducted</th>
<th>Mean Percentage IOA</th>
<th>Range of Percentage of IOA</th>
</tr>
</thead>
<tbody>
<tr>
<td>1</td>
<td>75</td>
<td>99</td>
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<td>95-100</td>
</tr>
<tr>
<td>8</td>
<td>38</td>
<td>100</td>
<td></td>
</tr>
</tbody>
</table>

Table 12

*Interobserver Agreement for Naming Intervention Sessions*

<table>
<thead>
<tr>
<th>Participant</th>
<th>Percentage of Sessions IOA was Conducted</th>
<th>Mean Percentage IOA</th>
<th>Range of Percentage of IOA</th>
</tr>
</thead>
<tbody>
<tr>
<td>1</td>
<td>33</td>
<td>100</td>
<td></td>
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<tr>
<td>2</td>
<td>40</td>
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<td>95-100</td>
</tr>
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<td>7</td>
<td>33</td>
<td>100</td>
<td></td>
</tr>
<tr>
<td>8</td>
<td>71</td>
<td>100</td>
<td></td>
</tr>
</tbody>
</table>
Chapter III

RESULTS

Dependent Variable

Mean Learn Units-to-Criteria for Curricular Objectives when Teacher Modeling was Present. The mean learn units required for the participants to meet criteria, with the presence of teacher modeling prior to learn unit delivery, were separately calculated and compared prior to the acquisition of Naming, and following the emergence of Naming. To calculate a mean, the number of learn units required to meet criteria during instructional sessions were totaled across the three objectives. The total was divided by three to determine a mean. This was calculated for the three objectives taught prior to the instantiation of Naming and following the instantiation of Naming. The mean learn units-to-criteria prior to the acquisition of Naming, and following the emergence of Naming are shown in Figure 5.
Figure 5. Mean Learn Units to Criteria (Rate of Learning) Prior to and Following the Emergence of Naming for Participants 1-8.
Participant 1 required a mean of 93.3 learn units-to-criteria prior to the acquisition of Naming, and required a mean of 53.3 learn units-to-criteria following the emergence of Naming. Therefore, Participant 1 acquired curricular objectives \(1.75\) times faster when teacher-modeling conditions were present, after the acquisition of Naming.

Participant 2 required a mean of 120 learn units-to-criteria prior to the acquisition of Naming, and required a mean of 53.3 learn units-to-criteria following the emergence of Naming. Therefore, Participant 2 acquired curricular objectives \(2.25\) times faster when teacher-modeling conditions were present, after the acquisition of Naming.

Participant 3 required a mean of 86.6 learn units-to-criteria prior to the acquisition of Naming, and required a mean of 33.3 learn units-to-criteria following the emergence of Naming. Therefore, Participant 3 acquired curricular objectives \(2.6\) times faster when teacher-modeling conditions were present, after the acquisition of Naming.

Participant 4 required a mean of 133.3 learn units-to-criteria prior to the acquisition of Naming, and required a mean of 40 learn units-to-criteria following the emergence of Naming. Therefore, Participant 4 acquired curricular objectives \(3.4\) times faster when teacher-modeling conditions were present, after the acquisition of Naming.

Participant 5 required a mean of 86.6 learn units-to-criteria prior to the acquisition of Naming, and required a mean of 53.3 learn units-to-criteria following the emergence of Naming. Therefore, Participant 5 acquired curricular objectives \(1.6\) times faster when teacher-modeling conditions were present, after the acquisition of Naming.

Participant 6 required a mean of 133.3 learn units-to-criteria prior to the acquisition of Naming, and required a mean of 53.3 learn units-to-criteria following the
emergence of Naming. Therefore, Participant 6 acquired curricular objectives 2.5 times faster when teacher-modeling conditions were present, after the acquisition of Naming.

Participant 7 required a mean of 73.3 learn units-to-criteria prior to the acquisition of Naming and 33.3 learn units-to-criteria following the acquisition of Naming. Therefore, Participant 7 acquired curricular objectives 2.2 times faster when teacher-modeling conditions were present, after the acquisition of Naming.

Participant 8 required a mean of 53.3 learn units-to-criteria prior to the acquisition of Naming, and required a mean of 33.3 learn units-to-criteria following the emergence of Naming. Therefore, Participant 8 acquired curricular objectives 1.6 times faster when teacher-modeling conditions were present, after the acquisition of Naming.

**Session-by-Session Learning Prior to and Following the Acquisition of Naming.** Figures 6, 7, 8 and 9 show the number of instructional sessions, including two antecedent teacher-models and twenty learn units, required for the participants to master each curricular objective. Session-by-session learning for Participants 1 and 2 is shown in Figure 6, Participants 3 and 4 is shown in Figure 7, Participants 5 and 6 is shown in Figure 8 and Participants 7 and 9 is shown in Figure 8. The solid line on the graphs show the emergence of Naming, separating the three objectives that were taught prior to the acquisition of Naming, and the three objectives that were taught following the emergence of Naming. Each session consisted of two teacher models followed by 20 learn units. Mastery was set at 90% accuracy (18/20) or higher for two consecutive sessions, or 100% accuracy (20/20) for one session. The pre-probe data showed the student did not have the skill in repertoire prior to instruction.
Figure 6. Number of Correct Responses to Learn Units under Teacher Modeling Conditions for Three Curricular Objectives Prior to and Following the Emergence of Naming for Participants 1 and 2.
Figure 6 shows session-by-session learning for Participants 1 and 2. Prior to the emergence of Naming, Participant 1 required 5 sessions to meet criterion on the first curricular objective (identifying the number of tens and ones using pictures of base ten blocks), 6 sessions to meet criterion on the second curricular objective (writing the number of tally marks), and 3 sessions to meet criterion on the third curricular objective (coloring equal parts of a shape to show a fraction). Following the emergence of Naming, Participant 1 required 4 sessions to meet criterion on the first curricular objective (drawing pictures to solve multiplication facts), 2 sessions to meet criterion on the second curricular objective (writing the fraction when given a picture of a shape with parts shaded in), and 2 sessions to meet criterion on the third curricular objective (identifying the ones, tens and hundreds place in a 2-3 digit number).

