Conditioned Seeing as Related to Bidirectional Naming for Unfamiliar Stimuli with Third through Fifth Grade Students Diagnosed with Autism

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ABSTRACT

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In a series of three experiments, I investigated the emergence of conditioned seeing, defined as delayed drawing responses, as a potential component of bidirectional naming (BiN) for unfamiliar stimuli, which was defined in this study as the emergence of untaught listener and speaker responses following a naming experience with school-aged participants diagnosed with autism. Following exposure to incidental naming opportunities (stimulus-stimulus pairing), participants demonstrated BiN responses to familiar stimuli but did not demonstrate BiN responses to unfamiliar stimuli. In Experiment I, I assessed BiN and delayed drawing responses to unfamiliar stimuli following a naming experience in which attending to auditory stimuli, or names of the symbol, was paired with reinforcing stimuli for 6 participants. Participants were matched for level of verbal behavior and subsequently assigned to an experimental multiple exemplar instruction (MEI) or control group. A multiple probe design with a simultaneous treatment condition was utilized. Participants in the MEI group were exposed to listener, speaker, and drawing (transcription) responses with teaching sets of stimuli, while the control group experienced the school curriculum only, Direct Instruction. Participants in the control group were also exposed to a repeated probe condition during which they experienced a matched number of probe sessions with participants in the MEI-experimental group. Results of the first experiment indicated the presence of BiN with unfamiliar stimuli and conditioned seeing repertoires for participants in the MEI-experimental group following the intervention, however BiN and delayed drawing responses were not present for participants in the control group. Based
on the results of Experiment I, I hypothesized that BiN and conditioned seeing behaviors may be evoked as a function of the establishment of a history for conditioned reinforcement for simultaneously observing a visual and auditory stimulus while engaging a drawing response. Two participants were selected for Experiment II as they demonstrated the presence of unidirectional naming for unfamiliar stimuli and delayed drawing responses during probe sessions; participants included in Experiment I did not demonstrate unidirectional naming for unfamiliar stimuli. Utilizing a multiple probe design, Experiment II tested whether the presence of unidirectional naming and drawing responses would evoke multiple stimulus control across speaker responses following exposure to a learn unit procedure. The learn unit procedure implemented in Experiment II required participants to emit an echoic for the name of the target stimuli while simultaneously attending to the visual and auditory stimuli, as well as drawing the stimuli. Results of the study indicated that BiN repertoires were present for unfamiliar stimuli following the intervention. In Experiment III, I again implemented the learn unit procedure but eliminated requirement of the echoic. Participants in Experiment III did not demonstrate unidirectional naming for unfamiliar stimuli or delayed drawing responses before the learn unit intervention. Three of these participants included in Experiment III had been assigned to the control group in Experiment I and a fourth participant was added. Results of Experiment III indicated that the learn unit procedure evoked BiN for unfamiliar stimuli and conditioned seeing for all four participants, indicating the presence of multiple stimulus control for verbal behavior. The source of this learning may be the establishment of conditioned reinforcement for observation of unfamiliar stimuli.
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“Never give up on something you can’t go a day without thinking about.”

--Winston Churchill
DEDICATION

This dissertation, my life’s work (to date!), is dedicated to “my little family” for your endless love and countless hours of support. No matter what the future brings, you will always be family.

This is also dedicated to my cousin, Allah-rakha. You are my inspiration in all things.
Chapter I

INTRODUCTION AND REVIEW OF LITERATURE

Introduction

Although theorists do not always agree on the processes by which children demonstrate rapid vocabulary growth, most researchers agree that children learn thousands of words during early childhood. According to Carey (2010), by the age of six the average child has learned over 6,000 words, requiring children to decipher the meanings of hundreds or thousands of words at a time. Fenson, Dale, Reznick, Bates, and Thal (1994) estimated that children’s productive vocabulary increases 300% between 12 and 24 months of age. In a seminal longitudinal study conducted by Hart and Risley (1995), investigators found that typically-developing children who are raised in language rich environments can acquire a vocabulary of 2,000 or more words by the age of three. Most of these words are not taught directly (Crystal, 2006) however, indicating that environment and the role of family are vital in language development for typically developing children. According to Crystal (2006), incidental language acquisition or naming experiences occur when a child and caregiver are simultaneously looking at, or sensing a stimulus (often described as joint attention).

Parents who foster language-rich environments, as described by Hart and Risley (1995), typically speak over 50,000,000 words to their children by the age of three, while those from language-poor environments are exposed to approximately 10,000,000 words. Much of the language that is acquired incidentally occurs through the child observing an object in the environment while hearing the name of the object emitted by his or her caregiver. After only a few instances a normally developing child is able to emit the name of the item as a speaker and listener without direct instruction in these topographies (Greer & Longano, 2010). This ability,
known as naming (Horne & Lowe, 1996), can lead to a “language explosion” (Crystal, 2006; Hart & Risley, 1995; Greer & Longano, 2010), enabling children to learn at a faster rate (Greer & Speckman, 2009).

In this paper, I will discuss language development and communication deficits commonly observed in children with autism. I will then review theories related to the development of incidental language acquisition through fast mapping (Carey, 2010; 1978) and slow mapping (Swingley, 2010). Behavior analytic theories behind the development of language will subsequently be examined, including Stimulus Equivalence (Sidman, 1971), Relational Frame Theory (RFT) (Hayes, 1991) and Horne and Lowe’s (1996) Naming Theory, and the Verbal Behavior Development Theory (Greer & Ross, 2008; Greer & Speckman, 2009). Direct Instruction (Engelmann, Becker, Carnine, & Gersten, 1988), as related to the development of language and corresponding derived relations, will be reviewed as well.

Verbal behavior development (Skinner, 1957) and verbal behavior developmental capabilities and cusps as related to conditioned social reinforcement will be investigated, with an emphasis on bidirectional naming (BiN) literature (Greer & Longano, 2010; Longano & Greer, 2014; Miguel, 2016). Finally, I will describe current research on conditioned seeing (Skinner, 1957), identified as “delayed remembering” (Mercorella, 2017; Shanman, 2013). Conditioned seeing will be related to BiN and the need for current research in this area will be outlined.

Note the term BiN will be used throughout this paper to refer to full naming, e.g., the bidirectional relation between speaker and listener repertoires during which language is acquired incidentally (Miguel, 2016).

Language and Communication Skills in Children Diagnosed with Autism
For typically developing children, listening and attending to their mother’s voices begins in utero (Gomez & Gerken, 2002; Moon, Lagercratz, & Huhl, 2013). The mother’s voice is paired with nutrients causing voices to become conditioned as a reinforcer early in life. Conditioned reinforcement for observing responses to voices is considered to be an essential pre-verbal foundational skill in language development (Greer & Du, 2015b) and is not necessarily inherent in children with autism. In a study of home videotapes taken during first birthdays, Osterling and Dawson (1994) found that participants who were later diagnosed with autism responded to their name being called significantly less than those who were considered typically developing. Similar findings were observed in a study conducted using home videotapes of typically developing children, children diagnosed with mental retardation, and children diagnosed with autism taken during first birthday parties (Osterling, Dawson, & Munson, 2002). In Osterling et al. (2002), children with autism did not orient to their spoken name as frequently as children diagnosed with mental retardation and typically developing children.

Observing responses to faces in typically developing children occur during infancy (Nelson, 2001) but may not occur in children diagnosed with autism without being taught (Greer & Ross, 2008; Maffei, Singer-Dudek, & Keohane, 2014; Senju, Kikuchi, Hasegawa, Tojo, & Osonai, 2008). Research indicates eye gaze and eye contact play an important role in social communication and cognitive development (Cleveland, Kobiella, & Striano, 2006; Senju et al., 2008), therefore conditioning observing responses to faces and voices are extremely important in language development (Greer & Du, 2015b; Maffei et al., 2014).

The ability to engage in joint attention skills, which involve orienting to an adult face, voice, and other stimuli in the environment, are often lacking in children with autism (McEvoy, Rogers, & Pennington, 1993; Tager-Flusberg, Paul, & Lord, 2005). According to Tager-Flusberg et al.
(2005), unlike many children with autism, typically developing children attend to voices and faces during infancy and begin to name objects, people and relationships by 12 to 18 months of age, gaining a vocabulary of 50 to 100 words. Mitchell et al. (2006) conducted a study on language development with 97 “at-risk” infant siblings of children with autism while 49 “low-risk” (e.g., did not have siblings diagnosed with autism) infants acted as a control. By 24 months of age, 15 at-risk infants had been diagnosed with autism and demonstrated fewer gestures and understood fewer phrases by 12 months as assessed by the MacArthur Communicative Development Inventory—Infant Form Words and Gestures (CDI-WG) (Fenson et al., 1993) when compared to their counterparts. Horovitz and Matson (2010) also found with typically developing children that language development indicators by 12 months included gestures, joint attention, babbling and by 18 to 24 months, vocabulary comprehension and orientation to name. These indicators are not present with many children diagnosed with autism (Horovitz & Matson, 2010). Without these prerequisite skills, children with autism spectrum disorder frequently do use not complex sentences, full grammatical forms and integrate real-world knowledge (Fulsberg et al., 2005) nor are they able to attend to nonverbal social cues, such as facial expressions and tones. These findings indicate that establishment of a history of conditioned reinforcement for observing responses in children with autism is key in the development of higher order language skills, such as incidental language acquisition or BiN.

Incidental Language Acquisition

Developmental Psychology Approach

Fast mapping. As mentioned previously, children acquire thousands of words by the age of six (Carey, 2010) and productive vocabulary increases significantly by the age of two (Fenson et al., 1994). Carey (1978) first proposed that only two sources of data are available in
language acquisition: linguistic and situational context. This proposed theory is shared by Tierney and Cunningham (1984) who believed that children must be taught word meanings before encountering them in text. Much of the current research conducted by cognitive developmental theorists on the process of incidental language acquisition concerns the process of fast mapping (Kucker, McMurray & Samuelson, 2015), in which new lexical entries are established through the linguistic content of a new word represented in nonlinguistic context (Carey, 2010) to form a partial or beginning meaning. To describe this process another way, fast mapping occurs when a new word is acquired rapidly (e.g., through minimal exposure) through understandings of linguistic and nonlinguistic contexts as compared to previously learned or emergent schemas (Anderson & Pearson, 1984). A new lexical entry is created for a word to form an initial representation of an object, causing the entry and representation to become linked for the learner (Kucker & Samuelson, 2012).

One of the first studies to investigate fast mapping was conducted by Carey (1978) with three-year-old children. Participants in the study were given a container of green water to which they could add or subtract water and were asked to make it so that there is “tiv” water in the container (production response). Participants in the study added water; six weeks later when hearing the word “tiv” one-fourth of the participants said “more” or “less” indicating some form of representation of this word had been mapped in the limited exposure. Carey and Bartlett (1978) investigated the fast mapping process in learning a new color word “chromium” (olive green). In a pilot study, 14 preschool children were exposed to the word “chromium” when they were given two objects that were olive green or a known color. Participants were asked by their teacher to give them the chromium tray, not the (known color) tray. Behaviorally, this would be described as a listener response (Greer & Ross, 2008) though participants were only exposed to
the target word once as it was delivered in a vocal verbal format. In a second experiment consisting of 20 preschool participants, production and sorting abilities were tested after receiving the same exposure to chromium as in the first study. Results indicated fast mapping occurred and “chromium” was added to the children’s lexicon. Over half the children demonstrated knowledge of the word chromium in novel environments six to ten weeks after exposure. It is important to note that although fast mapping occurred for many of the study’s participants, extended or slow mapping (“full mapping”), i.e., associating chromium with the color olive green, occurred for only two of the 34 participants (Carey & Bartlett, 1978). For many of the participants, exposure to the word “chromium” as associated with an olive color as a listener did not evoke the speaker response of labeling “chromium” when presented with an olive colored object.

Katz, Baker, and Macnamara (1974) demonstrated that fast mapping is joined with representation of context for children to understand how these words or partial words fits within previously learned semantics. Katz et al. (1974) participants heard the novel word “dax” in non-linguistic contexts, such as “this is Dax” or “this is a dax” when given a doll. When tested, participants had mapped a meaning of “Dax” to fit the context in which they were minimally exposed to the contrived word. Children who had heard “this is a dax” used various dolls interchangeably; children who had heard “this is Dax” picked up a specific doll. In this study, children were exposed to “dax” as a listener and were able to respond correctly with previously taught listener responses, however speaker responses and untaught listener responses were not assessed.

Fast mapping has also been demonstrated in spelling repertoires with five-year-old typically developing children (Apel, Wolter, & Masterson, 2006). Apel et al. (2006) investigated
orthographic processing, as defined by translation of sounds to letters, measured by children’s ability to spell and identify spellings of novel words. Through a simulated storybook reading, participants were exposed to twelve non-words. After exposure, they were asked to spell the novel word (speaker response) as well as identify it in a field of three (listener response). Results indicated 13 of the 45 participants correctly spelled, or fast mapped, at least one novel word; 34 participants identified more than four target non-words.

Casenhiser and Goldberg (2005) investigated how children come to learn fast mapping between novel full or partial words and meanings in two studies with 99 native English speaking children. Participants in an experimental group were shown a training film and audio descriptions of the scene were presented with novel words and were tested on the novel words using a forced-choice comprehension test in which two scenes were shown side-by-side, forcing the participants to choose a meaning of the nonsensical words (listener response) to which they were exposed. Results indicated the group that experienced training conditions performed significantly better on identifying meaning of novel words than the control group who watched the videos without sound. Casenhiser and Goldberg (2005) theorized that pairings of novel phrases and meanings are generalized rapidly, an effect that is more pronounced when pairings are conducted with a single verb.

Investigators have also found evidence that fast mapping has occurred with children as young as 24 months old (Horst & Samuelson, 2008). In a series of studies conducted by Horst and Samuelson (2008), forty-eight 24-month-old infants were exposed to novel words through a selection (listener) process described as referent selection. For example, when presented with a field of four known and one novel stimulus participants were asked to give the novel stimulus (e.g., “Can you get the cheem?”) (Horst & Samuelson, 2008, p.138). Results indicated
participants chose the target object more than would be expected by chance (listener response), however speaker responding and untaught listener responding to novel stimuli were not assessed. A similar procedure was conducted by Greer and Du (2015a) in which preschool students were assessed for incidental language learning by exclusion. The study conducted by Greer and Du (2015a) will be described in more detail in subsequent sections.

In the study conducted by Horst and Samuleson (2008), investigators found that, although the 24-month-old children did well on initial pairing of a word and novel object, these pairings were not maintained after a five-minute delay. Kucker and Samuelson (2012) subsequently conducted a series of five experiments to assess whether familiarization of a novel object or novel object names presented before a referent-selection fast mapping procedure would lead to higher rates of recall for initial or fast mapping. Kucker and Samuelson (2012) found that familiarity with a novel object only (not when familiarized with novel words) was functionally related to retaining novel mapping. Similarly, in a series of three experiments conducted by Cahill and Greer (2014), investigators explored the relation between incidental language acquisition and observing responses with actions. When names of items were coupled with actions, participants acquired speaker and listener responses as well as paired actions for novel items. This study will also be described in more detail in later sections.