Prior to the emergence of Naming, Participant 2 required 4 sessions to meet criterion on the first curricular objective (coloring equal parts of a shape to show a fraction), 7 sessions to meet criterion on the second curricular objective (identifying the number of tens and ones using pictures of base ten blocks) and 7 sessions to meet criterion on the third curricular objective (writing the number of tally marks). Following the emergence of Naming, Participant 2 required 2 sessions to meet criterion on the first curricular objective (writing the fraction when given a picture of a shape with parts shaded in), 3 sessions to meet criterion on the second curricular objective (identifying the ones, tens and hundreds place in a 2-3 digit number), and 3 sessions to meet criterion on the third curricular objective (drawing pictures to solve multiplication facts).
Figure 7. Number of Correct Responses to Learn Units under Teacher Modeling Conditions for Three Curricular Objectives Prior to and Following the Emergence of Naming for Participants 3 and 4.
Figure 7 shows session-by-session learning for Participants 3 and 4. Prior to the emergence of Naming, Participant 3 required 3 sessions to meet criterion on the first curricular objective (coloring equal parts of a shape to show a fraction), 6 sessions to meet criterion on the second curricular objective (drawing pictures to solve multiplication facts), and 4 sessions to meet criterion on the third curricular objective (identifying the ones, tens and hundreds place in a 2-3 digit number). Following the emergence of Naming, Participant 3 required 1 session to meet criterion on the first curricular objective (writing the fraction when given a picture of a shape with parts shaded in), 1 sessions to meet criterion on the second curricular objective (drawing pictures to solve a division problem), and 3 sessions to meet criterion on the third curricular objective (writing the number in standard form when given it in extended form).

Prior to the emergence of Naming, Participant 4 required 12 sessions to meet criterion on the first curricular objective (coloring equal parts of a shape to show a fraction), 5 sessions to meet criterion on the second curricular objective (writing the number of tally marks), and 3 sessions to meet criterion on the third curricular objective (identifying the number of tens and ones using pictures of base ten blocks). Following the emergence of Naming, Participant 4 required 2 sessions to meet criterion on the first curricular objective (writing the fraction when given a picture of a shape with parts shaded in), 2 sessions to meet criterion on the second curricular objective (identifying the ones, tens and hundreds place in a 2-3 digit number), and 2 sessions to meet criterion on the third curricular objective (drawing pictures to solve multiplication facts).
Figure 8. Number of Correct Responses to Learn Units under Teacher Modeling Conditions for Three Curricular Objectives Prior to and Following the Emergence of Naming for Participants 5 and 6.
Figure 8 shows session-by-session learning for Participants 5 and 6. Prior to the emergence of Naming, Participant 5 required 4 sessions to meet criterion on the first curricular objective (identifying the ones, tens and hundreds place in a 2-3 digit number), 2 sessions to meet criterion on the second curricular objective (coloring equal parts of a shape to show a fraction), and 7 sessions to meet criterion on the third curricular objective (writing the number of tally marks). Following the emergence of Naming, Participant 5 required 4 sessions to meet criterion on the first curricular objective (drawing pictures to solve multiplication facts), 2 sessions to meet criterion on the second curricular objective (writing the fraction when given a picture of a shape with parts shaded in), and 2 sessions to meet criterion on the third curricular objective (identifying the number of tens and ones using pictures of base ten blocks).

Prior to the emergence of Naming, Participant 6 required 3 sessions to meet criterion on the first curricular objective (writing the number of tally marks), 10 sessions to meet criterion on the second curricular objective (coloring equal parts of a shape to show a fraction), and 7 sessions to meet criterion on the third curricular objective (identifying the number of tens and ones using pictures of base ten blocks). Following the emergence of Naming, Participant 6 required 3 sessions to meet criterion on the first curricular objective (drawing pictures to solve multiplication facts), 2 sessions to meet criterion on the second curricular objective (identifying the ones, tens and hundreds place in a 2-3 digit number), and 2 sessions to meet criterion on the third curricular objective (writing the fraction when given a picture of a shape with parts shaded in).
Figure 9. Number of Correct Responses to Learn Units under Teacher Modeling Conditions for Three Curricular Objectives Prior to and Following the Emergence of Naming for Participants 7 and 8.
Figure 9 shows session-by-session learning for Participants 7 and 8. Prior to the emergence of Naming, Participant 7 required 2 sessions to meet criterion on the first curricular objective (write the number of tally marks), 2 sessions to meet criterion on the second curricular objective (coloring equal parts of a shape to show a fraction), and 7 sessions to meet criterion on the third curricular objective (identifying the ones, tens and hundreds place in a 2-3 digit number). Following the emergence of Naming, Participant 7 required 1 session to meet criterion on the first curricular objective (drawing pictures to solve multiplication facts), 2 sessions to meet criterion on the second curricular objective (writing the fraction when given a picture of a shape with parts shaded in), and 2 sessions to meet criterion on the third curricular objective (identifying the value of the underlined digit).

Prior to the emergence of Naming, Participant 8 required 3 sessions to meet criterion on the first curricular objective (identifying the ones, tens and hundreds place in a 2-3 digit number), 2 sessions to meet criterion on the second curricular objective (drawing pictures to solve multiplication facts), and 2 sessions to meet criterion on the third curricular objective (writing the number of tally marks). Following the emergence of Naming, Participant 8 required 1 session to meet criterion on the first curricular objective (writing the fraction when given a picture of a shape with parts shaded in), 1 session to meet criterion on the second curricular objective (identifying the value of the underlined digit) and 3 sessions to meet criterion on the third curricular objective (drawing pictures to solve a division problem).
Independent Variable

**Naming Pre-MEI and Post-MEI Probe Sessions.** Figure 10 shows the number of correct responses to Naming pre-experimental probe sessions, post-experimental probe sessions, and novel post-experimental probe sessions for Participants 1 - 8. Each session consisted of 20 probe trials of the point response, followed by 20 probe trials of the tact response, followed by 20 probe trials of the intraverbal response. To be consistent with the prior study (Greer et al., 2010), the listener response (point) was tested prior to the speaker responses (tact and intraverbal). Criterion for acquisition of the Naming capability was set at 80% accuracy, or 16/20 correct, for point, tact and intraverbal responses on the post-experimental probe and novel post-experimental probe sessions. These results showed that all of the participants acquired both the listener and speaker components of Naming.
Figure 10. Correct Point, Tact and Intraverbal Responses for Probe Sessions Prior to and Following the Emergence of Naming for Participants 1-8.
Participant 1 emitted 14 correct point responses, 7 correct tact responses, and 8 correct intraverbal responses on pre-MEI probe trials, showing he did not have Naming. After MEI with gemstone stimuli (amethyst, ruby, amber, emerald, and sapphire), Participant 1 emitted 20 correct point responses, 12 correct tact responses and 15 correct intraverbal responses on post-MEI probe trials. Participant 1 met criterion (set at 80%) for the listener response, but did not meet criterion for either speaker response. Therefore a second set of MEI was conducted with new stimuli (community helpers: surgeon, pharmacist, server, florist and gardener). Following the second set of MEI, Participant 1 emitted 20 correct point responses, 17 correct tact responses, and 19 correct intraverbal responses on post-MEI probes. Participant 1 met criterion for both listener and speaker responses. A novel probe was conducted in which Participant 1 emitted 19 correct point responses, 20 correct tact responses, and 20 correct intraverbal responses. Participant 1 met criterion of 80% accuracy for both the post-experimental probe and the novel post-experimental probe. These results showed that Participant 1 acquired Naming following MEI.