**Slow mapping.** In the seminal study discussed previously, Carey and Bartlett (1978) tested fast mapping in a pilot study conducted with students in a nursery school. When given a choice of two objects, one for whom the color name was previously learned and one with a novel color (e.g., a blue tray and an olive cup) the students were asked to “bring the chromium tray, not the blue one, the chromium one” (Carey & Bartlett, 1978, p. 271). During initial post-teaching assessments, investigators found that all but one student was able to choose the target tray or cup.
Follow up studies, however, indicated that children were not able to vocally label “chromium” but were able to differentiate the target color from known colors, indicating that although conceptual and lexical domains had been formed the novel word “chromium” had not yet been fully mapped. According to Carey and Bartlett (1978) these results indicate that “lexical acquisition” (p. 274) or incidental language learning can be an efficient process in which partial or “fast” mapping can occur for novel phonemes or labels when given a child’s previous instructional history (Casenhiser & Goldberg, 2005; Kucker et al., 2015). After this initial mapping occurs, however, a further experience is required before learning of a novel phoneme or word can be completed.

Wagner, Dobkins, and Barner (2013) hypothesized that mapping colors and color categories is a gradual slow mapping process in which children acquire initial meanings for color words before forming “adult-like meanings” (p. 308), (e.g., using red to label all objects that fit this category exclusively). In a series of experiments, Wagner et al. (2013) investigated first meanings children assign to color words in both language production and comprehension. In the first experiment, investigators exposed 141 children, mean age of 3.0, to 11 colored paper fish in which each participant labeled the color of each fish until the stimuli set was completed, after which participants were asked to label 11 colors presented in a book and found that the majority of children made systematic errors such as labeling orange as red. In a second experiment, 28 three-year-old children were presented with 11 colored fish and were asked “Give me a (red) fish” or “Can you put a (red) fish in my hand?” Results of the second experiment indicated that 36% of trials resulted in error, greater than the rate predicted by chance (Wagner et al., 2013, p. 315). Investigators concluded that children typically used color words in a “meaningful” and consistent manner, but through broad categories with only beginning adult-like meanings
attributed (Wagner et al., 2013, p. 315). Agreeing with Carey and Bartlett’s (1978) theory that fast mapping is only the beginning of a slow mapping process to acquire full meanings or lexicons, children begin acquisition of color words through broad inductive inferences and acquire adult-like meanings as their categories shrink or become more specific through experiences and time. It should be noted that research in verbal behavior has indicated that speaker and listener repertoires are not necessarily joined until the child is exposed to multiple naming experiences (Greer & Speckman, 2009). The cusp of BiN has not been established, therefore hearing the name of an item does not necessarily indicate a child will be able to respond as a listener to that item. For example, after seeing a strawberry and hearing “this is a strawberry” the child may not be able to correctly respond to “please give me the strawberry” or the child may be able to give the speaker a strawberry, but cannot say the word “strawberry.”

In a 2010 paper describing the history in language development through a cognitive approach, i.e., lexical development, Carey claimed that for extended or slow mapping to occur hypothesis testing over previously learned schematic repertoires must be joined with new features that “articulate the lexicon” (p. 5). In essence, when hearing a novel word or phonetic structure the learner must search through previously learned information to create new meaning, a procedure that can take multiple repetitions beyond the initial hearing or fast mapping process. To represent this point, Carey (2010) discussed learning the meaning of words to express integers. At age two, English-language learners acquire words that express integers, such as “one,” “two,” and “six.” Although toddlers at this age begin to understand “one,” they do not yet assign meaning to other numbers in that they are unable to provide the target number of objects when asked “give me two pennies” (Wynn, 1990, 1992 as cited in Carey, 2010). At the age of two children appear to have the understanding that “one” contrasts with other names of integers
but do not yet have full understanding of integers and associated representations in repertoire. LeCorre and Carey (2007) demonstrated that children begin to understand numerical representations of one through four, after which higher order numbers are acquired at a more rapid rate indicating that fast and extended mapping must occur in understanding “verbal numbers” (Carey, 2010, p. 6).

*Fast and slow mapping summarized.* The term “fast mapping,” as described in Carey and Bartlett (1978) and subsequent studies, refers to initial meanings children assign to novel words or morphographs into a syntactic context to broadly understand the concept of a previously unlearned sound (Carey, 2010). Extended or “slow mapping” occurs when the learner either sorts through learned concepts and rejects or accepts an accompanying hypothesis (a six to eight month process) or creates previously unformed concepts in which they begin to associate novel words with meanings. Carey (2010) described this as “representational discontinuity” (p. 7) in which language acquisition occurs when a newly formed concept surpasses previously learned conceptual representations. To extend the previous example of learning integers, children display fast mapping with an understanding of number word meanings as quantifiers (“one” refers to a single entity and other numerals contrast with one); slow mapping occurs when adult-like meanings begin to be associated with integers, e.g., “four” succeeds “three” and “four” represents four items (one to one correspondence).

Thus far, additional research in fast mapping has demonstrated that children may have the ability to select a novel name after one exposure (Gershkoff-Stowe & Hahn, 2007) and can fast map a word in under three seconds (Halberda, 2003). Graf Estes, Evans, Alibali, and Saffran (2007), found evidence indicating auditory experiences, such as receiving multiple exposures to whole words prior to mapping tasks, can increase retention of fast-mapped words. Further,
Kucker and Samuelson (2012) demonstrated that object use, when paired with novel words, can boost retention of fast-mapped words. Slow mapping, however, appears to be a long, laborious process particularly when compared to fast, initial mapping (Carey, 2010; Swingley, 2010). When slow mapping occurs, children must select out meanings from thousands of words given learned constructs. Kucker et al. (2015) have recently argued that fast and slow mapping should not be differentiated by separate stages but should instead be considered as per the functions of each skill. Fast mapping requires a motivational context in which children must discern what the speaker is referring to within the moment (behaving in situation time); slow mapping includes learning in developmental time in which knowledge is accrued through encoding experiences. This is described by Kucker et al. (2015) as hearing the word *cup* when presented with a cup and shoe on a table. References are drawn between the spoken word “cup” with the items cup, shoe, and table. As the child continues to hear *cup* when presented with the corresponding object a stronger reference is drawn between the object and name, thus adding *cup* to the learner’s experiences (Kucker et al., 2015, p. 4).

**Exploring mapping literature through a behavioral perspective.** It is important to note that the majority of investigations on fast and slow mapping have occurred in experimental conditions to investigate antecedent knowledge children gain in different developmental stages (Swingley, 2010). Although applied research certainly exists in the area of mapping and lexical development, studies do not typically demonstrate the effect of mapping on incidental language acquisition outside of the experimental setting. The utility and validity of the findings that do currently exist can be limited due to the inherent nature of these theories as untestable psychological constructs. According to Swingley (2010), however, the seminal Carey and Bartlett (1978) study on fast mapping was vital in understanding language development. Carey
and Bartlett (1978) demonstrated young children were able to “create a new lexical entry” (p. 180) from minimal word exposure and maintain this in memory over at least a few days. Further, exposure to a novel word in a given context (i.e., being asked to give a “chromium tray” when given the choice of an unlearned and learned color object in the same field) can lead to changes in current concepts.

While not discussed within mapping literature itself as speaker or listener responses (Greer & Speckman, 2009; Greer & Ross, 2008), I will examine the referenced studies through a behavioral lens. As briefly discussed earlier, research has indicated that speaker and listener responses do not become joined within the skin until the learner is exposed to naming experiences across speaker and listener topographies (Greer & Speckman, 2009). Before the cusp of bidirectional naming is present (Miguel, 2016) exposure to stimuli as a listener does not necessarily indicate speaker responses will be present. In Carey (1978), children were asked to pour “tiv” water into the container; in Carey and Bartlett (1978) participants were asked to give the investigator the “chromium” object. Both seminal studies deliver the target contrived word as a speaker while requesting a listener response. Katz et al. (1974) presented children with a doll along with the vocal verbal antecedent of “this is a dax” or “This is Dax,” followed by an assessment in children’s use of “dax.” Participant responses were coded as to whether they used the doll interchangeably or used a specific doll, arguably a listener response. Gershkoff and Hahn (2007) and Halberda (2003) asked participants to choose or map a word using referent selection after hearing the word one time (listener responses). Additionally, Casenhiser and Goldberg (2005) requested participants choose a meaning for novel words through a forced-choice comprehension task (listener response). Although Graf Estes et al. (2007) paired an auditory experience with novel words, the responses emitted by participants in the study can be
classified as listener responses as children were asked to engage in referent selection. Horst and Samuelson (2008) and Kucker and Samuelson (2015) also implemented a referent selection process after exposing participants to the name of the stimuli through spoken words or sounds delivered by buttons.

While Apel et al. (2006) and Wagner et al. (2013) also employed referent or forced choice selections in their experiments, both of these experiments also tested for speaker responses in addition to listener responses. Specifically, Apel et al. (2006) asked participants to choose the correct spelling of novel words in a field of three as well as spell the novel words they had just learned, or mapped. In one condition, Wagner et al. (2013) had participants “give” or “show” the experimenters targeted colors (e.g., “give me the orange fish”). In the second condition, participants were asked to label colors in a book. See Table 1 for a summary of these findings.
<table>
<thead>
<tr>
<th>Study</th>
<th>Naming experiences</th>
<th>Test for listener response</th>
<th>Test for speaker response</th>
</tr>
</thead>
<tbody>
<tr>
<td>Katz et al. (1974): presented children with a doll and stated “this is Dax” or “this is a dax”</td>
<td>Listener</td>
<td>Assessed whether children used specific doll or used all dolls interchangeably</td>
<td>None</td>
</tr>
<tr>
<td>Carey (1978): children were asked to pour “tiv” into a container</td>
<td>Listener</td>
<td>None</td>
<td>None</td>
</tr>
<tr>
<td>Carey &amp; Bartlett (1978): participants were asked to give experimenters the “chromium” object when unknown color was paired with known color</td>
<td>Listener</td>
<td>1-week follow-up: identify the chromium object</td>
<td>6-week follow up: Asked participants to identify the color of the object</td>
</tr>
<tr>
<td>Apel et al. (2006): participants were exposed to novel words paired with pictures four times within the context of listening to a story</td>
<td>Listener</td>
<td>Participants were asked to identify the novel word in a field of three</td>
<td>Participants were asked for the novel word when given the picture</td>
</tr>
<tr>
<td>Horst &amp; Samuleson (2008): presented participants with novel objects paired with novel names</td>
<td>Listener</td>
<td>Asked participants to choose the object when given the novel name</td>
<td>None</td>
</tr>
<tr>
<td>Wagner et al. (2013): presented preschool participants with stimuli of different colors</td>
<td>None</td>
<td>Asked participants to give the experimenter a specific color</td>
<td>Asked participants to label colors in a book (e.g., “give me the red fish”)</td>
</tr>
<tr>
<td>Kucker &amp; Samuelson (2015): presented participants with novel objects paired with novel names; habituated</td>
<td>Listener</td>
<td>Asked participants to choose the object when given the novel name</td>
<td>None</td>
</tr>
</tbody>
</table>
participants to novel names
and objects before testing
Many of these studies do not differentiate between listener and speaker responding which are typically not inherently joined for children diagnosed with developmental disabilities or for typically-developing children under the age of three. For these children, derived relations, or incidental language acquisition, may not be evoked through the procedures described in mapping literature. The following sections will review behavior analytic approaches to language in depth and how incidental language acquisition may occur with children for whom joint attention is not yet in repertoire.

**Behavior Analytic Approach**

**Verbal behavior.** Skinner (1957) outlined a behavioral approach to language, verbal behavior, in which a speaker mediates the environment by affecting the behavior of the listener. This is a crucial step in language development. For example, a child is able to say “cold,” affecting the behavior of his mother who closes the window. Complex learning and independence become possible when a child is able to act as a speaker and listener within the same skin (Skinner, 1957). A child can engage in covert behavior by thinking “I am cold” and responding to this verbal stimulus by closing the window himself. In this example, the child does not depend on his mother and is able to act independently to mediate his environment.

Skinner (1957) sought to interpret a complex type of human behavior mediated by others and identified six verbal operants: *autoclitic, mand, tact, intraverbal, echoic, textual response*. According to Skinner (1957), the *mand* occurs in response to a state of deprivation for a preferred item, which creates an establishing operation or motivating condition (Laraway, Snycerski, Michael & Poling, 2003) for that item and specifies its reinforcer. A *tact* allows the speaker to come into contact with the environment and occurs in a state of deprivation for generalized social reinforcement. The child will name the item in the environment to evoke
attention or confirmation from the listener, which current research suggests mediates tacting behavior (Eby & Greer, 2017; Schmelzkopf, Greer, Singer-Dudek, & Du, 2017). Social reinforcement for the tact plays a vital role in development of verbal social behavior, or acting as a speaker and listener with others (Eby & Greer, 2017; Schmelzkopf et al., 2017).

The *echoic* (Skinner, 1957) is a vocal verbal response and type of emulation that has correspondence with a vocal discriminative stimulus. The echoic is extremely important in that the speaker is making a vocal verbal attempt to come into contact with her environment and derive reinforcement from the listener; the beginning to becoming truly verbal (Greer & Ross, 2008). An *intraverbal* response is one that is elicited by a verbal antecedent that differs in topography from the response (Skinner, 1957). For example, the antecedent “7…8…9…” may evoke the response “10” from the listener.

The *autoclitic* serves to modify the mand or tact such that it quantifies, specifies, or qualifies the mand or tact (Skinner, 1957) through adjectives, adverbs, suffixes, tone of voice, etc., e.g., a child stating “I want the Oreo cookie, please” affecting the behavior of the listener by handing the child an Oreo cookie instead of chocolate chip. Lastly, textual responding occurs when a printed stimulus elicits a vocal verbal response (Skinner, 1957). These verbal operants are the basis for building complex verbal repertoires. Skinner’s (1957) conceptual theory of language development was subsequently adapted by behavior analysts as a basis for identifying verbal operants missing in children with autism, leading to research-based theories of verbal behavior development.

*Stimulus equivalence (SE).* SE, as proposed by Sidman (1971) is a theory of language that seeks to explain how derived relations, i.e., the nature of equivalence among stimulus-stimulus relations, develop with individuals diagnosed with developmental disabilities. In a
pivotal experiment conducted by Sidman (1971), a male participant with mental retardation was taught a stimulus relation between A1 and B1 (matching spoken words to print). A probe was then conducted to test for matching print to pictures, as well as for reading printed words. Results indicated equivalence emerged as a function of teaching matching spoken words to print, which was deemed reading comprehension. Subsequent experiments conducted (e.g., Sidman & Tailby, 1982) further tested for similar relations between stimuli. For example, participants were taught a stimulus relation between A1 and B1, then taught a relation between B1 and C1. A relation was derived, according to probe sessions, between A1 and C1.