Participant 2 emitted 10 correct point responses, 4 correct tact responses, and 4 correct intraverbal responses on pre-MEI probes, showing he does not have Naming. After MEI with gemstone stimuli, post-MEI probe trials were conducted in which Participant 2 emitted 16 correct point responses, 16 correct tact responses and 16 correct intraverbal responses. Participant 2 met criterion (set at 80%) for both listener and speaker responses. Participant 2 emitted 12 correct point responses, 14 correct tact responses, and 10 correct intraverbal responses on a novel post-MEI probe. Participant 2
did not meet criterion on the novel probe, therefore another set of MEI was conducted with new stimuli (community helpers: cheerleader, news reporter, referee, dog walker, taxi driver). After a second set of MEI, another post probe was conducted in which Participant 2 emitted 11 correct point responses, 13 correct tact responses, and 11 correct intraverbal responses. Participant 2 did not meet criterion for either the listener and speaker responses, therefore MEI with a third set of stimuli (beekeeper, surgeon, construction worker, pharmacist, server) was conducted. Following mastery of the third set of stimuli with MEI, Participant 2 met criterion on post-MEI probe sessions with the with 19 correct point responses, 20 correct tact responses and 19 correct intraverbal responses. A novel post-MEI probe was conducted in which Participant 2 emitted 19 correct point responses, 16 correct tact responses, and 16 correct intraverbal responses. Participant 2 met criterion of 80% accuracy for both the post-MEI probe and the novel post-MEI probe. These results showed that Participant 2 acquired Naming following MEI.

Participant 3 emitted 18 correct point responses, 4 correct tact responses, and 4 correct intraverbal responses on pre-MEI probe trials. Upon Participants 1 and 2 meeting criterion for Naming, a second pre probe was administered to Participant 3 in which the point, tact and intraverbal probe sessions were repeated without match instruction. Participant 3 emitted 13 correct point responses, 10 correct tact responses, and 14 correct intraverbal responses. After MEI with gemstone stimuli, post-MEI probe trials were conducted in which Participant 3 emitted 18 correct point responses, 16 correct tact responses and 16 correct intraverbal responses. Participant 3 met criterion for both listener and speaker responses. A novel post-MEI probe was conducted and Participant 3
Participant 3 emitted 20 correct point responses, 19 correct tact responses, and 16 correct intraverbal responses. Participant 3 met criterion of 80% accuracy for both the post-MEI probe and the novel post probe. These results showed that Participant 3 acquired Naming following MEI.

Participant 4 emitted 19 correct point responses, 10 correct tact responses, and 12 correct intraverbal responses on pre-MEI probes. When Participants 1 and 2 met criterion for the acquisition of Naming, a second pre-MEI probe was conducted in which the point, tact and intraverbal responses were tested again without additional match instruction. Participant 4 emitted 19 correct point responses, 19 correct tact responses and 20 correct intraverbal responses on the second pre probe. Due to Participant 4 meeting the initial criteria for Naming, a novel pre-MEI probe was conducted. Participant 4 emitted 4 correct point responses, 4 correct tact responses, and 8 correct intraverbal responses on the novel pre probe. It was concluded that Participant 4 did not have Naming, as determined by the second pre probe; therefore MEI was conducted.

After MEI (with gemstone stimuli) Participant 4 emitted 18 correct point responses, 13 correct tact responses and 14 correct intraverbal responses on post-MEI probe trials. Participant 4 met criterion (set at 80%) for the listener responses, but not for the speaker responses. A second set of MEI with community helper stimuli (cheerleader, news reporter, referee, dog walker, taxi driver) was taught. Participant 4 emitted 20 correct point responses, 20 correct tact responses, and 20 correct intraverbal responses on post-MEI probe trials. Participant 4 met criterion, therefore a novel post probe was conducted. Participant 4 emitted 18 correct point responses, 9 correct tact responses, and 8 correct intraverbal responses on the novel post probe. Participant 4 met criterion of
80% accuracy for the listener half of Naming, but not for the speaker half of Naming. A third set of stimuli (community helpers: beekeeper, pilot, judge, sheriff, artist) was taught using MEI. Following mastery of MEI set three, Participant 4 met criterion on 80% accuracy on the post-MEI probes with 20 correct point responses, 16 correct tact responses and 16 correct intraverbal responses. Participant 4 emitted 20 correct point responses, 13 correct tact responses and 15 correct intraverbal responses on a novel probe, showing Naming did not emerge. A fourth set of stimuli (tools: drill, wrench, pliers, chisel, screwdriver) was taught using MEI. Participant 4 emitted 20 correct point responses, 20 correct tact responses and 20 correct intraverbal responses on the post-MEI probes. Participant 4 emitted 20 correct point responses, 20 correct tact responses and 20 correct intraverbal responses on a novel post-MEI probe. Participant 4 met criterion of 80% accuracy on both the post-MEI probe and the novel probe. These results showed that Participant 4 acquired Naming following MEI.

Participant 5 emitted 8 correct point responses, 0 correct tact responses, and 0 correct intraverbal responses on pre-MEI probes. Upon Participants 3 and 4 meeting criterion for Naming, a second pre probe was administered to Participant 5 in which the point, tact and intraverbal probe sessions were repeated without match instruction. Participant 5 emitted 9 correct point responses, 4 correct tact responses, and 4 correct intraverbal responses on the second pre-MEI probe trials. After MEI with gemstone stimuli, Participant 5 emitted 11 correct point responses, 5 correct tact responses and 7 correct intraverbal responses on post-MEI probe trials. Participant 5 did not meet criterion for Naming, therefore another set of stimuli (community helpers: referee, news reporter, dog walker, taxi driver, cheerleader) was taught using MEI. Following MEI,
Participant 5 emitted 10 correct point responses, 7 correct tact responses and 5 correct intraverbal responses on post-experimental probe trials. Participant 5 did not meet criterion for Naming, therefore another set of stimuli (community helpers: pilot, judge, sheriff, artist, bee keeper) was taught using MEI. Following the third set of MEI, Participant 5 emitted 11 correct point responses, 4 correct tact responses and 4 correct intraverbal responses.

Due to the significant length of time since Participant 5 received match instruction on the initial probe stimuli, a novel post-MEI probe was conducted with a new set of stimuli. Participant 5 emitted 20 correct point responses, 20 correct tact responses and 20 correct intraverbal responses. An additional novel post-MEI probe was administered to further test the presence of Naming. Participant 5 emitted 20 correct point responses, 16 correct tact responses and 16 correct intraverbal responses. Participant 5 met criterion for both listener and speaker responses. Participant 5 met criterion of 80% accuracy for both the post-MEI probe and the novel post-MEI probe. These results showed that Participant 5 acquired Naming.