The major properties of SE are as follows: reflexivity, symmetry, and transivity. Reflexivity or A=A occurs when a stimulus is matched with an identical stimulus (e.g., matching a picture of a car to an identical picture of a car). Symmetry (A=B, then B=A) occurs when a relation is derived (match to sample) between the printed word for car and a picture of a car. When one response form is taught (pointing to the word car) it evokes an untrained relation (matching word to picture of a car). Transivity (A=B and B=C, then A=C) occurs when stimulus A is taught as a relation to stimulus B; stimulus B is trained as a relation to stimulus C and an untaught relation between stimulus A and stimulus C emerges. To expand upon our example, an individual is taught that the printed word for car is related to a picture of a car, then said individual is taught that the picture of a car is related to the spoken word “car.” Transivity is said to have occurred if the untaught or derived relation, in this case the printed word for car to the spoken word “car,” is evoked.

**Relational Frame Theory (RFT).** RFT, as proposed by Barnes-Holmes et al. (2001), Hayes (1991), and Hayes (1994), builds upon the theory of SE in the acquisition of language and derived relations and expands upon Skinner’s theory of verbal behavior (1957). According to
RFT, relational frames develop due to a history of relational responding to contextual cues; that is, acquisition of higher order verbal operants is evoked as a function of derived relations that occur in various contexts after other relations are trained. A frame is defined as having two components that are equivalent to each other, which is bi-directionality. Bi-directionality is present when both components of the frame do not need to be explicitly taught. For example, when one asks: “What is a vehicle that has two wheels?” and the response is “a motorcycle,” “vehicle” and “two wheels” are equivalent. Hayes’ (1994) theory directly contributes to current Naming theories (Greer & Longano, 2010; Horne & Lowe, 1996) in that untaught relations and higher order verbal repertoires (i.e., untrained listener and speaker responses) are derived from acquisition of a single trained relation (i.e., tact training or match-to-sample repertoires).

**Naming theory.** As proposed by Horne and Lowe (1996), Naming is a bidirectional relation between speaker and listener repertoires in which language is learned incidentally. For example, after hearing the tact for “shoe” while seeing a picture of a shoe the child can then get a shoe when requested (listener response) as well as say “That’s a shoe!” when shown the actual object without direct instruction. While RFT, Naming Theory, and Stimulus Equivalence theories have suggested the importance of the listener and related observing responses, potential experiential sources for emergent behavior were needed. RFT (Barnes-Holmes, et al., 2001) was among the first to theorize that Naming can be induced through multiple exemplar instruction (MEI), however this was first demonstrated in a series of studies conducted through the CABAS® research laboratory from Teachers College, Columbia University (Greer & Longano, 2010). This will be explored in depth in subsequent sections.

In addition, Greer and Speckman (2009) identified Naming as a behavioral developmental cusp (Rosales-Ruiz & Baer, 1997) that is a capability, meaning that individuals who develop...
Naming repertoires reliably learn the names of things from a single experience. As defined by Rosales-Ruiz and Baer (1997), a cusp is the acquisition of a skill or milestone that is difficult or tedious to accomplish, but when induced allows the organism to come into contact with contingencies with which he or she was previously unable. In addition, it enables the organism to come into contact with other cusps to further development (Rosales-Ruiz & Baer, 1997). Because Naming allows a child to learn in new ways as well as come into contact with higher order verbal behavioral repertoires, it becomes a cusp that is also a capability (Greer & Speckman, 2009). As discussed previously, the term BiN will be used to described Naming as a bidirectional relation that is evoked from a singular naming experience. When BiN is in repertoire we have a “language explosion” (Greer & Longano, 2010; Crystal, 2006; Hart & Risley, 1995), as discussed previously, and children are able to learn at a higher rate (Greer & Speckman, 2009).

**Verbal Behavior Development Theory (VBDT).** Skinner’s (1957) text allowed behavior analysts to operationalize complex cognitive repertoires and paved the way for a research program to investigate verbal behavior development with children for whom language is more difficult to achieve, particularly children with autism (Greer & Keohane, 2005; Keohane & Greer, 2005). To be considered truly verbal, the speaker must also simultaneously behave as a listener (Barnes-Holmes, Barnes-Holmes, & Cullinan, 2001; Greer & Ross, 2008; Horne & Lowe, 1996) which may need to be taught for individuals with autism. **Verbal behavior development** refers to children’s experientially acquired or learned capabilities. This development enables children, particularly children with autism, to learn higher order operants and be taught new relations, therefore allowing students to learn multiple responses and multiple
stimulus control after one experience, learn at a faster pace, and learn in ways they could not prior to acquisition (Greer, 2008; Greer & Speckman, 2009).

Greer and Ross (2008) and Greer and Keohane (2005) identified preverbal foundational developmental cusps, speaker and listener cusps, and verbal capabilities or stages along with protocols to induce them. Much of this research takes place in Comprehensive Application of Behavior Analysis to Schooling® or CABAS® schools (Greer, 2002; Greer, Keohane & Healy, 2002) in which teaching is implemented through behavior analytic methodologies. See Greer (2002), Singer-Dudek, Speckman, and Nuzzolo (2010) and Twyman (1998) for extensive analysis of CABAS® as a systematic and scientific approach to teaching.

Speaker-as-own-listener cusps are at the heart of anecdotal linguistic evidence regarding what scholars believe is unique about language functions (Barnes-Holmes et al., 2001; Crystal, 2006; Greer & Ross, 2008; Hayes, Barnes-Holmes, & Roche, 2001; Hayes & Hayes, 1989; Horne & Lowe, 1996). An individual becomes verbal when the listener and speaker responses are joined within the same skin, allowing for higher order verbal behavior developmental repertoires to be achieved.

Verbal milestones are defined by cusps and capabilities necessary to achieve these repertoires (Greer & Speckman, 2009). Pre-listener and listener cusps are vital in the development of higher order language skills. Thus far, literature has identified the following pre-listener cusps including sit still, eye contact, respond to name, generalized motor imitation; conditioned reinforcement for voices and faces (Decasper & Spence, 1987; Greer, Pistoljovic, Cahill & Du, 2011; Keohane et al., 2009; Maffei et al., 2014); match-to-sample (Greer & Ross, 2008); conditioned reinforcement for observing responses to 2D stimuli (Greer & Han, 2015; Keohane et al., 2008; Pereira-Delgado et al., 2009), and conditioned reinforcement for observing
responses to 3D stimuli (Du, Broto, & Greer, 2015; Keohane et al., 2008; Speckman-Collins, Longano, & Syed, 2017).

Listener cusps include basic listener literacy (Goswami, 2014, Greer, Chavez-Brown, Nirgudkar, Stolfi, & Rivera-Vales, 2005) in which the child is able to fluently and discriminatively respond to speech or spoken phonemes presented without visual cues (Greer & Ross, 2008) typically taught through a listener emersion protocol (Goswami, 2014; Greer et al., 2005; Greer & Ross, 2008) and auditory matching (Chavez-Brown, 2005; Choi et al., 2015; Greer & Ross, 2008), a skill that allows the child to discriminate between matching and non-matching sounds. Choi et al. (2015) probed responses to a vocal antecedent with visual distractor prior to implementation of the auditory matching protocol (Chavez-Brown, 2005; Greer & Ross, 2008). Before auditory matching, students overwhelmingly attended to a visual distractor. Following intensive auditory discrimination training the vocal directions selected out participants’ observing responses, indicating that establishing a history of reinforcement experiences for an auditory response increases the likelihood an individual will respond to an auditory stimulus.

Another listener cusp includes the listener component of naming (Greer, Stolfi, Chavez-Brown & Rivera-Valdes, 2005), or what I propose to describe as unidirectional naming, in which children are able to hear the name, label, or tact of a stimulus and respond to stimulus as a listener. It is important to note that while a learner may demonstrate unidirectional naming (i.e., can acquire the listener component of naming before acquiring the speaker repertoires), BiN may not be demonstrated. Unidirectional naming must typically be present before BiN (joining of listener and speaker) is achieved.
Generalized Imitation (GI), or the ability to imitate novel actions (e.g., “true imitation”), is considered a cusp that is a capability (Du & Greer, 2014) that can emerge as a function of implementation of the mirror protocol (Du & Greer, 2014; Moreno, 2012). Induction of GI as a capability allows the child to learn in ways through which he was previously unable (see-do correspondence). In a series experiments, Du and Greer (2014) and Moreno (2012) found that GI can be established using a mirror to teach correspondence between seeing and duplicating as a conditioned reinforcer.

In studying the development of speaker-as-own listener cusps, Lodhi and Greer (1989), found that young children engaged in self-talk when playing alone with three-dimensional toys that had anthropomorphic characteristics. This development makes complex verbal behavior possible (Greer, 2008; Greer & Keohane, 2005; Greer & Ross, 2008; Greer & Speckman, 2009; Keohane & Greer, 2005; Lodhi & Greer, 1989). Before the development of self-talk repertoires, however, echoic repertoires such as echoic-to-mand and echoic-to-tact (Tsiouri & Greer, 2003, 2007) and independent mand and tact repertoires are typically established (Pistoljevic & Greer, 2006; Greer & Ross, 2008; Schauffler & Greer, 2006) after vocalizations and parroting emerge (Yoon & Bennett, 2000). Speaker-as-own listener repertoires then allow the organism to engage in say-do correspondence (Farell, 2017; Greer & Ross, 2008), engage in conversational units (Donley & Greer, 1993) and act as a listener and speaker within the same skin. Once this has emerged, children are subsequently able to acquire BiN (Fiorile & Greer, 2006; Greer & Du, 2014; Greer et al., 2005) and observational learning (Greer, Singer-Dudek, & Gautreaux, 2006; Reilly-Lawson & Walsh, 2007) as cusps that are capabilities.

BiN, or full naming, is the bidirectional relation that allows the child to learn language incidentally as a speaker and listener without direct instruction (Greer & Longano, 2010; Horne
& Lowe, 1996; Longano & Greer, 2015). It allows for a generative verbal repertoire that has been called a “higher order class” (Catania, 2013) and has been described through RFT (Hayes et al., 2001) as a transfer of stimulus control. A particular response to a single stimulus or category of stimuli when learned either as a listener or speaker is immediately available to the individual in other response topographies without direct instruction once the individual has acquired transfer of stimulus control across speaker and listener behaviors. Greer and Keohane (2005) suggest that presence of incidental multiple exemplar (MEI) experiences provide the type of naming experience for most typically-developing children to acquire verbal milestones because they have both the environmental experiences and neural capabilities. Naming (BiN) will also be explored in greater detail later in this paper.

Observational learning (OL) is defined as and consists of acquisition of new operants or higher order operants as a function of indirect contact or observation of contingencies of reinforcement and correction received by others (Neu, 2013). Greer et al. (2006) identified five types of OL including changes in performance, acquisition of new repertoires, acquisition of conditioned reinforcers through observation, acquisition of higher order operants, and acquisition of observational learning per se (OL repertoires) (e.g., individual can now learn through observation; pre-baseline data indicate that he or she could not). Induction of the OL capability has been demonstrated through use of yoked contingencies (Davies-Lackey, 2005; Stolfi, 2005), peer monitoring (Gautreaux, 2005; Pereira Delgado, & Greer, 2009), peer tutoring (Greer, Keohane, Meincke, Gautreaux, Pereira, Chavez-Brown, & Yuan, 2004), and through conditioned reinforcement for observing (Schmelzkopf et al., 2017; Singer-Dudek, Greer, & Schmelzkopf, 2008; Singer-Dudek, Oblak, & Greer, 2011; Zrinzo & Greer, 2013).
When listener and speaker repertoires are joined within the skin, other higher order verbal behavior cusps can be induced such as conditioned reinforcement for observing books (Buttigieg, 2015; Singer-Dudek et al., 2011; Tsai & Greer, 2006), textual responding (Buttigieg, 2015; Tsai & Greer, 2006), acquisition of joint stimulus control across writing and speaking (Greer, Yuan, & Gautreaux, 2005), and writing to affect emotions of reader (Greer & Ross, 2008; Madho, 1997). The ability to engage in verbal mediation allows the individual to engage in transformation of verbally governed and verbally governing written and spoken functions in regards to problem solving (Greer & Ross, 2008), therefore enabling full independence.

VBDT research has confirmed the importance of the listener (Greer et al., 2005) and the importance of joining the listener and speaker (Greer, Corwin & Buttieig, 2011; Greer & Longano, 2010). The essential aspect of verbal behavior is that it is behavior involving interactions between the speakers and listeners, i.e., engagement in verbal episodes (Skinner, 1957) that encompass speaker and listener exchanges within one’s own skin. As reviewed earlier, speaker-as-own-listener (Lodhi & Greer, 1989) is critical to becoming truly verbal (Horne & Lowe, 1996).

Verbal episodes between individuals have been categorized as incidences of, and measures of, social behavior between individuals (Schmelzkopf et al., 2017). Continuation of conversational units between individuals is a critical measure of social reinforcement and socialization as each individual is reinforced as a speaker. Greer and Du (2015b) argued that verbal behavior is truly a social behavior, requiring study of interlocking verbal operants between individuals. Verbal behavior scientists have heretofore focused on development of instructional histories (ontogeny) that lead to acquisition of verbal milestones or cusps as well as importance of reinforcement learning or conditioning histories (e.g., history of conditioned...
reinforcement) (Greer & Speckman, 2009). Greer and Du (2015b), however, expanded on the synopsis provided by Greer and Speckman (2009) by providing the first in-depth analysis of its importance in verbal development and social behavior.

*Emergence of cusps as a function of conditioned reinforcement.* Cusps, such as observational learning (OL) appear to emerge as the result of the onset of newly learned reinforcers (Greer & Du, 2015b). Several studies have identified a number of cusps that emerge as a function of conditioning new reinforcers for observing responses (i.e. conditioned reinforcers), such as conditioned reinforcement for observation of 2D print stimuli (Greer & Han, 2015). In this study, investigators identified children with autism who could not match identical and abstract (non-identical) numbers, letters, shapes, or pictures, after which observing responses to print stimuli were established. Following this protocol, participants matched 77 untaught visual items and rate of learning increased. Other cusps that emerged as a function of conditioned reinforcement include conditioned reinforcement for 3D stimuli (Du et al., 2015; Speckman et al., 2017), conditioned reinforcement for voices (Choi et al., 2015; Greer, Pistoljevic et al., 2011), and conditioned reinforcement for faces (Maffei-Lewis et al., 2014). These cusps make awareness of others possible, establishing learned reinforcement of see-do correspondence allowing the GI capability to be possible (Du & Greer, 2014). Another cusp that has emerged as a function of conditioned reinforcement includes conditioned reinforcement for observing responses to books by conditioning textual stimuli (Buttigieg, 2015, Tsai & Greer, 2006).