Participant 6 emitted 13 correct point responses, 5 correct tact responses, and 4 correct intraverbal responses on pre-MEI probe sessions, showing he did not have Naming in repertoire. Upon Participants 3 and 4 meeting criterion for Naming, a second pre probe was administered to Participant 6 in which the point, tact and intraverbal probe sessions were repeated without match instruction. Participant 6 emitted 11 correct point responses, 1 correct tact responses, and 2 correct intraverbal responses, showing he still did not have Naming. After MEI with gemstone stimuli, Participant 6 emitted 20 correct point responses, 20 correct tact responses and 20 correct intraverbal responses on post-
MEI probe trials. Participant 6 met criterion for both listener and speaker responses. A novel post probe was conducted in which Participant 6 emitted 19 correct point responses, 18 correct tact responses, and 17 correct intraverbal responses. Participant 6 met criterion of 80% accuracy for both the post-MEI probe and the novel post probe. These results showed that Participant 6 acquired Naming following MEI.

Participant 7 emitted 9 correct point responses, 7 correct tact responses and 8 correct intraverbal responses on the first pre-MEI probe conducted. He emitted 7, 1, and 0 correct responses for point, tact, and intraverbal respectively on the second pre-MEI probe, and 20, 12, and 12 correct responses respectively on the third pre-MEI probe. All three of the pre-MEI probes were conducted with the car stimuli. The pre-MEI probes showed Participant 7 did not have Naming in repertoire. Participant 7 met criterion on the car stimuli after the first set of MEI (gemstones) with 18, 16, and 16 correct point, tact and intraverbal responses respectively. Participant 7 did not meet criterion on the novel probe (flowers) with 20, 9, and 12 correct point, tact and intraverbal responses respectively. Following the second set of MEI (community helpers), Participant 7 emitted 20 correct point responses, 19 correct tact responses and 20 correct intraverbal responses (flower stimuli), meeting the criterion. A novel probe was conducted (tree stimuli) and Participant 7 emitted 20 correct point responses, 12 correct tact responses and 12 correct intraverbal responses. Participant 7 did not meet criterion for the acquisition of Naming, therefore another set of MEI was conducted. Following the third set of MEI (Phoenician symbols), Participant 7 met criterion on tree stimuli with 19, 18 and 17 point, tact and intraverbal responses respectively. A novel probe was conducted (flowers, set 2) in which Participant 7 emitted 19, 7 and 5 correct point, tact and intraverbal responses.
respectively. He did not meet on the novel probe; therefore a fourth set of MEI was conducted with contrived stimuli. Following MEI set four, Participant 7 met criterion on the flower stimuli with 20 correct point responses, 19 correct tact responses and 19 correct intraverbal responses. A novel probe was conducted (fish) in which Participant 7 emitted 20 correct point responses, 16 correct tact responses, and 16 correct intraverbal responses. Participant 7 met criteria on the both the post and novel probe, meeting criteria of 80% accuracy for Naming following MEI.

Participant 8 emitted 12 correct point responses, 4 correct tact responses and 4 correct intraverbal responses on the first pre-MEI probe conducted. He emitted 12, 4, and 4 correct responses for point, tact, and intraverbal respectively on the second pre-MEI probe, and 11, 11, and 12 correct responses respectively on the third pre-MEI probe. All three of the pre-MEI probes were conducted with the car stimuli. The pre-MEI probes showed Participant 8 did not have Naming in repertoire. Due to the lengthy amount of time since Participant 8 received match instruction before the first pre probe, a novel pre probe was conducted with tree stimuli. These stimuli were then tested in the post-MEI probe. Participant 8 emitted 19 correct point responses, 13 correct tact responses and 12 correct intraverbal responses on the novel pre probe, which showed he did not have Naming in repertoire prior to MEI. After MEI with gemstone stimuli, Participant 8 emitted 20, 16 and 16 correct responses on point, tact and intraverbal respectively on the post probe. A novel post probe was conducted with flower stimuli and Participant 8 emitted 19, 9, and 8 correct responses on point, tact and intraverbal respectively.

Participant 8 did not meet criterion on the novel post probe, therefore another set of stimuli were taught using MEI. Following the second set of MEI, Participant 8 emitted 20
correct point responses, 17 correct tact responses and 20 correct intraverbal responses on
the post-MEI probes. Participant 8 met criterion for both listener and speaker responses.
A novel post probe was conducted in which Participant 8 emitted 19 correct point
responses, 16 correct tact responses, and 16 correct intraverbal responses. Participant 8
met criterion of 80% accuracy for both the post-MEI probe and the novel post probe.
These results showed that Participant 8 acquired Naming following MEI.

**Multiple Exemplar Instruction Across Listener and Speaker Responses to
Induce Naming.** Multiple exemplar instruction (MEI) across match, point, tact and
intraverbal responses was the intervention used to induce Naming. Criteria for mastery of
the intervention was set at 90% accuracy for two consecutive sessions or 100% accuracy
for one session. Figure 11 shows the number of correct responses emitted during MEI for
Participants 1-4. Figure 12 shows the number of correct responses emitted during MEI
for Participants 5-8.
Figure 11. Correct Match, Point, Tact and Intraverbal Responses during MEI for Participants 1-4
Figure 11 shows the session-by-session learning during MEI for Participants 1, 2, 3 and 4. Participant 1 met criterion after 2 sessions with both the first set of MEI (gemstones) and the second set of MEI (community helpers). Participant 2 met criterion for the first set (gemstones) after 4 sessions, met criterion for the second set (community helpers, Set 1) after 3 sessions, and met criteria for the third set (community helpers, Set 2) after 3 sessions. Participant 3 met criterion for the first set (gemstones) after 5 sessions. Participant 4 met criterion for the first set (gemstones) after 4 sessions, met criterion for the second set (community helpers, Set 1) after 3 sessions, met criterion for the third set (community helpers, Set 2) after 2 sessions, and met criterion for the fourth set (tools) after 3 sessions.
Figure 12. Correct Match, Point, Tact and Intraverbal Responses during MEI for Participants 5-8.
Figure 12 shows the session-by-session learning during MEI for Participants 5, 6, 7, and 8. Participant 5 met criterion for the first set (gemstones) after 2 sessions, met criterion for the second set (community helpers, Set 1) after 3 sessions, and met criterion for the third set (community helpers, Set 2) after 4 sessions. Participant 6 met criterion for the first set (gemstones) after 3 sessions. Participant 7 met criterion for the first set (gemstones) after 8 sessions, met criterion for the second set (community helpers) after 5 sessions, met criterion for the third set (Phoenician symbols) after 3 sessions and met criterion for the fourth set (contrived symbols) after 5 sessions. Participant 8 met criterion for the first set (gemstones) after 2 sessions and met criterion for the second set (tools) after 5 sessions.
Chapter IV

DISCUSSION

Summary

The acquisition of Naming resulted in an overall increase in rate of mastery of novel skills for all participants when the participants observed a teacher-model prior to the delivery of learn units. The results answered the research questions: 1) Do children need to have the Naming capability to learn academic skills from observing; and 2) Does Naming allow children to learn in a new way and learn faster in the classroom setting? When taken in conjunction with the prior study (Greer et al., 2010) the results support that children, such as the ones in the two studies, need to have the Naming capability to benefit from teacher modeling.