Longano and Greer (2015) stated that conditioned reinforcement for visual and auditory stimuli may be necessary fundamental components for the effectiveness of procedures that are used to induce naming across speaker and listener responses, a capability that allows children to
learn language incidentally as well as from demonstrations (Corwin & Greer, in press; Greer, Corwin, et al., 2011) including children with autism or from impoverished backgrounds. BiN emerges as a function of learned reinforcement for observing a stimulus resulting in attention and simultaneously the speech sounds reinforce attention to the spoken word. Intensive tact instruction (Pistoljevic & Greer, 2006; Schauffler & Greer, 2006) is tied to conditioning social attention as reinforcers for extended social verbal episodes (conversational units) and can result in significant increases in spontaneous speech.

Research suggests that some social reinforcers can be socially learned and the cusps for doing so may have been identified (Greer et al., 2008). Attention and approval is a conditioned reinforcer and is often missing in young children who are environmentally handicapped. Greer et al., (2008) found that children for whom praise and attention did not function as a reinforcer acquired conditioned reinforcement for approval as a function of an observational learning procedure. In another experiment, Schmelzkopf et al. (2017) found that conditioning praise as a reinforcer using the same observational learning procedure resulted in significant increases in initiated tacts and conversational units with preschool students diagnosed with language delays. Cumiskey Moore (2017) found that establishing reading as a reinforcer through peer-yoked contingencies also led to increase in reading comprehension repertoires. Indeed, it appears the sources of many verbal behavior developmental cusps consist of the induction, onset, and emergence of newly conditioned reinforcement, particularly social reinforcement (Greer & Du, 2015b). Social reinforcers must be conditioned for children with autism as they are vital in the development of verbal behavior; research indicates this appears to be socially learned (Greer et al, 2006).
Importance of identification and establishment of conditioned reinforcement in VBDT.

Greer and Du (2015b) discussed the importance of the establishment of conditioned reinforcers, particularly conditioned social reinforcers, as the source of many communicative functions. Children with autism may not come into contact with these reinforcers without direct instruction. Behavior analytic research thus far has made strong contributions to the identification of experiences that establish verbal behavior developmental milestones and how to establish milestones. This research shows the ontogenetic sources of language development and has identified the relation between certain verbal milestones or cusps and how children need to be taught differentially based on specific developmental cusps.

Recent literature suggests the acquisition of conditioned reinforcement for observing speech, faces, and two-dimensional and three-dimensional stimuli is the initial cusp in acquisition of observing responses and therefore subsequent higher-order learning, including BiN (Keohane, Luke, & Greer, 2008; Greer & Du, 2015b; Longano & Greer, 2015). A conditioned reinforcer is defined as any stimulus that is paired with a conditioned or unconditioned reinforcer until the stimulus becomes reinforcing to the individual (Oblak, Greer, & Singer-Dudek, 2015) or acquires reinforcing properties. Research has identified that conditioned reinforcement can also be acquired through observation (Greer, Singer-Dudek, Longano & Zrinzo, 2008; Oblak et al., 2015); conditioned reinforcement and early observing responses are necessary for achieving pre-verbal foundational cusps. While pre-listener repertoires are not verbal repertoires, they are the foundation for acquisition of verbal cusps and capabilities (Lo, 2016) such as BiN.

Bidirectional Naming (BiN)

Horne and Lowe (1996) identified naming as a basic unit of verbal behavior. Through learning listener behavior and then echoic responding, the individual learns bidirectional
relations between classes of objects or events and his or her own speaker-listener behavior thus acquiring *naming* (a higher order behavioral relation). Once established, the bi-directionality incorporated in naming extends across behavior classes such as those defined by Skinner (1957). Because naming is evoked by, and itself evokes, *classes* of events it brings about new or *emergent* behaviors such as those reported in stimulus equivalence studies (Sidman, 1971).

Greer and Longano (2010) stated that naming appears to be the source of the explosion in language development for children with and without disabilities. It involves integration of initially separate listener and speaker responses (Greer & Longano, 2010, p. 77) and has a role in development of reading, writing, and the following and construction of verbal algorithms leading to complex human behavior. BiN is a particular higher order verbal operant that is an important milestone in language development (Greer & Ross, 2008; Horne & Lowe, 1996) in that, after hearing the tact for an object, the child can respond to a stimulus as a speaker and listener without direct instruction. This idea of naming expanded on Skinner’s (1957) concept of speaker-as-own-listener by emphasizing the *speaker-listener relation* (Horne & Lowe, 1996). As we have discussed previously, sources suggest that naming is the beginning of being truly verbal and speaker-as-own-listener is key to advancement of verbal behavior. Miguel (2016) discussed the importance of naming as related to the verbal behavior development theory and suggested this speaker-listener relation (Horne & Lowe, 1996) is bidirectional naming (BiN). The presence of only one component of naming, listener responding, may be described as unidirectional naming.

While Greer and Longano (2010) expand on the VBDT (Greer & Ross, 2008; Greer & Speckman, 2009) they emphasize that BiN appears to be *a or the* crucial stage in verbal development, allowing children to learn language incidentally, therefore causing it to be a
capability or the foundation to more advanced verbal development for children with language delays. A child with BiN can acquire verbal behavior as a result of certain encounters with environment or naming experiences (Greer & Longano, 2010), which occur when a child and caregiver are simultaneously looking at, or sensing, a stimulus (e.g., *joint attention*) (Crystal, 2006). Although this may happen naturally for typically developing individuals, there may be phylogenetic and/or ontogenetic variables that hinder this phenomenon in children with disabilities.

**Procedures to Establish BiN**

*Multiple Exemplar Instruction (MEI).* Multiple exemplar instruction (MEI), as heretofore discussed in this paper, consists of presenting a set of teaching stimuli in a counterbalanced rotated fashion across listener (match, point) and speaker (tact, intraverbal) response topographies, until 20 learn units (Albers & Greer, 1991) have been completed across each topography. During MEI with a teaching set, corrections or reinforcement are delivered as consequences.

The first study to demonstrate the emergence of BiN as a function of a particular instructional history was conducted by Greer, Stolfi, Chavez-Brown, and Rivera-Valdes (2005). Greer, Stolfi et al. (2005) implemented MEI with preschool students diagnosed with developmental disabilities in a time-lagged multiple probe design. Before MEI, participants were initially asked to match a target set of five stimuli containing four exemplars per target. Throughout the match instruction an auditory stimulus (hearing the name of the target stimuli) were presented with the visual stimulus), which continued until criteria of 90% correct responding across two consecutive twenty learn-unit sessions was achieved. After a delay, probe trials were conducted for point-to, tact, and listener responses. Baseline data indicated that two
of the three participants demonstrated unidirectional naming. BiN was not present during initial probes for any participants, however untaught correct responses to probe trials emerged after mastery of MEI with a teaching set of stimuli. Untaught speaker responses emerged at 60% to 85% for two participants and 40-70% for one participant. It is interesting to note that criteria for subsequent BiN research across untaught speaker and listener responses are frequently set at 80% of correct responding across each response topography, however it should also be noted that designation of criteria for mastery is an arbitrary differential set by investigators. Therefore, criterion per response topography may differ per study.

A later study conducted by Greer, Stolfi, and Pistoljevic (2007) compared Single Exemplar Instruction (SEI) with MEI using an experimental and control group design with nested multiple probes. The majority of participants in this study were diagnosed with language and/or cognitive delays. SEI consisted of presenting stimuli in 20 learn unit blocked massed trials across separate response topographies, beginning with listener responses; MEI instruction rotated response topographies across listener and speaker responding. Results indicated MEI only was successful in the emergence of BiN, indicating an experience of one response type at a time without rotation does not equate to experiences in other responses. The success of MEI in the induction of BiN has been demonstrated in a number of studies, including Fiorile and Greer (2007); Gilic and Greer (2011), Greer, Corwin et al. (2011); Helou-Care (2008), Pistoljevic (2008), and Tullo Woolslayer (2013).

**Intensive Tact Instruction (ITI).** Intensive tact instruction (ITI) involves increasing tact instruction by providing an additional 100 instructional tact learn units in addition to learning experienced during a regular school day (Greer & Du, 2010; Pistoljevic & Greer, 2006; Shaufler & Greer, 2006) as pure tact and intraverbal instruction (Greer & Ross, 2008). Research indicates
it has been successful in increasing spontaneous vocal verbal utterances with participants diagnosed with developmental disabilities (Pereira-Delgado & Oblak, 2007; Pistoljevic & Greer, 2006; Shauffler & Greer, 2006)

Pistoljevic (2008) investigated ITI on the emergence of BiN with preschool students diagnosed with developmental disabilities and found that BiN emerged after ITI was implemented. Pistoljevic (2008) proposed various theories that led to the emergence of BiN as a function of ITI. It is possible that participants were coming under the control of generalized reinforcement and were learning to emit tacts to recruit generalized attention. A child receives listener naming experiences in which he is asked to attend to stimuli (i.e., “pick up a toy”) and reinforcement is delivered contingent upon this response, evoking transformation of stimulus control across speaker and listener responses. Horne and Lowe (1996) also stated that BiN can develop naturally after multiple opportunities to observe caregivers naming items. Finally, the echoic could be the source of reinforcement for the emergence of BiN (Cao, 2016; Lowenkron, 1996).

**Auditory matching.** The auditory matching protocol involves matching like and unlike sounds and words to teach discrimination (Choi, Greer & Keohane, 2015). Choi et al. (2015) assessed whether the auditory matching protocol evoked BiN with participants diagnosed with autism and found that full BiN emerged for three of seven participants, while increases in untaught response topographies increased for four. Speckman-Collins, Park, and Greer (2007) demonstrated that the listener half of BiN emerged as a function of auditory matching with preschool students diagnosed with developmental delays. Data from this study suggested that mastery of the auditory matching procedure may precede the onset of BiN as the protocol appeared to condition and therefore select out observing responses to verbal occurrences in the
environment as a reinforcer. Findings from Choi et al. (2015) and Speckman-Collins et al. (2007) suggest that the auditory matching procedure may indirectly condition voices as a reinforcer which in turn may cause the echoic to become a conditioned reinforcer, a possible source of reinforcement for BiN (Longano, 2008).

**Emergent BiN Repertoires as Investigated through Recent Literature**

*Incidental learning language capability (ILLC)*. Incidental learning language capability (ILLC) (Cahill & Greer, 2014) occurs when an individual simply hears a word or phrase while observing an object in any of the senses and can then produce the word or phrase as a speaker or respond as a listener for the object at a later time without instruction (Greer & Ross, 2008). Cahill and Greer (2014) investigated the relation between observing responses and incidental language acquisition by children aged three to five years with and without developmental disabilities through three experiments. In Experiment 1 children heard name of object while observing an accompanying action. Results indicated participants acquired novel object use but learned few names. Experiment II compared responses to stimuli presented with and without actions with results indicating presence of an action hindered rather than facilitated incidental acquisition of names. In Experiment III participants were selected who acquired listener responses when actions were present but did not readily acquire speaker responses. Following MEI, participants acquired both speaker and listener responses along with action responses for novel stimuli. Based off of these findings, Cahill and Greer (2014) concluded that when children are provided with specific instructional history they can acquire multiple benefits from a single language exposure experience.

*Naming by Exclusion (NE)*. Naming by exclusion (NE) is an extension of BiN as a behavioral developmental cusp and capability that makes it possible for children to learn the
names of things incidentally. When children have NE in repertoire they learn word-object relations from hearing a word for an unknown stimulus when they know the names of all items in view except one. Greer and Du (2015a) tested for NE with typically developing children as well as children with autism through two experiments utilizing a nonconcurrent multiple probe design, in which participants were exposed to the intervention in a delayed manner. Sixteen participants who did not demonstrate NE were randomly assigned to two groups. The experimental group received EMEI and the school curriculum while the control received school curriculum alone. All participants in the experimental group were exposed to a pre-intervention probe with Set 0 simultaneously. A second pre-intervention probe was conducted for the first participant in the experimental group, after which he was exposed to EMEI (exclusion multiple exemplar training). After the first participant met criterion on the first EMEI intervention set, a post-probe was conducted with the Set 0 probe stimuli set while the next participant experienced a second pre-intervention probe. This continued until all participants in the EMEI experimental group received the intervention. The EMEI group experienced a teaching set in which had 5 unknown stimuli given contrived names were presented with known stimuli along with a vocal verbal antecedent, such as “Give me the bave.” Results indicated that eight of eight participants who received EMEI training acquired NE; it emerged for only one participant in the control group.

**Emergence of BiN as a function of multiple experiences.** In a series of three experiments, Lo (2016) tested for the BiN capability with preschoolers diagnosed with a disability after the presentation of BiN experiences with an additional sensory experience. Results of the first experiment indicated the presence of BiNBiN following exposure to visual stimuli presented with the spoken word and an additional auditory stimulus, which was paired with the
corresponding spoken word through a stimulus-stimulus pairing procedure. In the second experiment, Lo (2016) tested for establishment of conditioned reinforcement as a function of repeated probe sessions on the emergence of nBiN with non-contrived and contrived stimuli and found that correct BiN responses increased during post-intervention probe sessions though only one participant acquired BiN. In her final experiment, Lo (2016) conducted repeated probe sessions with only contrived stimuli which were paired with an additional sensory experience, such as was implemented in Experiments I and II. Results indicated an increase across targeted response topographies (listener and speaker components of BiN across contrived stimuli) with all participants.

Frias (2017) investigated the emergence of BiN across auditory, tactile and olfactory stimuli with preschool students with and without diagnoses of autism who demonstrated the BiN capability across speaker and listener responses with visual stimuli. In Experiment I, Frias (2017) implemented a stimulus-stimulus pairing procedure during which a visual, auditory, tactile, or olfactory stimulus was presented with the names of the stimuli in a set of 20 BiN experiences. Results of this demonstration study indicated BiN in at least one other modality (e.g., auditory, tactile, or olfactory) emerged after two stimulus-stimulus pairing sessions for five of the six participants. In Experiment II, Frias (2017) implemented a delayed repeated probe design across three dyads using the stimulus-stimulus pairing procedure across the different modalities. Results indicated that for some modalities, correct responses decreased over time demonstrating that certain stimuli may have become a conditioned punisher, therefore affecting acquisition of target speaker responses. For four participants, however, BiN emerged across different modalities in post-intervention probes indicating these stimuli now functioned as a conditioned reinforcer for observation.
Source of Reinforcement BiN

**Conditioned reinforcement.** As stated earlier, the source of BiN repertoires may lie in the establishment of a history of reinforcement for observing visual and auditory stimuli, resulting in acquisition of multiple responses from a single experience. For participants with and without an autism diagnosis, Longano and Greer (2015) systematically paired reinforcement with observing responses for non-preferred visual and auditory stimuli on a computer screen. Stimuli were then combined in that the visual stimulus was presented while the auditory stimulus was spoken. Results indicated that after multiple observations children acquired names of stimuli. Overt echoic behavior may itself be a source of reinforcement for BiN (Horne & Lowe, 1996; Lowenkron, 1996) with the caregiver playing an important role in reinforcement of this behavior. When a child obtains multiple opportunities to hear and repeat the name of a stimulus, a history of conditioned reinforcement for attending behavior emerges. Lo (2016) tested whether exposure to sets of stimuli through repeated probes would function to create a history of conditioned reinforcement for target stimuli. Results indicated an increase in untaught correct listener and speaker responses for untaught contrived stimuli emerged with participants who demonstrated BiN repertoires for non-contrived stimuli.