The prior study (Greer et al., 2010) isolated the teacher-model component by alternating conditions in which the teacher-model was present and absent across multiple instructional sessions. In that study, the participants with Naming learned significantly faster (2-4 times faster) when the teacher-model was present. Following the induction of Naming for those participants who lacked it, the results further showed that Naming was the link between accelerated learning from observing a teacher-model. The present study further isolated the Naming component, as opposed to the teacher-model component. I isolated the Naming component by selecting participants who did not have the verbal developmental capability Naming. The teacher-model procedure remained constant
(teacher-modeling was included in all instructional sessions, as opposed to alternating the teacher-model component which was done in the prior study) prior to and following the induction of Naming. Therefore this study further isolated the Naming component by testing the participants’ rate of learning in the absence and presence of the capability. Due to the isolation of teacher-model in the prior study, and the isolation Naming in the present study, it is important to view the results of both studies to provide a more complete analysis of the phenomenon. It is also important to note that the isolation of the Naming component was built on and extended the results of the Greer et al. (2010) study.

The results of the present study showed that eight participants learned significantly faster (1.6 to 3.4 times faster) under teacher-modeling conditions, after the acquisition of Naming. When taken alone, the results showed an accelerated rate of learning following the acquisition of Naming. When analyzed in conjunction with the prior study, the results suggest that the acquisition of the Naming capability shown in the present study allowed the participants to learn by observing the teacher-model, subsequently leading to accelerated learning and that not having Naming, as shown in the Greer et al. (2010) study, may prove to be a major obstacle for children’s success in school. The results of Participants 3, 7 and 8 also support the theory that the acquisition of Naming led to the ability to learn from observing a teacher model. These three participants emitted zero correct responding on pre-tests for certain skills. Following the observation of the teacher-model, these three participants emitted 100 percent correct responding. These data showed that the acquisition of Naming allowed the participants to learn by observing the teacher-model, a skill that did not appear to be in repertoire prior to the emergence of Naming.
Therefore the results suggest that Naming might be an essential prerequisite to learn academic skills from observing. In addition, the results support that children may learn in a new way (by observing a teacher-model) upon the acquisition of Naming. The ability to learn academic skills by observing a teacher model how to emit an accurate response has significant implications for children. Without the verbal developmental capability of Naming in repertoire, children with autism do not learn new skills by observing, and continue to require the direct contingencies provided by the learn unit. Although the eight participants in the study continued to receive, and learn from, the learn unit, I propose the accelerated rate of learning that occurred following the induction of Naming was due to the acquisition of the ability to learn from observing. Based on the results of the prior study (Greer, Corwin & Buttigieg, 2010) and the subsequent expansion of those findings in the present study, I propose that Naming may be a necessary prerequisite for children to learn academic skills from observing.

**Relevant Literature**

**Source of Reinforcement for Naming**

The results of the present study may provide further evidence of the source of reinforcement for Naming. There is some agreement among verbal behavior theorists that the initial reinforcement for Naming is the echoic (Greer & Longano, 2010; Horne & Lowe, 1996; Longano, 2008). Longano (2008) tested the theory, and in her first experiment showed that for children for whom MEI was not successful, the addition of an echoic component in the MEI intervention showed the induction of Naming. Although the experiment showed that participants who did not previously acquire Naming through MEI did acquire the capability with the addition of the echoic, the source for
reinforcement for Naming was still unclear. Therefore Longano conducted subsequent studies in which a stimulus-stimulus pairing procedure was implemented to condition the echoic as a reinforcer. Longano conditioned neutral stimuli (both visual and vocal) using already conditioned stimuli (both visual and vocal). Following the stimulus-stimulus pairing procedure, which resulted in the acquisition of the echoic as a reinforcer, the participants attained Naming. Greer and Longano (2010) theorized that the reinforcement for the acquisition of Naming is based on conditioning experiences. A child’s history of reinforcement across many conditioning experiences (multiple exemplars of stimulus pairings of observed stimuli with voices) is what leads to the incidental (without intervention) acquisition of Naming.

For children who do not have such conditioning experiences or do not benefit from the conditioning opportunities, Naming may not be acquired incidentally. Children who are born to language-impoverished homes, such as those described in the Hart and Risley (1996) study, do not acquire language at a rapid rate, and were reported to have less successful educational outcomes as a result. Children with autism spectrum disorder may not benefit from language experiences in their environment, due to the lack of reinforcement for observing to such experiences. Therefore, these children (both those who are not provided with such language experiences, or children who do not benefit from language experiences) do not incidentally develop the conditioning experiences central to the source of reinforcement for Naming.

Greer and Longano (2010) state, “in vocal verbal behavior, the acquisition of Naming for a stimulus requires both the observation of the word that is spoken by the caregiver, together with the child observing with one sense, or a combination of the
senses” (p. 7). If a child does not have conditioned reinforcement for observing the language experience provided by his or her caregiver (i.e., the stimuli do not select out their attention), the child will not benefit from the language experience. Therefore in order for a child to acquire a repertoire of a history of reinforcement of conditioned language experiences, Naming must be present.

**Verbal Observation and Production and Generalized Imitation**

It is important to distinguish between *verbal observation and production* and *see-do*, as in generalized imitation (Greer & Speckman, 2009). The type of learning acquired from observing the teacher-model is an example of a child verbally observing, and producing. It is not a case of generalized imitation. In the case of generalized imitation, reinforcement is direct because the action of imitating behavior is in itself the reinforcement. Each response, or imitation, is independent of any other response. In verbal observation and production relations, the reinforcement is indirect because it requires the mediation of another individual acting as a speaker or a listener. In addition, the responses of observing, and subsequently producing, must be joined in order to complete the behavior (Greer & Speckman, 2009). Therefore the type of observing and producing described in this study is far more complex than the see-do behavior required in generalized imitation.