**Echoic training.** In the experiment conducted by Longano in 2008, BiN may have emerged for one participant diagnosed with developmental delays as a function of the echoic emitted during MEI across listener responses. In a recent study, Cao (2016) conducted a series of experiments investigating the acquisition of BiN in Chinese with monolingual English-speaking preschool children who demonstrated BiN in English with non-contrived visual stimuli. In the first experiment, Cao (2016) randomly assigned participants to two groups and conducted probes for the presence of echoic responding in Chinese and English. Results indicated distinctive
Chinese phonemes and percentage of English echoic responses were predictors of correct Chinese echoic responses. In her second experiment, Cao (2016) implemented echoic training in Chinese with preschool participants who demonstrated BiN across speaker and listener repertoires in English with contrived stimuli. She found that BiN with contrived stimuli in English emerged for all participants as a function of echoic training. Additionally, BiN with non-contrived stimuli in Chinese emerged for six of the eight participants and BiN with contrived stimuli emerged for five of the eight participants.

**Stimulus-stimulus pairing.** Discussed in the previous section, Longano and Greer (2015) tested the effects of a stimulus-stimulus pairing procedure with three children aged five to seven years with and without autism on the emergence of BiN responses with novel stimuli in joint attention and incidental conditions. In the first phase, auditory stimuli were paired with reinforcers through a pair/test interval procedure (Greer & Ross, 2008) for one participant while visual stimuli were paired with reinforcers for another participant. Following this phase, another pairing procedure was conducted during which auditory and visual stimuli were presented together for all participants. During the second phase, however, a tact probe was conducted instead of a test-trial following the pair interval. Results indicated an increase in correct untaught speaker and listener responses in both the joint attention and incidental conditions following the two sets of stimuli presented through the pairing procedure. Longano and Greer (2015) also observed an increase in echoic behavior during pairing sessions as well as the acquisition of tacts and auditory and visual stimuli as reinforcers.

Reviewed in-depth earlier in this paper, Frias (2017) also found that BiN across untaught listener and speaker responses emerged across stimulus modalities as a function of stimulus-stimulus pairing. Data from both studies suggest that establishment of visual and auditory
stimuli as conditioned reinforcers is key in the emergence of BiN and may indeed be the foundational cusp in allowing for incidental language acquisition. It is not yet clear, however, if children with autism who demonstrate BiN with familiar stimuli also demonstrate transfer of stimulus control to untaught responses with unfamiliar stimuli. Does BiN with unfamiliar stimuli need to be established independently of BiN with familiar stimuli?

Figure 1 represents the possible framework in the development of BiN repertoires.
Hearing the name of a novel stimulus while simultaneously observing the stimulus (joint attention)

**Example:** Mom points to a flower and says, “That’s an orchid.”

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**Bidirectional relation has been formed** (joint stimulus control across listener and speaker responses); derived relation is formed

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**Listener Response**

**Example:** At a later time (not immediately following the naming experience), the child can hears “Look at that orchid!” and is able to look at or point to the appropriate flower.

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**Speaker Response**

**Example:** At a later time (not immediately following the naming experience), the child is looking at a picture of an orchid or an actual orchid and says “Mom, I found an orchid!”

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**Figure 1.** Bidirectional Naming Repertoires. Emergence of bidirectional naming repertoires as a function of observing responses to stimuli. After a child observes the vocal and visual stimuli simultaneously (i.e., engaging in joint attention) through naming experiences, bidirectional naming emerges without direct instruction. Adapted from “A Rose by Naming: How We May Learn How to Do It” by R.D. Greer and J. Longano (2010), *The Analysis of Verbal Behavior*, 26(1), p. 92. Copyright 2010 by R.D. Greer and J. Longano.
Conditioned Seeing

Skinner defined conditioned seeing as a private event or behavior occurring beneath the skin (1953, 1957). Specifically, he argued that conditioned seeing is a conditioned reflex emitted in the absence of the actual stimulus to any stimulus that has been previously paired such as a sound, image or smell. It is a behavior in which an image is seen within the skin in the absence of the physical stimulus, which has been labeled in other literature as a memory. A more appropriate tact for this behavior may be delayed remembering behavior, or the behavior of remembering, as the individual must recall stimuli presented at an earlier time. For example, when hearing “rose” one may see an image of this specific flower even if it is not physically present. Skinner argues that the sounds associated with “rose,” R/O/S/E, have become associated with conditioned seeing of a rose as a private event. Therefore, the auditory stimulus elicited the response of conditioned seeing through previous instructional history, not unlike hearing a story.

According to Skinner, when a response is elicited based on first-order classical conditioning a conditioned sensory response is emitted. For example, a baby bird opens his beak to receive food when he hears his mother approaching the nest. Hearing his mother fly towards the nest causes the bird to sense the impending food delivered by his mother. As discussed by Skinner, conditioned seeing also accounts for responses to stimuli that are not currently present but have a history of conditioned reinforcement in the past, e.g., hearing the word “diamond” evokes a feeling of joy as conditioned by a previous response to a diamond ring given during an engagement.
Shanman (2013) tested for the presence of conditioned seeing as a measurable behavior through drawing responses. In an initial experiment, a correlation between BiN speaker responses and drawing responses was observed. Shanman (2013) then implemented a multiple probe design across six participants to test for the effects of a phonemic response intervention on the presence of BiN and conditioned seeing. Results indicated that no speaker components of BiN occurred without drawing responses. Specifically, participants responded in one of the following ways: emitting both drawing responses and speaker responses, emitting drawing responses but not speaker responses, or emitting neither speaker nor drawing responses. No speaker responses were present independently of drawing responses, providing evidence of a relation between speaker and drawing repertoires. Figure 2 represents the proposed addition of conditioned seeing as a component of BiN repertoires.
Figure 2. Conditioned Seeing as a Related to the Emergence of Bidirectional Naming. After a child observes the vocal and visual stimuli simultaneously (i.e., engaging in joint attention) through naming experiences presented with a drawing component, bidirectional naming and conditioned seeing may become joined and emerge without direct instruction. Adapted from “A Rose by Naming: How We May Learn How to Do It” by R.D. Greer and J. Longano (2010), *The Analysis of Verbal Behavior*, 26(1), p. 92. Copyright 2010 by R.D. Greer and J. Longano.
Mercorella (2017) tested for delayed drawing as a measure of conditioned seeing as related to BiN and reading comprehension across three experiments. In Experiment I, 41 school-aged children, typically and non-typically developing participated. Assessments were conducted for the presence of listener and speaker BiN responses as well as drawing responses to contrived stimuli that were also used in the Shanman (2013) study. Results of the study indicated that 65.9% of participants had unidirectional naming, 29.5% demonstrated the speaker component and 40.9% of the students had the drawing component; only 22.2% of students with below grade-level reading comprehension correctly drew the stimuli. Subsequent experiments conducted by Mercorella (2017) tested for the presence of reading comprehension with and without pictures as well as reading comprehension skills after sequencing, representing conditioned seeing, was introduced. Comprehension increased as a function of the intervention, sequencing pictures.

Although Shanman (2013) provided support of a speaker and drawing response relation, the results were indicative of a correlational relationship. Mercorella (2017) did provide evidence of a functional relationship between conditioned seeing, BiN, and reading comprehension, however the functional relationship between BiN and conditioned seeing necessitates further study. In addition, if these repertoires are functionally related, will the implementation of MEI with a drawing response successfully evoke BiN for unfamiliar stimuli and delayed drawing responses?

**Direct Instruction (DI)**

Direct instruction (DI) (Engelmann et al., 1988) will be reviewed in this paper in that it served as the daily classroom curriculum for all participants involved in the following study. DI is a teaching model that emphasizes well-developed and carefully planned lessons, modeling,
repetition, and explicitly-stated teaching procedures (Parette, Blum, Boeckmann, & Watts, 2009) that build sequentially on prerequisite skills until higher order learning is achieved. The curricula presented in DI are research-based to contain the most effective wording possible (Stockard, 2010) and have been implemented effectively to teach emergent literacy (Parette et al., 2009), language (Flores & Ganz, 2007; Ganz & Flores, 2009; Shillinsburg, Bowen, Peterman, & Gayman, 2015), reading comprehension (Laurent-Prophete, 2017), and mathematics (Skarr, Zielinski, Ruwe, Sharp, & Williams, 2014), amongst other subjects.

In a recent study, Laurent-Prophete (2017) investigated the implementation of *Corrective Reading* versus a control curriculum *RAZ Kids* on the development of reading comprehension and derived relations with typically developing first graders. *Corrective Reading* is a DI curriculum that teaches multiple exemplar training throughout to evoke derived relations. For example, a child may learn that kangaroos are a type of marsupial (kangaroo= marsupial) and marsupials are a type of mammal (marsupial= mammal). When a derived relation is formed, the child understands that kangaroos are a type of mammal (kangaroo= mammal) without directly being taught. Laurent-Prophete found that correct responses to derived relations and metaphors increased for all participants after exposure to *Corrective Reading*. In a second experiment (Laurent-Prophete, 2017), four students were exposed to five lessons of the *Corrective Reading* curriculum and correct derived relational responding increased as did correct responses to explicit reading comprehension skills (identifying the bidirectional relationship between two stimuli, i.e., spoken word *kangaroo*\(=\) picture of kangaroo, therefore picture of kangaroo= spoken word *kangaroo*) and implicit reading comprehension skills (identifying the relationship between at least three related stimuli, i.e., spoken word *kangaroo*\(=\) picture of kangaroo, picture of
kangaroo= written word “kangaroo,” therefore spoken word kangaroo= written word “kangaroo).

The results of Laurent-Prophete (2017) provided strong evidence of an increase in derived relational responding following implementation of Corrective Reading, however we have not yet investigated if the implementation of DI curricula will evoke BiN repertoires, which is an integral milestone in forming derived relations and transfer of stimulus control across verbal stimuli.

**Learn Unit and Operant Behavior**

Operant behavior commonly refers to behavior that is selected and maintained as a function of consequences when a discriminative stimulus is reliably present (Skinner, 1938; Spielberger & DeNike, 1966) and whose future frequency is determined by its history of reliably evoking a stimulus change. Therefore, operant conditioning is a type of learning that leads to behavior change through a history of consequences (Kirsch, Lynn, Vigorito, & Miller, 2004). In other words, when operant conditioning occurs a stimulus change immediately follows a behavior that increases or decreases the likelihood the behavior will occur in the future.

Greer and Keohane (2005) expand on operant behavior and operant conditioning by discussing the importance of operant behavior through consideration and analysis of ontogeny, phylogeny, motivating operations, antecedent stimuli, consequence and behaviors. Previous research indicates that the implementation of operant conditioning has been successful in evoking newly learned, or operant, behaviors (Donahoe & Palmer, 2004). While previous studies have established the importance of a stimulus-stimulus pairing procedure, known as classical conditioning (Kirsch et al., 2004), on the emergence of conditioned reinforcers (Frias, 2017; Greer, et al., 2011; Longano & Greer, 2015), additional research also states that
conditioned reinforcement may emerge as a function of operant conditioning as well (Donahoe & Palmer, 2004; Greer & Han, 2015).

The learn unit, as described by Greer (1994), is comprised of interlocking *operants* that address student and teacher interactions. Instruction delivered as a learn unit integrates student and teacher interactions and serve as predictors for student behavior, which in turn signal the teacher’s response (Greer & McDonough, 1999). When implemented accurately and fluently, learn unit presentations lead to a higher rate of correct responding (Albers & Greer, 1991) allowing the learner to acquire operant behaviors at a more rapid pace. Learn unit implementation is a research-based, effective methodology implemented to evoke operant behavior by analyzing the contingencies surrounding instruction to deliver consequences effectively for behaviors emitted in the presence of establishing operations and discriminative stimuli (Greer & Keohane, 2006; Greer & McDonough, 1999; Greer & Ross, 2008). Throughout this study, operant conditioning implemented as *learn unit* presentations was investigated as related to the establishment of multiple stimulus control across untaught speaker, listener, and drawing responses for unfamiliar stimuli.

**Current Investigation and Research Questions**

The present study seeks to add to literature utilizing drawing responses as a measure of conditioned seeing (Skinner, 1957) and investigates whether a functional relationship exists between BiN for unfamiliar stimuli and conditioned seeing. In Experiment I, I investigated if the implementation of MEI with a drawing component would evoke untaught BiN and delayed drawing responses for unfamiliar stimuli. Would these responses also emerge for participants who experienced only the school curriculum, Direct Instruction (Englemann et al., 1988) and were matched for the number of probes participants in the MEI group experienced? In
Experiment II, I tested the effect of learn units on the development of BiN with unfamiliar stimuli for participants who demonstrated unidirectional naming and delayed drawing. Would the learn unit procedure evoke untaught BiN responses for unfamiliar stimuli? In Experiment III, I conducted the learn unit procedure but omitted the requirement of an echoic response. Specifically, would implementation of the learn unit procedure evoke multiple stimulus control for BiN and delayed drawing with unfamiliar stimuli with participants who did not demonstrate unidirectional naming or delayed drawing for unfamiliar stimuli?
Chapter II

EXPERIMENT I

Method

Participants

Six participants were selected from a private, publicly-funded school for school-aged children diagnosed with developmental disabilities. Three participants were selected from a campus located in a major metropolitan area; the remaining participants were selected from a campus located in a suburb of a major metropolitan area, however both campuses functioned under the umbrella of a larger organization and are considered different campuses of the same school that implemented a behavior analytic approach to teaching. Necessary prerequisite repertoires for the study included teacher presence resulting in instructional control, basic listener literacy, point-to topography, independent tact repertoires, independent mand repertoires, and textual responding at 80 words per minute or higher (Greer & Ross, 2008). In addition, participants also had the following cusps and capabilities (Greer & Speckman, 2009; Rosales-Ruiz & Baer, 1997) in repertoire at the onset of the study: conditioned reinforcement for two-dimensional and three-dimensional stimuli, match-to-sample, generalized imitation, listener literacy, and auditory matching. All participants in the study demonstrated bidirectional naming (BiN), or untaught listener and speaker responses derived from one naming experience, to familiar stimuli (i.e., exotic animals) but did not demonstrate BiN for unfamiliar stimuli. See Table 2 for description of participants, all of whom were male, functioned at speaker/listener levels of verbal behavior and had been diagnosed with autism spectrum disorder prior to the onset of the experiment.
Participant A was 10.3 years old at the onset of the study; Participant B was 11.5 years old; Participant C was 10.4 years old. Participant D was 11.8 years old at the onset of the study; Participant E was 10.4 years old, and Participant F was 10.1 years old. As of part of the typical academic day, instruction delivered to Participants A, B, C, D, E and F consisted of Direct Instruction (DI) (Engelmann et al., 1988) through curriculum such as Reading Mastery, Spelling Mastery, Language for Thinking and Connecting Math Concepts (see Table 4 for a full list of curricula and instruction each participant experienced throughout the study; see Chapter I for further description of DI). It should be noted here that a recent dissertation by Laurent-Prophete (2017) provided evidence that implementation of Corrective Reading, a Direct Instruction curriculum, was effective in improving reading comprehension repertoires as well as increasing the number of accurate derived relational responses emitted during post-test conditions. Participants assigned to the control group, described in subsequent sections, received DI only during their instructional day while participants in the experimental group were exposed to multiple exemplar instruction (MEI) and DI.
Table 2

*Description of Participants at the onset of Experiment I.*

<table>
<thead>
<tr>
<th>Participant</th>
<th>Age/ Gender/ Level of VB</th>
<th>Current grade level</th>
<th>Test Scores</th>
</tr>
</thead>
<tbody>
<tr>
<td>A</td>
<td>10.3/ Male/ Reader/ ASD/ City</td>
<td>3rd grade Math*</td>
<td>Math Reasoning SS-63</td>
</tr>
<tr>
<td>B</td>
<td>11.5/ Male/ Reader/ ASD/ City</td>
<td>4th grade Math***</td>
<td>Calculation SS-102</td>
</tr>
<tr>
<td>C</td>
<td>10.4/ Male/ Reader/ ASD/ City</td>
<td>2nd grade Reading*</td>
<td>Reading Comprehension SS-89</td>
</tr>
<tr>
<td>D</td>
<td>11.8/ Male/ Reader/ ASD/ Suburb</td>
<td>4th grade Math**</td>
<td>Not available</td>
</tr>
<tr>
<td>E</td>
<td>11.4/ Male/ Reader/ ASD/ City</td>
<td>2nd grade Math*</td>
<td>Math Reasoning SS-82</td>
</tr>
<tr>
<td>ASD/ Suburb</td>
<td>Writer</td>
<td>4th grade Reading*</td>
<td>Reading Comprehension</td>
</tr>
<tr>
<td>--------------</td>
<td>--------</td>
<td>-------------------</td>
<td>-----------------------</td>
</tr>
<tr>
<td></td>
<td></td>
<td></td>
<td>SS-119</td>
</tr>
</tbody>
</table>

|          | 10.1/ Male/ | Reader/          | 2nd grade Math** | Not available |
|----------|-------------|-----------------|------------------|

ASD/ Suburb   Writer 2nd grade Reading**

---

Note: SS refers to Standard Score. ASD refers to Autism Spectrum Disorder.

*Participants assessed by the Wechsler Intelligence Achievement Test®—Third Ed.

**Participants assessed by the BRIGANCE® III. Standard scores for the Brigance® III are not available.

***Participants assessed by Woodcock-Johnson® III Tests of Achievement.
Table 3

Curricula taught to participants as part of daily academic instruction throughout Experiment I.

<table>
<thead>
<tr>
<th>Participant</th>
<th>Examples of Curricula Taught During Experiment</th>
</tr>
</thead>
<tbody>
<tr>
<td>A</td>
<td>Reading Mastery, Spelling Mastery, Connecting Math Concepts, Language for Thinking</td>
</tr>
<tr>
<td>B</td>
<td>Reading Mastery, Spelling Mastery, Connecting Math Concepts, Language for Thinking</td>
</tr>
<tr>
<td>C</td>
<td>Reading Mastery, Spelling Mastery, Connecting Math Concepts, Language for Writing</td>
</tr>
<tr>
<td>D</td>
<td>Scott Foresman Social Studies, Scott Foresman Science, Instructional Trials for Reading, Math, Spelling</td>
</tr>
<tr>
<td>E</td>
<td>Scott Foresman Social Studies, Scott Foresman Science, Instructional Trials for Reading, Math, Spelling</td>
</tr>
<tr>
<td>F</td>
<td>Scott Foresman Social Studies, Scott Foresman Science, Instructional Trials for Reading, Math, Spelling</td>
</tr>
</tbody>
</table>

**Setting**

Participants in the study were habituated to the principal and secondary investigators prior to beginning work. Sessions took place in the students’ classroom or in a neighboring conference room. The classrooms on both campuses consisted of eight individual student desks and chairs facing a whiteboard or SMART Board®. Five teacher desks and chairs were present in each room. The conference room consisted of two supervisor desks, one rectangular table,
one child-sized chair and four adult chairs. Both classrooms contained bookshelves consisting of age-appropriate reading materials, textbooks and student notebooks. The classroom located in a major metropolitan area also included toys such as Legos® and board games.

When sessions were conducted in the classroom setting teachers and teaching assistants were engaged in Direct Instruction (Engelmann et al., 1988) and/or instructional trial delivery on academic repertoires (e.g., Mathematics, English Language Arts, Spelling, Social Studies, Science) in 1:1 or small-group settings. Teaching sessions typically took place after Morning Message; probe sessions were typically conducted before free-time in the afternoon. Whenever possible, sessions were videotaped or another teacher or classroom supervisor was recruited to collect interobserver agreement. Teaching and probe sessions were conducted at a teacher table or at the large rectangular table in the conference room with the student seated next to the experimenter. Other independent observers sat on the other side of the participants to record data independently of the principal investigator.

Materials

Materials for intervention and probe sessions consisted of Microsoft® PowerPoint™ presentations, blank paper, data sheets, pens, pencil, and 20-trial graphs. Teaching sessions consisted of one presentation in which stimuli sets consisting of five unfamiliar stimuli were presented to test for the presence of delayed remembering. Each stimulus in the set was presented four times in a random fashion. Probe sessions consisted of two PowerPoint™ presentations. Using the first presentation (point-to probes) participants were asked to point to the targeted stimuli presented in a field of three. Participants were then requested to vocally identify stimuli using the second presentation, after which participants were given a blank piece of paper to draw the stimuli. Four sets of stimuli were created for the purpose of this study (see
Table 4 for stimuli probe sets), which consisted of characters taken from languages unfamiliar to the participants and given one-syllable nonsensical names. Specifically, the languages targeted were Arabic, Belarusian, Chinese, Korean, Armenian, Russian, and Bengali. Materials for intervention sessions consisted of sets of unfamiliar visual stimuli used specifically for MEI sessions.

**Visual and vocal stimuli.** Visual stimuli were created and presented via Microsoft® PowerPoint™. All stimuli were approximately 2 centimeters by 2 centimeters and contained 5 stimuli per set. Set 1 consisted of characters taken from the written lowercase Korean alphabet; Set 2 consisted of characters from the written lowercase Armenian alphabet; Set 3 consisted of characters from the written uppercase Armenian alphabet; and Set 4 consisted of characters from the written uppercase Wubi Xing alphabet. Vocal stimuli consisted of nonsensical one-syllable consonant-vowel-consonant (CVC) or consonant-vowel-vowel-consonant (CVVC) combinations and were selected using combinations of arbitrarily assigned letters to numbers. For example, 7=D, 15=O, 34=D. These combinations were chosen using a random generator in Microsoft Excel®. Random generation was conducted for each vocal stimulus.

**Drawing (delayed remembering) responses.** At the conclusion of probe trials to assess for the presence of listener and speaker responses to stimuli sets, participants were given a piece of white, blank piece of paper sized 8.5-inches by 11-inches on which they were requested to draw the symbols they had just learned. Delayed remembering probes were implemented to assess for the presence of delayed drawing, or conditioned seeing.
Table 4

*Visual and auditory unfamiliar stimuli used for pre- and post-intervention probe sets in Experiment I.*

<table>
<thead>
<tr>
<th>Set 1</th>
<th>Set 2</th>
<th>Set 3</th>
<th>Set 4</th>
<th>Novel set</th>
</tr>
</thead>
<tbody>
<tr>
<td>⒩</td>
<td>⒫</td>
<td>⒱</td>
<td>⒲</td>
<td>⒳</td>
</tr>
<tr>
<td>大</td>
<td>$</td>
<td>$q</td>
<td>الكم</td>
<td>⒴</td>
</tr>
<tr>
<td>下</td>
<td>));</td>
<td>));</td>
<td>الكم</td>
<td>⒵</td>
</tr>
<tr>
<td>ظ</td>
<td>));</td>
<td>));</td>
<td>الكم</td>
<td>Ⓐ</td>
</tr>
<tr>
<td>ﾡ</td>
<td>));</td>
<td>));</td>
<td>الكم</td>
<td>Ⓑ</td>
</tr>
<tr>
<td>Auditory</td>
<td>Auditory</td>
<td>Auditory</td>
<td>Auditory</td>
<td>Auditory</td>
</tr>
<tr>
<td>Dod</td>
<td>Lop</td>
<td>Nud</td>
<td>Rup</td>
<td>Sook</td>
</tr>
<tr>
<td>Ruk</td>
<td>Frad</td>
<td>Wix</td>
<td>Min</td>
<td>Yut</td>
</tr>
<tr>
<td>Wiv</td>
<td>Tor</td>
<td>Tay</td>
<td>Daw</td>
<td>Pret</td>
</tr>
<tr>
<td>Hab</td>
<td>Giz</td>
<td>Quag</td>
<td>Hib</td>
<td>Raz</td>
</tr>
<tr>
<td>Tun</td>
<td>Rew</td>
<td>Fer</td>
<td>Vil</td>
<td>Vin</td>
</tr>
</tbody>
</table>
**Design and Procedure**

A multiple probe design (Horner & Baer, 1978) across dyads was utilized to test for a functional relation between MEI and BiN with conditioned seeing. This was counterbalanced with a simultaneous treatment condition (Kazdin & Hartmann, 1978) that was implemented across participants to control for experience with the DI curriculum, as research suggests DI has induced derived relational responding (Laurent-Prophete, 2017) and improved language skills for children with autism (Flores & Ganz, 2007; Ganz & Flores, 2009; Shillinsburg et al., 2015).

Participants were matched for level of verbal behavior as well as number of years functioning below grade level. For example, a participant who presented with a reader/writer level of verbal behavior (Greer & Ross, 2008) functioning two grade levels below was matched with a similar participant. Following the assignment of dyads, participants were randomly assigned to the control or experimental group (Table 5).

After mastery criteria for the first intervention set was met by the target participant (experimental group) in the first dyad, probe sessions were again conducted to assess for the presence of BiN and delayed drawing responses to unfamiliar stimuli. The target participant in the second dyad then received the intervention, and so on.

The control group received daily academic instruction via Direct Instruction curricula throughout the school day while the experimental group was exposed to MEI and DI. When a participant in the experimental group met criteria on an MEI intervention set, the target and confederate participants were assessed for BiN and delayed drawing responses to unfamiliar stimuli. The number of probe sessions experienced by dyads were matched, allowing the investigator to assess if untaught listener, speaker and drawing responses to unfamiliar stimuli were induced through DI and repeated probes. Once the target participant in the experimental
group demonstrated criteria-level responding during probe sessions with novel stimuli, the intervention ceased and the confederate peer no longer experienced additional probe sessions. See Figure 3 for a visual representation of the experimental design.

Table 5

*Participant dyads, grouping, and assigned sequence within intervention throughout Experiment I.*

<table>
<thead>
<tr>
<th>Dyad/ Sequence</th>
<th>Multiple Exemplar Instruction</th>
<th>Control Condition</th>
</tr>
</thead>
<tbody>
<tr>
<td>1</td>
<td>Participant D</td>
<td>Participant E</td>
</tr>
<tr>
<td>2</td>
<td>Participant A</td>
<td>Participant B</td>
</tr>
<tr>
<td>3</td>
<td>Participant F</td>
<td>Participant C</td>
</tr>
<tr>
<td>Dyad</td>
<td><strong>Participant</strong></td>
<td>Pre-intervention probes conducted</td>
</tr>
<tr>
<td>-------</td>
<td>-----------------</td>
<td>-----------------------------------</td>
</tr>
<tr>
<td>1</td>
<td><strong>D</strong></td>
<td></td>
</tr>
<tr>
<td></td>
<td><strong>E</strong></td>
<td></td>
</tr>
<tr>
<td></td>
<td><strong>F</strong></td>
<td></td>
</tr>
<tr>
<td>2</td>
<td><strong>A</strong></td>
<td></td>
</tr>
<tr>
<td></td>
<td><strong>B</strong></td>
<td></td>
</tr>
<tr>
<td>3</td>
<td><strong>C</strong></td>
<td></td>
</tr>
</tbody>
</table>

Figure 3. Design sequence of intervention and probe sessions for all dyads throughout Experiment I. Participants in bold were assigned to the experimental condition; participants in italics were assigned to the control condition. The implemented experimental design was a multiple probe design across dyads with a simultaneous treatment condition.
Pre-experimental probes to assess for the presence of bidirectional naming for familiar stimuli and unfamiliar stimuli. Prior to the onset of the experiment, participants were tested for untaught listener and speaker responses to familiar stimuli (exotic animals). Delayed drawing was not assessed at this time. All participants demonstrated untaught listener and speaker responses for familiar stimuli, but did not demonstrate untaught listener and speaker responses for unfamiliar stimuli.

Pre-experimental probes for contrived or unfamiliar stimuli. Prior to the onset of teaching and probe sessions, participants were asked if they had seen or had any familiarity with the presented stimuli. If any participants indicated an instructional history with the target stimuli sets these stimuli were removed from the study.

Naming experiences for probe sets. Participants were exposed to each of the five target stimuli within a set four times for a total of twenty learn units (Albers & Greer, 1991; Greer, 2002), which are interlocking operants in which the behavior of the student functions as an antecedent for the instructor; the teacher’s behavior functions as an antecedent for the student’s behavior and so on. Participants were presented with each stimulus in the targeted probe set via Microsoft® PowerPoint™. Five stimuli were presented in a rotated fashion for a total of 4 opportunities per stimulus. One stimulus was presented per screen and the name of the stimulus was simultaneous delivered (e.g., when visual stimulus ▼ was presented the vocal antecedent “dod” was delivered). Praise was delivered when the student engaged in echoic behavior for the vocal stimuli while simultaneously attending to the visual stimuli. If the participant did not emit an echoic the visual and auditory stimuli were re-presented as a correction procedure. If the participant did not echo the auditory stimulus after the correction the experimenter moved to the
next learn unit. Criteria for mastery was 90% accuracy across two consecutive sessions or 100% accuracy across one session.

Naming experiences were conducted in a sequential fashion such that participants were not exposed to more than one naming experience or probe session per set at a time. Further, naming experiences were presented only before the first probe sessions and were not presented for subsequent probe sessions.

**Probe sessions to assess for bidirectional naming: Dependent Variable.** After at least two hours, participants were assessed for the listener and speaker component of naming, or BiN (Miguel, 2016). It is important to note that probe sessions for each set were conducted sequentially. For example, naming experiences were delivered for Probe Set 1 and after at least a two hour delay probe sessions were conducted. Participants would not be exposed to naming experiences for the Probe Set 2 until probe sessions for the Probe Set 1 were completed.