**The Antecedent**

The teacher-model in the current study was conducted prior to the delivery of learn units. In a regular education classroom, teacher modeling is generally provided prior to student practice. The teacher-model is essentially an extended antecedent. Much of the research in the area of applied behavior analysis, as well as verbal behavior, has
revolved around the impact the consequence has on changing behavior (Stichter, Conroy & Boyd, 2004). Skinner’s (1957) theory of verbal behavior was the catalyst in defining the consequence as the most important component in the three or four-term contingency. The three-term contingency consists of an antecedent, a behavior (or response) and a consequence. The focus of past research in the field has been on the importance of the consequence in changing behavior. However, as new cusps and capabilities are identified, and procedures to induce such verbal developmental stages are tested, it is important to focus on new ways to teach.

It is important to consider the role of the antecedent in relation to Naming. There may be a link as to why the participants benefited from observing this extended antecedent following the acquisition of Naming, but not prior to the acquisition of Naming. The measurement procedures used in Naming probes in the current study as well as throughout the research involve only an antecedent presentation and a participant response (Feliciano, 2006; Gilic, 2005; Greer et al., 2010; Greer et al., 2007; Greer et al., 2007; Helou-Care, 2008; Pistoljevic, 2008). No consequence was provided during the probe sessions; therefore responding to the Naming probe was maintained by the antecedent. Perhaps reinforcement for observing an extended antecedent and producing a response emerges following the induction of Naming. Therefore, for children with more complex levels of verbal behavior, the antecedent as a reinforcing consequence for observing may maintain responding. This suggests that the consequence is a result of the conditioning history making the provision of direct consequences unnecessary. However, it may be that the antecedent is functioning as a consequence for observing, wherein the
reinforcement is that which is observed aurally and visually, or aurally and other senses (smell, taste, touch, hear).

**Major Findings**

**In Relation to the Source of Reinforcement for Naming**

Longano (2008) conditioned the echoic, and essentially observing experiences, in order to induce Naming. The participants in the present study differed in that they did not require a conditioning procedure to benefit from MEI. Therefore, the echoic was already a conditioned reinforcer for these participants. However, similar to other children who do not have Naming in repertoire, conditioned reinforcement for observing another individual say the name for a stimulus, and subsequent learning of the name of that stimulus, was not in repertoire for these participants. In addition, the participants were not learning from observing the teacher-model during curriculum objective instruction. I theorize that observing a teacher demonstrate skills relevant to curricular material was not a conditioned reinforcer for the participants; therefore they were not benefiting from the observation. I propose that the procedure that induces Naming, MEI, and conditioned reinforcement of for the stimuli observed leads to Naming.

In Longano’s (2008) study, the participants required multiple sessions of stimulus-stimulus pairing to acquire the conditioned reinforcement for Naming experiences. Similarly, six of the eight participants in the present study required multiple sets of stimuli taught in MEI prior to the acquisition of Naming. It can be concluded that multiple exposures to these types of pairing experiences are required to acquire conditioned reinforcement for Naming experiences.
If the procedure that induces Naming, MEI, conditions observing experiences for children such as those in the present study, then these observing experiences may take many forms. I modeled the steps required to solve a problem accurately two times prior to delivery of learn units. However, the correction procedure was very similar to the teacher-model procedure. The difference in the teacher-model procedure was that I modeled it twice, with no interaction with the participant (I did not evoke a response from the participant, I only prompted him to watch me), and I modeled different exemplars of a similar problem. During that session, the participant did not complete the exact problem that I modeled for him. Therefore, upon the acquisition of Naming, the participants may have not only been learning from the teacher-model, but also learning faster from the correction. This is demonstrated by a drastic increase in correct responding following the first session of instruction for many participants. For example, Participants 1, 2, 5, and 6 often emitted low levels of correct responding on the first session, but showed a dramatic increase on the second session, often demonstrating mastery. For these participants, it is possible that observing the correction in the first session, followed by the model in the next session increased their rate of learning. Participants 3, 7 and 8, who had the listener half of Naming prior to MEI, learned solely from the teacher-model on one or two curricular objectives, as shown by 100% correct responding on the first session.

**In Relation to the Listener Component of Naming**

The two halves of Naming include the listener component and the speaker component. It is agreed that an individual does not become fully verbal until these two halves are joined, in what is referred to as full Naming (Greer & Ross, 2008; Greer & Speckman, 2009; Greer & Longano, 2010; Hayes et al., 2001; Horne & Lowe, 1996). Of
the eight participants, Participant 3 began the study with the listener half of Naming in repertoire. That is, he was able to point to the stimuli with 80% accuracy after only hearing the names for the stimuli when learning to match in MTS instruction. Participants 7 and 8 did not have the listener half of Naming as measured by the first and second pre-experimental probes. However, they did acquire the listener half of Naming without intervention prior to undergoing MEI. Interestingly, Participants 3, 7 and 8 all had very low learn units-to-criteria prior to the acquisition of Naming. Although Participants’ 3, 7, 8 learn units-to-criteria decreased further upon the acquisition of Naming, perhaps the presence of the listener half of Naming allowed the participants to benefit in some way from the teacher-model. In addition, Participant 3 required only one set of stimuli taught in MEI prior to acquiring Naming. Participants 7 and 8 however required multiple sets of stimuli taught in MEI prior to acquiring Naming.

In Relation to the Verbal Behavior Developmental Sequence

Greer and Speckman (2009) proposed that listener and speaker capabilities develop at different rates within an individual, which subsequently affects the joining of the listener and speaker functions, or the onset of Naming. Therefore differences in the presence or absence of listener and speaker cusps and capabilities, as specified by their listener and speaker behaviors, is an important variable to consider when inducing Naming. There were significant differences in the level of verbal behavior between Participant 3, and Participants 7/8. Participant 3 had far more developed speaker and listener functions, even though he was the youngest participant in the study. When accounting for his age and diagnosis of autism, he acquired academic and language skills at a fast rate even prior to the acquisition of Naming. Subsequently, he only required one
set of MEI prior to acquiring Naming. Participants 7 and 8, the oldest of the participants, had far fewer developed speaker and listener behaviors; however they did have the listener half of Naming. They both required a high number of learn units to acquire basic academic and language skills and they required many exposures to various MEI sets prior to acquiring Naming. Therefore the existing cusps and capabilities of participants may determine how much exposure to MEI is necessary prior to attaining Naming.