Participants were first assessed for unidirectional naming (i.e., listener component). Participants viewed a Microsoft® PowerPoint™ presentation on which stimuli from the target set was presented in a field of three and were asked to point to each target stimulus two times, presented in a rotated fashion. Following the probe for listener responses participants viewed a second PowerPoint™ presentation in which one stimulus per slide was presented with the vocal verbal antecedent “What is this?” to assess for intraverbal responding (speaker response). Probe trials were not consequated. Reinforcement was delivered on a variable interval schedule for attending behavior. Criterion for BiN was 80% accuracy, or 8/10 correct responses per response topography per probe set. It is important to note, however, that if significant gains were observed during post-intervention probes even if criterion was not achieved across each response
topography in each probe set, the principal investigator made a decision to test for BiN with novel stimuli sets.

**Probe sessions to assess for delayed drawing responses: Dependent Variable.** Immediately following probe sessions to assess for the presence of BiN, participants were given a blank sheet of paper as well as a pencil and were given the vocal verbal antecedent “Draw the symbols you just learned as best as you can.” Participants were given five minutes to draw the characters after which the participants were told they could put their pencils down. If the participant stated he was finished before five minutes had expired he was told he could put his pencil down. Delayed drawing probe session were not consequated.

Probe sessions were conducted for each participant across four unfamiliar stimuli sets prior to implementation of the intervention. Criterion for mastery for the delayed drawing component was 80% accuracy, or 4/5 correct responses per probe set of stimuli. As with the probes for BiN response, the experimenter made a decision to test for delayed drawing with a novel probe set if significant increases in correct responding were observed even if criterion was not obtained per stimuli probe set. Following achievement of mastery criteria with probe stimuli sets, a probe for delayed drawing was conducted with a novel set of stimuli.

**Multiple exemplar instruction (MEI) across listener, speaker, and drawing responses with training sets of stimuli: Independent Variable.** Participants in the experimental group were exposed to the independent variable, multiple exemplar instruction (MEI). During MEI (Greer et al., 2005; Fiorile & Greer, 2006) listener (point-to), speaker (stimulus-stimulus pairing, intraverbal) and drawing response topographies were rotated in a counterbalanced fashion with a contrived, unfamiliar teaching stimuli set that differed from probe stimuli sets (see Table 6 for teaching stimuli sets). The stimulus-stimulus pairing
procedure consisted of the experimenter giving the echoic or auditory stimulus for the unfamiliar stimuli; point-to responses were targeted in a field of three; intraverbal responses consisted of the experimenter presenting one target stimuli on the screen and asking “What is this?”; drawing responses consisted of the experimenter presenting the target stimuli on the screen and giving the vocal verbal antecedent “Draw ___. ” This functioned as a drawing response as participants viewed the stimulus while drawing it. I will note here that the requirement of a drawing or transcription response differs from previous studies that have implemented MEI. Greer, Stolfi et al. (2005) implemented MEI across match, point-to, intraverbal and tact responses to induce BiN as did Fiorile and Greer (2007), Gilic and Greer (2011), Greer et al. (2007), Tullo Woolslayer (2007) and others. Cahill and Greer (2014) implemented MEI across imitation with actions, listener responses, tact responses and intraverbal responses to induce incidental language learning with actions, however previous MEI research has not utilized a transcription response.

Learn units (Albers & Greer, 1991) were delivered throughout the intervention such that correct responses were conseuated with reinforcement in the form of praise and incorrect responses were conseuated with corrections. Within a single intervention session, all responses were rotated until 20 learn units had occurred for each topography for a total of 80 learn units. Mastery criteria was 100% across the initial session or 90% across two consecutive sessions for each response topography. Once a topography had been mastered, instruction continued to include the response in rotation but data on this response were no longer graphed (see Table 7 for an example MEI sequence).

**Control group: Direct Instruction (DI) and repeated probes.** Participants in the experimental group experienced MEI as well as the school curriculum, DI, throughout the study. As mentioned earlier, research supports the implementation of DI on increased derived relational
responding with typically developing first grades, as well as improved language and reading comprehension skills in children diagnosed with autism (Flores & Ganz, 2007; Ganz & Flores, 2009; Laurent-Prophete, 2017; Shillinsburg et al., 2015; Stockard, 2010). To control for exposure to DI on the emergence of derived relations and incidental language acquisition within the study, both groups experienced DI. Repeated probes were conducted for the confederate peer in the control group to assess whether BiN and delayed drawing repertoires had emerged as a function of daily academic DI instruction.

**Post-probe sessions for bidirectional naming and delayed drawing.** After the target participant in the experimental group achieved mastery on the intervention, probe sessions were again conducted for each member of the dyad BiN and delayed drawing responses.

Participants in the MEI-experimental group were exposed to probe stimuli sets before implementation of MEI as well as following mastery of each MEI teaching set. With the exception of novel probe sets, the participants in the control group received the same number of probe trials as participants in the MEI group. Criteria-level responding for BiN with unfamiliar stimuli was 8/10 across untaught speaker and listener response topographies for probe stimuli sets and novel stimuli sets. BiN with unfamiliar stimuli was considered to be mastered when participants in the MEI-experimental group achieved criteria with novel sets.
Table 6

Visual and auditory unfamiliar stimuli used for MEI intervention sets throughout Experiment I.

<table>
<thead>
<tr>
<th>Set 1</th>
<th>Set 2</th>
<th>Set 3</th>
</tr>
</thead>
<tbody>
<tr>
<td>Visual</td>
<td>Visual</td>
<td>Visual</td>
</tr>
<tr>
<td>ز</td>
<td>د</td>
<td>土</td>
</tr>
<tr>
<td>ﺣ</td>
<td>ﻰ</td>
<td>田</td>
</tr>
<tr>
<td>ﻟ</td>
<td>ﻰ</td>
<td>火</td>
</tr>
<tr>
<td>ﻳ</td>
<td>ﮃ</td>
<td>之</td>
</tr>
<tr>
<td>ﻣ</td>
<td>ﻯ</td>
<td>女</td>
</tr>
<tr>
<td>Auditory</td>
<td>Auditory</td>
<td>Auditory</td>
</tr>
<tr>
<td>Zim</td>
<td>Muz</td>
<td>Boz</td>
</tr>
<tr>
<td>Yer</td>
<td>Bey</td>
<td>Ritz</td>
</tr>
<tr>
<td>Res</td>
<td>Nox</td>
<td>Lub</td>
</tr>
<tr>
<td>Rit</td>
<td>Vit</td>
<td>Mim</td>
</tr>
<tr>
<td>Wex</td>
<td>Das</td>
<td>Quin</td>
</tr>
</tbody>
</table>
Table 7

Example of MEI learn unit intervention sequence implemented throughout Experiment.

<table>
<thead>
<tr>
<th>First LU</th>
<th>Second LU</th>
<th>Third LU</th>
<th>Fourth LU</th>
</tr>
</thead>
<tbody>
<tr>
<td>SS pair Zim</td>
<td>Point Yer</td>
<td>Intraverbal Res</td>
<td>Draw Rit</td>
</tr>
<tr>
<td>Point Wex</td>
<td>Intraverbal Zim</td>
<td>Point Res</td>
<td>SS pair Rit</td>
</tr>
<tr>
<td>Draw Yer</td>
<td>Draw Zim</td>
<td>SS pair Wex</td>
<td>Point Rit</td>
</tr>
<tr>
<td>Intraverbal Yer</td>
<td>Point Zim</td>
<td>Draw Wex</td>
<td>SS pair Res</td>
</tr>
<tr>
<td>Intraverbal Rit</td>
<td>Draw Res</td>
<td>Intraverbal Wex</td>
<td>SS pair Yer</td>
</tr>
</tbody>
</table>

Note: LU represents learn unit; SS pair represents stimulus-stimulus pairing procedure. Drawing represents a transcription response.

Data Collection

Data were collected on correct (+) and incorrect (-) responses to learn units and probe trials presented during teaching and intervention sessions. In addition, if the participant vocally stated they were reminded of a familiar person, place, or thing when viewing the stimuli (i.e., “That looks like a ninja”) this was also recorded.

Interobserver and Interscorer Agreement

Interobserver agreement (IOA) for the listener and speaker responses to probe sessions testing for the presence BiN was conducted using trial-by-trial IOA (Cooper, Heron & Heward, 2007) in which at least two observers independently scored and compared responses to probe
trials; IOA data collection for the naming experiences presented before probe trial sessions was conducted on echoics emitted by the participants during stimulus-stimulus pairings.

IOA was also conducted for intervention sessions. With prior parental consent, sessions were video and audiotaped on a HIPAA-compliant device for the sole purpose of IOA and maintaining integrity of data collection. After each observer scored each session the number of agreements and disagreements were calculated across all trials. Total number of agreements was divided by total number of trials scored (agreements plus disagreements); this number was then multiplied by 100 to obtain percentage agreement. Across all participants, IOA was collected for 43% of naming experiences as well as for 69% of bidirectional naming probe sessions. Mean agreement for naming experiences was 98% (range 95%-100%); mean agreement for probe sessions was 90% (range 80%-100%). For Participants F, A, and H, 41% of intervention sessions were calculated for IOA with 88% agreement (range 85%-100%). See Table 8 for interobserver agreement calculations per participant.
Table 8

*Interobserver agreement calculated across probe and intervention sessions for participants in Experiment I.*

<table>
<thead>
<tr>
<th>Participant</th>
<th>Percentage of</th>
<th>Calculated</th>
<th>Percentage of</th>
<th>Calculated</th>
<th>Percentage of</th>
<th>Calculated</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>Naming Sessions</td>
<td>IOA*</td>
<td>Probe Sessions</td>
<td>IOA*</td>
<td>Intervention</td>
<td>IOA**</td>
</tr>
<tr>
<td></td>
<td>with IOA</td>
<td>with IOA</td>
<td>Sessions with IOA</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>A</td>
<td>50%</td>
<td>100%</td>
<td>70%</td>
<td>95%</td>
<td>37%</td>
<td>94%</td>
</tr>
<tr>
<td>B</td>
<td>30%</td>
<td>95%</td>
<td>50%</td>
<td>90%</td>
<td>N/A</td>
<td>N/A</td>
</tr>
<tr>
<td>C</td>
<td>50%</td>
<td>100%</td>
<td>65%</td>
<td>92%</td>
<td>N/A</td>
<td>N/A</td>
</tr>
<tr>
<td>D</td>
<td>33%</td>
<td>95%</td>
<td>60%</td>
<td>85%</td>
<td>42%</td>
<td>85%</td>
</tr>
<tr>
<td>E</td>
<td>60%</td>
<td>100%</td>
<td>90%</td>
<td>80%</td>
<td>N/A</td>
<td>N/A</td>
</tr>
<tr>
<td>F</td>
<td>40%</td>
<td>100%</td>
<td>80%</td>
<td>100%</td>
<td>45%</td>
<td>87%</td>
</tr>
</tbody>
</table>

Note: N/A indicate data are not available. Participants B, C, and E were placed in the control group, therefore they were not exposed to the multiple exemplar instruction intervention.

*Range of calculated IOA for probe sessions was 80%-100%.

**Range of calculated IOA for intervention sessions was 85%-100%.
Interscorer agreement (ISA) (Cooper et al., 2007; Shanman, 2013) was conducted for delayed drawing responses. Five independent observers scored delayed drawing responses emitted by each participant across all stimuli sets. ISA was calculated by dividing the number of agreements across each response by the number of possible agreements; this number was then multiplied by 100 to obtain percentage agreement. 69% of sessions were calculated for ISA across all participants with a mean agreement of 96% (range 80%-100%). See Table 9 for ISA calculated per participant.
Table 9

*Interscorer agreement calculated for delayed drawing responses across probe session for participants in Experiment I.*

<table>
<thead>
<tr>
<th>Participant</th>
<th>Percentage of Probe Sessions</th>
<th>Calculated ISA with ISA</th>
</tr>
</thead>
<tbody>
<tr>
<td>A</td>
<td>70%</td>
<td>80%</td>
</tr>
<tr>
<td>B</td>
<td>50%</td>
<td>95%</td>
</tr>
<tr>
<td>C</td>
<td>65%</td>
<td>100%</td>
</tr>
<tr>
<td>D</td>
<td>60%</td>
<td>100%</td>
</tr>
<tr>
<td>E</td>
<td>90%</td>
<td>100%</td>
</tr>
<tr>
<td>F</td>
<td>80%</td>
<td>100%</td>
</tr>
</tbody>
</table>

Note: Interscorer agreement was calculated across four independent scorers and the experimenter (total of five scorers). The calculated interscorer agreement column represents mean agreement across all five observers.
Results

Bidirectional Naming Probes for Unfamiliar Stimuli

Dyad 1: Participants D and E. During pre-intervention probes, Participant D emitted a mean of 5.25 (range 4-7) correct responses to listener, or point-to, topographies across all sets of probe stimuli when given 10 opportunities to respond per response topography per set (40 opportunities total) (Figure 4), with 21 total correct point-to responses across all four sets (Figure 5). He emitted a mean of 5 (range 4-6) correct speaker or intraverbal responses across all four sets during pre-intervention probe and 20 total correct responses. Following the first MEI intervention set Participant D emitted a total of 25 correct listener responses (mean= 6.25, range 3-7) and 14 correct speaker responses (mean= 2.8, range 0-7) across stimuli probe sets 1-4 indicating an increase in unidirectional naming repertoires while demonstrating a decrease in the speaker component of BiN with unfamiliar stimuli. Following a second MEI intervention, Participant D emitted a total of 32 correct listener responses (mean 8.0, range 7-10) and 28 correct speaker responses (mean 9.5, range 7-10). Participant D was then tested for the presence of BiN with a novel set and emitted 8 correct listener responses and 10 correct speaker responses indicating the presence of BiN.

During the first probe session Participant E emitted 26 correct listener responses (mean= 6.5, range 4-10) and 13 correct speaker responses (mean= 3.25, range 1-4) out of 40 opportunities, 10 per response topography per stimuli set; during the second probe session he emitted 21 total correct listener responses (mean= 5.25, range 5-6) and 12 correct speaker responses (mean= 3, range 1-5) (Figures 4 and 5); during the third probe session Participant E emitted 11 correct speaker responses (mean= 2.75, range 0-5) and 7 correct listener responses (mean= 1.75, range 0-5) demonstrating a decrease in correct responding to BiN probes.
Correct responding to BiN probes with unfamiliar stimuli emitted by Participants D and E are compared per stimuli set in Figure 6 and as a total per probe session in Figure 7. Analysis of these data further indicate an increase in untaught listener and speaker responses for Participant D until criteria were achieved while a decrease in untaught listener and speaker responses for Participant E were observed across each repeated probe session.

**Dyad 2: Participants A and B.** During the initial pre-intervention probe, Participant A emitted 18 total correct responses to point-to probe trials across all four sets (mean= 4, range 3-6) (Figures 4 and 5); 2 total correct responses to intraverbal probe trials (mean= 0.5, range 0-2). During the second intervention probe, Participant A emitted a total of 17 correct listener responses (mean 4.25, range 1-6) and 0 correct speaker responses.