**Anecdotal Observations**

Although observations by caregivers and educators in the participants’ environment cannot be considered empirical evidence, there are several anecdotal observations that support the validity of the experiment. Prior to the induction of Naming, teaching the participants the three novel curriculum objectives was a lengthy procedure. Due to the complexity of the objectives chosen, the participants demonstrated signs of frustration when they required multiple sessions to master a skill. They required many teacher prompts to observe me as I modeled the skill for them. Although the participants appeared to be observing (i.e., oriented towards me, eyes on the paper or white board), there was no other student behavior to measure if they were in fact observing. Following the acquisition of Naming, it was very clear by the participants’ behavior that they were observing the teacher-model. During curricular instruction following the acquisition of Naming, all of the participants attended to the model without teacher prompting to do so, kept their eyes on the paper or white board where the skill was being demonstrated, and often vocally participated by providing a response or echoing the teachers vocal model. Often the participants requested to try completing the skill on their own after observing only one teacher-model, resulting in my direction to “watch me one more time, and then
it is your turn”. In addition, several of the participants requested to work on curricular objectives they already mastered, after the acquisition of Naming (“Ms. Corwin, can we do the circles again?” in reference to multiplication instruction). In addition, the assistants in the classroom, other educators in the school building, and the parents of the several participants commented on the increases in language use and rate of learning demonstrated by the participants.

Participant 4’s results, as well as anecdotal observations made by the adults in his environment, were the most interesting of the participants. Participant 4’s initial Naming pre-experimental probe showed he had the listener half of Naming in repertoire. The second pre-experimental probe conducted, due to the delay in the experimental design, showed Participant 4 had Naming in repertoire. As the classroom teacher, it was very clear to me that although his responses on pre-experimental probe sessions showed he had Naming, his performance in the classroom showed otherwise. Participant 4 was not learning language incidentally, or acquiring novel responses from exposure in only one response. His ratio of learn units-to-criteria across all of his curricular programs was extremely high, showing he was learning at a very slow rate. It was decided that perhaps the stimuli used (colorful flowers and trees) were reinforcing to him, and possibly this reinforcement distorted the data. I conducted a novel pre-experimental probe with Phoenician symbols. It was highly unlikely he had any reinforcement history with these symbols. Participant 4 did not have Naming according to this third probe. Subsequently, instruction in curricular objectives relevant to the study showed Participant 4 had very high learn-units to criteria prior to the induction of Naming. After the induction of Naming, Participant 4 had the most significant decrease in learn units-to-criteria (he
learned 3.4 times faster). As his classroom teacher, I can report anecdotally that following the emergence of Naming, Participant 4 had a “language explosion” similar to what is described by researchers in language development. Due to the drastic changes in Participant 4 following the induction of Naming, it poses the question as to why he presented as having Naming on the initial pre-experimental probes. I theorize that a reinforcement history with certain stimuli may occasion what appear to be “Naming experiences”. However, without a broad history of reinforcement for observation, Naming is not in fact present.

**Additional Empirical Findings**

In addition to showing a functional relationship between decreased learn units-to-criteria under teacher-model conditions and the Naming capability, the results also showed that MEI was effective in inducing Naming for eight participants. This component of the study was a systematic replication of the effects of MEI on Naming, and the results were consistent with prior studies (Fiorile & Greer, 2007; Feliciano, 2006; Gilic, 2005; Greer et al., 2010; Greer et al., 2007; Greer et al., 2007; Helou-Care, 2008; Pistoljevic, 2008).

**Educational Implications**

The present data show significant educational implications for children with autism, and possibly all children. The data showed that not only do children require Naming as a prerequisite capability to learn from teacher modeling, but also children who do not have this capability in repertoire do not benefit from this type of instruction. This finding may be even more telling than the finding that Naming results in faster learning. That is, the children who lack Naming are at risk. In a typical classroom, ranging in
grades from kindergarten through college-level, the majority of teaching styles involve a teacher-led lesson in which children are expected to observe, listen and then produce. The Naming capability is the joining of the listener and speaker functions that may provide children with the ability to observe and produce. Assessment of the presence or absence of Naming can provide educators with critical information regarding how a child can learn. Recent research, including the present study, has shown that MEI is effective in inducing Naming, and subsequently expanding the ways a child can learn in a classroom (Felicano, 2006; Gilic, 2005; Greer et al., 2007; Greer et al., 2010; Greer & Pistoljevic, 2007; Helou-Care, 2008; Pistoljevic, 2008).

Upon identification of the presence or absence of Naming, a teacher’s instruction should change accordingly. Once a child acquires Naming, he or she can learn multiple responses from instruction in one response (Greer & Speckman, 2009). For example, when directly taught to identify the color green by pointing to a green card, a child with Naming can also vocally identify the color green as an untaught, emergent response because Naming also results in a bidirectional relation. Therefore teachers no longer need to teach multiple responses for children with Naming, but should continue to do so for children without Naming.

As shown by the present study and the Greer et al. (2010) study, children can learn in a new way upon the emergence of Naming. Once Naming emerges (either incidentally or following an intervention), a child can now learn by observing a teacher or caregiver model or demonstrate the steps to complete a task or problem. For children without Naming, it is critical to continue to provide direct learning contingencies (direct learn units) until Naming emerges. For children with Naming, teachers can increase a
child’s rate of learning by modeling. It is important to note that the Naming pre- and post-experimental probe procedures, as well as the MEI procedures, are not lengthy. Naming probes, not including the MTS instruction, require less than 10 minutes. The MEI procedure requires 10 to 15 minutes per session. Therefore, Naming can be induced for a child in approximately one to two weeks. The benefits of Naming far outweigh the small amount of time required to induce the capability.

The acquisition of the Naming capability leads to more complex verbal behavior, which provides additional learning implications. Reilly-Lawson (2008) showed the link between phonemic control and Naming. Lee-Park (2005) and Helou-Care (2008) showed the link between reading comprehension and Naming. In addition, it is theorized that Naming lays the foundation for other complex verbal behavior, such as writing and problem solving (Greer & Speckman, 2009).

**Limitations**

There are several limitations to the experiment that should be noted. The study was conducted in the classroom in which all of the participants were present. Therefore the other participants had incidental exposure to the stimuli used for Naming probes. For example, if a Naming probe was conducted with one participant, it is possible the other participants could have heard the names for the stimuli, even though they were not in view of the stimuli. Because the participants lacked Naming, they should not have been able to learn the names of the stimuli incidentally. However, it should be noted that they might have heard the words of the stimuli more than the exposure they had to the words in their own probe sessions.
Another limitation is the lack of a control group. All of the participants observed teacher modeling prior to and following the acquisition of Naming. If a control group, (who did not receive teacher modeling as part of the experiment) was present, that feature might further isolate the observation of the teacher-model as the source of learning. Therefore I must refer to the results of the current study in conjunction with the prior study (Greer et al., 2010) to provide the necessary empirical support to isolate the teacher-model. Taking the results of the current study alone, it could be debated that the acquisition of Naming itself was the source of the decrease in learn units-to-criteria. However the prior study alternated conditions in which the teacher-model was present, and then absent, for nine participants. The results of that study showed the teacher-model was in fact allowing the participants with Naming to learn faster. The present study sought to further test the impact of Naming and its link to observing a teacher-model. The additional component of a control group would have provided more validity when isolating the role of the teacher-model. Moreover, the staggered baseline in the present study controlled for maturation and history. The children received standard tested tactics when they lacked Naming and after they attained Naming, suggesting that it was not just any intervention but the onset of Naming was responsible for accelerated learning.

Although not explicitly a limitation, the design of the study could have been improved to further show the effects of Naming on the acquisition of learning through teacher modeling. The teaching of additional curriculum objectives prior to the acquisition of Naming, for participants whose intervention was delayed, would have further improved the validity of the experiment by showing they did not acquire the curricular objectives from the teacher-model across a longer period of time. This would
have been especially beneficial for Participants 7 and 8, who acquired the listener half of Naming incidentally. If those participants had additional data prior to the acquisition of Naming, it could have been useful to determine if the acquisition of the listener half of Naming had any effect on their rate of learning with a teacher-model.

Another limitation is the continued math instruction that the participants had exposure to throughout the experiment. For ethical reasons, math instruction continued to be delivered based on the participants’ regular education curriculum. The curricular objectives were chosen because the participants had no prior exposure to those skills or concepts and those objectives were not part of standard instruction in the classroom at that time. In addition, curricular pre-tests were administered to ensure the skills were not in the participants’ repertoire prior to instruction. However, there are some prerequisite skills that could have been acquired through the participants’ regular curricular programming, which may have aided the participants in the acquisition of the novel objectives. These objectives would include number concept skills that were not present at the onset of the study. Due to the significant amount of time that elapsed for Participants 5-8, it is difficult to determine if they acquired prerequisite skills that resulted in low learn units-to-criteria prior to the acquisition of Naming. Participants 7 and 8 had especially low learn units-to-criteria prior to the induction of Naming. It is difficult to determine if this is due to 1) those participants having a lower rate of learning as measured by learn units-to-criteria overall, 2) the acquisition of the listener half of Naming, or 3) the acquisition of prerequisite skills that aided them in learning the objectives. Therefore, altering the design to include ongoing instruction in novel curricular objectives may have been beneficial in determining that the participants were
not acquiring skills that may have aided them in learning skills faster prior to the onset of Naming.

**Future Research**

This study in conjunction with the prior study (Greer et al., 2010) laid the foundation for the link between the Naming capability and the ability to learn from observing a teacher-model. Although the contributions of the research between these two studies is exciting, the small amount of empirical evidence gathered thus far leads us to ask many new research questions.

Expanding the research to participants of differing levels of verbal behavior, such as children with autism whose language deficits are more severe than the current participants, as well as typically developing children would be beneficial. Research with children with significant language delays can lead us to answering research questions about how we can maximize learning for these students by inducing Naming. Research with children with more significant language delays may also lead to answering research questions about the source of reinforcement for Naming, and how the ability to observe language experiences plays a critical role in language development. Expanding the research with typically developing children may lead to more effective means to instruct children in the classroom. In addition, expanding research with children from language impoverished homes, as well as with children who learned English as a second language may lead to further evidence towards theories of language development, as well as guiding educators to maximize educational outcomes for these students.

Considering the limitations of the current study, conducting further research is essential to further test the link between Naming and learning from a teacher-model. It is
important to test the way the teacher-model is presented, especially for children taught in larger group settings. Testing what capabilities are necessary for a child to learn from observing a teacher model in a large group is critical, as this is how the majority of children are taught. In addition, testing the elimination of the learn unit in the procedure to further identify how children learn from observing alone would be beneficial for research with typically developing children. This would further expand the research pertaining to the importance of the antecedent and consequence in instruction. Perhaps children with certain advanced capabilities no longer require instruction consisting of all of the elements of the learn unit if they learn from observing extended antecedents.

Additional variables should be tested as well. Anecdotally, it was observed that the participants increased the number of verbal operants emitted in all settings, as well as an overall increase in rate of learning across their academic programs. Further measurement of these variables would be beneficial. Schmelzkopf (2010) conducted a study in which adult approvals were conditioned using an observational conditioning procedure. During the procedure, a confederate peer received reinforcement in the form of adult approval, while the target peer listened. The procedure conditioned adult approvals for the target peer, as well as increasing the participants’ vocal verbal operants emitted in non-instructional settings. Perhaps similar conditioning procedures occurred during the teacher-model, however it was not measured in the study. Therefore, further measurement of vocal verbal operants in relation to Naming acquisition and the link between observation and production may be necessary. In addition, testing the relation between Naming and observational learning in regards to the emergence of reinforcement
for observing and producing would be valuable to further test the verbal behavior development theory.

The current study supports the verbal behavior developmental theory in that it provided further evidence to support the emergence of reinforcement between observing and producing, as well as provided evidence of children learning in a new way, upon on the onset of Naming. Further research in all areas of verbal behavior theory is critical to learn new teaching methods to maximize language development and educational outcomes for all students.
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*Dissertations Abstracts Item: AAT 9631721*.

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young children: Listener behavior training. *Journal of the Experimental Analysis of
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Appendix

Example Place Value Worksheet Used During Instructional Sessions

<table>
<thead>
<tr>
<th>Name</th>
<th>Date</th>
</tr>
</thead>
</table>

Write O if the underlined digit is in the ones place.
Write T if the underlined digit is in the tens place.
Write H if the underlined digit is in the hundreds place.

<p>| | | | | | |</p>
<table>
<thead>
<tr>
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<td>432</td>
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<td>523</td>
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Example Fraction Worksheet Used During Instructional Sessions

<table>
<thead>
<tr>
<th>Name:</th>
<th>Date:</th>
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</thead>
</table>

Color the shape to represent the fraction.

<table>
<thead>
<tr>
<th>1/2</th>
<th>1/3</th>
<th>2/3</th>
</tr>
</thead>
<tbody>
<tr>
<td><img src="image" alt="Triangle" /></td>
<td><img src="image" alt="Triangle" /></td>
<td><img src="image" alt="Triangle" /></td>
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<tr>
<td>3/4</td>
<td>2/2</td>
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<td><img src="image" alt="Rectangle" /></td>
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<td>3/4</td>
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<td><img src="image" alt="L-shape" /></td>
<td><img src="image" alt="L-shape" /></td>
<td><img src="image" alt="L-shape" /></td>
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<tr>
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<tr>
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<td><img src="image" alt="Half-circle" /></td>
<td><img src="image" alt="Half-circle" /></td>
</tr>
<tr>
<td>1/4</td>
<td><img src="image" alt="Quarter" /></td>
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### Example Tally Mark Worksheet Used During Instructional Sessions

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Example Multiplication Worksheet Used During Instructional Sessions

Name: 

Date: 

Draw a picture to solve the multiplication problem.

2 x 2 =

4 x 3 =

5 x 2 =

3 x 3 =

3 x 5 =

4 x 1 =

4 x 2 =

3 x 2 =

4 x 4 =

2 x 3 =