Following the first MEI intervention condition, Participant A emitted a total of 21 correct listener responses (mean 5.25, range 5-6) and 17 correct speaker responses (mean 4.25, range 4-5); following a second set of MEI intervention Participant A emitted a total of 25 correct listener responses (mean 6.25, range 5-7) and 24 correct speaker responses (mean 6.25, range 4-7). Following a third MEI intervention, Participant A emitted 31 total correct point-to responses (mean= 7.75, range 5-9) and 19 total correct intraverbal responses (mean= 4.75, range 3-7) across all four probe sets. A decision was then made to test for BiN repertoires with a novel probe set. During BiN probes with novel unfamiliar stimuli, Participant A achieved 8 correct point-to responses and 2 correct intraverbal responses indicating the presence of unidirectional naming.

Participant B emitted 13 total correct listener responses (mean= 3.25, range 0-6) and 0 correct speaker responses (Figures 4 and 5) during the first probe session, 7 correct total listener responses (mean= 1.75, range 1-3) and 4 correct speaker responses (mean=1.0, range 0-2) during
the second probe session; 16 total correct listener responses (mean=4.0, range 3-5), 4 total correct speaker responses (mean= 1.0, range 0-3); 17 total correct listener responses (mean= 4.25, range 1-3), 7 total correct speaker responses (mean= 1.75, range 1-3); 16 total correct listener responses (mean= 4.0, range 2-5) and 5 correct speaker responses (mean= 1.25, range 1-2) in the third, fourth, and fifth probe sessions respectively indicating BiN with unfamiliar stimuli had not emerged.

Correct responding to BiN probes with unfamiliar stimuli emitted by Participants A and B are further compared per stimuli set and as a total per probe session in Figures 8 and 9. Increases in untaught listener and speaker responses for Participant A was observed, though criteria-level responding for unidirectional naming were achieved for Stimuli Sets 1, 2 and 4 as well as with novel stimuli. Participant A did not achieve criteria for untaught speaker responses across any stimuli sets. Participant B did not meet criteria or demonstrate near criteria responding for untaught listener and speaker responses during any repeated probe sessions.

Dyad 3: Participants F and C. Participant F emitted a total of 27 correct point-to responses (mean 6.75, range 6-10) across stimuli sets (Figures 4 and 5) and a total of 3 correct speaker responses during the initial pre-intervention probe (mean= 0.75, range 0-2) and 17 total correct point-to responses (mean 4.25, range 2-7) and 2 correct speaker responses (mean= 0.5, range 0-2) during the second pre-intervention probe. Following the first MEI intervention set implemented for Participant F, 29 correct listener responses were emitted (mean 7.25, range 6-10) and 9 correct speaker responses were emitted (mean= 2.25, range 1-4) (Figures 4 and 5). Following a second MEI intervention set a total of 33 correct listener responses were emitted (mean= 8.25, range 6-10) and 28 correct speaker responses were emitted (mean= 7, range 4-10). Following the third MEI intervention, Participant F emitted a total of 36 correct listener
responses and 32 correct speaker responses during post-intervention probes. Note that although Participant F demonstrated higher rates of correct responding during post-MEI probe 2 (see Figure 4), BiN repertoires were not demonstrated with a novel set as Participant F emitted 3 correct listener responses and 4 correct speaker responses, therefore a decision was made to implement the third MEI teaching set. Following completion of the third MEI set, probes were again conducted with Novel Set 1. Participant F emitted 8 correct point-to responses and 7 correct intraverbal responses. When a probe was conducted for a second novel set, Participant F emitted 8 correct point-to responses and 6 correct intraverbal responses (Figure 4) demonstrating the emergence of unidirectional naming and an increase in the speaker component of BiN.

Participant C emitted 25 total correct listener responses (mean= 6.25, range 1-10) and 20 correct speaker responses (Figures 4 and 5) (mean= 4, range 2-9) during the first probe session, 14 correct total listener responses (mean= 3.5, range 1-6) and 2 correct speaker responses (mean=0.5, range 0-2) during the second probe session; 9 total correct listener responses (mean=2.25, range 0-5), 2 total correct speaker responses (mean= 0.5, range 0-1); 18 total correct listener responses (mean= 4.5, range 4-5), 8 total correct speaker responses (mean= 2.0, range 1-3); 16 total correct listener responses (mean= 4.0, range 2-5) and 6 correct speaker responses (mean= 1.5, range 1-2) in the third, fourth, and fifth probe sessions respectively.

Correct responses per stimuli set during probe sessions and as a total per probe session emitted by Participants F and C are directly compared in Figures 10 and 11. Decreases in untaught listener and speaker responses emitted by Participant C were observed across repeated probe sessions; increases in untaught listener and speaker responses emitted by Participant F were observed following each MEI intervention.
Figure 4. Correct responses to bidirectional naming probe sessions conducted pre-and post-MEI intervention sessions for participants in the experimental group as well as for participants in the control repeated probe condition for probe sets 1-4 and novel sets.

Note: Numbers above each set of data indicate correct responding per stimuli set, i.e., 1= Set 1; 2= Set 2; 3= Set 3; 4= Set 4.
Figure 5. Total sum of participants correct responses to bidirectional naming probes for Sets 1, 2, 3 and 4 across MEI-experimental and control groups.
Figure 6. Comparison of correct responses to bidirectional naming probe sessions conducted pre-and post-MEI intervention sessions as well as in repeated probe conditions emitted by Dyad 1 for probe sets 1-4 and novel sets.

Note: Numbers above each set of data indicate correct responding per stimuli set, i.e., 1= Set 1; 2= Set 2; 3= Set 3; 4= Set 4.
Figure 7. Comparison of total sum of correct responses to bidirectional naming probes for Sets 1, 2, 3 and 4 emitted by Dyad 1 pre- and post-intervention sessions as well as during repeated probe sessions.
Figure 8. Comparison of correct responses to bidirectional naming probe sessions conducted pre-and post-MEI intervention sessions as well as in repeated probe conditions emitted by Dyad 2 for probe sets 1-4 and novel sets.

Note: Numbers above each set of data indicate correct responding per stimuli set, i.e., 1= Set 1; 2= Set 2; 3= Set 3; 4= Set 4.
Figure 9. Comparison of total sum of correct responses to bidirectional naming probes for Sets 1, 2, 3 and 4 emitted by Dyad 2 pre- and post-intervention sessions as well as during repeated probe sessions.
Figure 10. Comparison of correct responses to bidirectional naming probe sessions conducted pre- and post-MEI intervention sessions as well as in repeated probe conditions emitted by Dyad 3 for probe sets 1-4 and novel sets.

Note: Numbers above each set of data indicate correct responding per stimuli set, i.e., 1= Set 1; 2= Set 2; 3= Set 3; 4= Set 4.
Figure 11. Comparison of total sum of correct responses to bidirectional naming probes for Sets 1, 2, 3 and 4 emitted by Dyad 3 pre- and post-intervention sessions as well as during repeated probe sessions.
Delayed Drawing Probes for Unfamiliar Stimuli

Participants in the MEI-experimental group were assessed for delayed drawing repertoires to probe stimuli sets before implementation of MEI as well as following mastery of each MEI teaching set. With the exception of novel stimuli sets, participants in the control group received the same number of probe trials for delayed drawing responses as participants in the MEI group. Criteria-level responding for delayed drawing with unfamiliar stimuli was 4/5 correct responses to probe stimuli sets and novel stimuli sets. Delayed drawing with unfamiliar stimuli was considered to be mastered for participants in the MEI-experimental group when criterion was met with novel stimuli.

Dyad 1: Participants D and E. During the pre-intervention probe session, Participant D emitted 10 total correct drawing responses (mean= 2.5, range 2-3) (Figures 12 and 13) out of 20 opportunities, 5 per stimuli set. During the first post-MEI intervention probe, Participant D emitted 14 total correct drawing responses (mean= 3.5, range 3-5) (Figures 12 and 13). During the third and final post-intervention probe, Participant D emitted a total of 15 correct drawing responses (mean= 3.75, range 3-4) and emitted 5/5 correct delayed drawing probe responses with a novel set of stimuli indicating criterion-level responding for delayed drawing repertoires.

During the first probe session, Participant E emitted 3 total correct delayed drawing responses (mean= 1.0, range 0-2) out of 20 opportunities, 5 per set; during the second and third probe sessions, he emitted 6 and 10 total correct delayed drawing responses (Figures 12 and 13) (mean= 1.5, range 1-3 and mean= 2.5, range 1-4) respectively.

Correct responding for delayed drawing probe sessions emitted by Participants D and E were directly compared by stimuli set (Figure 14) and by total correct responses per probe session (Figure 15). Although total correct responding increased for both participants across
probe sessions, Participant E only demonstrated criterion with Set 1 while Participant D demonstrated criteria with Sets 1, 3 and 4.

**Dyad 2: Participants A and B.** During the pre-intervention probe session, Participant A emitted 1 total correct drawing response (mean= 0.25, range 0-1) (Figures 12 and 13). In the second pre-intervention probe session, Participant A emitted a total of 4 correct delayed drawing responses (mean= 1.0, range 0-2). During the first and second post-intervention probes, Participant A emitted a total 8 and 10 correct drawing responses (mean= 2.0, range 1-3 and mean= 2.5, range 1-3), respectively (Figures 12 and 13). Following a third intervention set, Participant A emitted 13 total correct drawing responses (mean= 3.25, range 2-4) and emitted 2/5 correct delayed drawing probe responses with a novel set of stimuli.

Participant B emitted 2 correct total delayed drawing responses during the first probe session (mean= 0.5, range 0-1) (Figures 12 and 13); during the second, third, fourth and fifth probe sessions he emitted 11 total correct, 9 total correct, 8 total correct, and 6 total correct responses (mean= 2.75, range 1-3; mean= 2.25, range 1-3; mean= 2, range 1-4; mean= 1.5, range= 1-2), respectively.

Correct responding for delayed drawing probe sessions emitted by Participants A and B were directly compared by stimuli set (Figure 16) and by total correct responses per probe session (Figure 17). Participant A met criteria for Sets 1 and 2 but did not meet for Sets 3, 4 or with the novel set, however total number of correct responses increased following each MEI intervention. Participant B only demonstrated criterion with Set 3. Total number of correct delayed drawing responses initially increased but subsequently decreased with each repeated probe session.
**Dyad 3: Participants F and C.** During the pre-intervention probe session, Participant F emitted 2 total correct drawing responses (mean= 0.5, range 0-1) (Figures 12 and 13). In the second pre-intervention probe session, Participant F emitted a total of 5 correct delayed drawing responses (mean= 1.25, range 0-2). During the first and second post-intervention probes, Participant F emitted a total 8 and 11 correct drawing responses (mean= 2.0, range 1-3 and mean= 2.75, range 2-3), respectively (Figures 12 and 13). Following a third intervention set, Participant F emitted 12 total correct drawing responses (mean= 3.0, range 2-4) for Sets 1-4. When first presented with Novel Set 1, Participant F emitted 4/5 correct delayed drawing probe responses. During later probe sessions with Novel Set 1 Participant F emitted 4/5 correct delayed drawing responses and 3/5 correct delayed drawing responses for Novel Set 2 indicating emergence of delayed drawing repertoires.

During the first session Participant C emitted 4 total correct delayed drawing responses (Figures 12 and 13) (mean= 1.0, range 0-2), during the second, third, fourth and fifth probe sessions he emitted 10 total correct, 12 total correct, 15 total correct, and 8 total correct responses (mean= 2.5, range 1-4; mean= 3.0; mean= 3.75, range 1-4; mean= 12, range= 1-3), respectively.

Correct responding for delayed drawing probe sessions emitted by Participants F and C were directly compared by stimuli set (Figure 18) and by total correct responses per probe session (Figure 19). Participant F met criteria for Set 2 and Novel Set 1, however total number of correct responses increased slightly following each MEI intervention. Participant C demonstrated criterion with Set 1. Total number of correct delayed drawing responses increased with each repeated probe session with the exception of the last session in which there was no difference in correct responding.
Figure 12. Correct responses to delayed drawing probes conducted pre- and post-MEI intervention for participants in the experimental group as well as for participants in the repeated probe control group for probe sets 1-4 and novel sets.

Note: Numbers above each set of data indicate correct responding per stimuli set, i.e., 1= Set 1; 2= Set 2; 3= Set 3; 4= Set 4.
Figure 13. Comparison of total sum of participants’ correct responses to delayed drawing probes for Sets 1, 2, 3 and 4 across experimental and control groups.
Figure 14. Comparison of correct responses to delayed drawing probes emitted by Dyad 1 pre- and post-MEI intervention and in the repeated probe condition for probe sets 1-4 and novel sets. Note: Numbers above each set of data indicate correct responding per stimuli set, i.e., 1= Set 1; 2= Set 2; 3= Set 3; 4= Set 4.
Figure 15. Comparison of total sum of correct responses to delayed drawing probes for Sets 1, 2, 3 and 4 emitted by Dyad 1 pre- and post-MEI as well as during repeated probes.
Figure 16. Comparison of correct responses to delayed drawing probes emitted by Dyad 2 pre- and post-MEI intervention and in the repeated probe condition for probe sets 1-4 and novel sets. Note: Numbers above each set of data indicate correct responding per stimuli set, i.e., 1= Set 1; 2= Set 2; 3= Set 3; 4= Set 4.
Figure 17. Comparison of total sum of correct responses to delayed drawing probes for Sets 1, 2, 3 and 4 emitted by Dyad 2 pre- and post-MEI as well as during repeated probes.
Figure 18. Comparison of correct responses to delayed drawing probes emitted by Dyad 3 pre- and post-MEI intervention and in the repeated probe condition for probe sets 1-4 and novel sets. Note: Numbers above each set of data indicate correct responding per stimuli set, i.e., 1= Set 1; 2= Set 2; 3= Set 3; 4= Set 4.
Figure 19. Total sum of correct responses to delayed drawing probes for Sets 1, 2, 3 and 4 emitted by Dyad 3 pre- and post-MEI as well as during repeated probes.
**Intervention sessions for MEI-experimental group**

Participant D was exposed to two sets of MEI intervention. He met criteria across all response topographies for Set 1 in four sessions (Figure 20) and met criteria for Set 2 in two sessions. Participant A was exposed to three sets of MEI intervention. He met criteria on Set 1 in nine sessions; Set 2 in six sessions and Set 3 in 8 sessions (Figure 21). Participant F was also exposed to three MEI intervention sets and met Set 1 in five sessions, Set 2 in three sessions and Set 3 in three sessions (Figure 22).

![Figure 20](image)

**Figure 20.** Participant D correct responses to MEI intervention sets. Participant D was exposed to MEI intervention Sets 1 and 2.
Figure 21. Participant A correct responses to MEI intervention sets. Participant A was exposed to MEI intervention Sets 1, 2 and 3.

Figure 22. Participant F correct responses to MEI intervention sets. Participant F was exposed to MEI intervention Sets 1, 2 and 3.
Discussion

The first experiment investigated whether conditioned seeing is a component of bidirectional naming (BiN) for unfamiliar stimuli and whether these repertoires are evoked as a function of multiple exemplar instruction. Results of the study indicate that BiN for unfamiliar stimuli was present for Participant D following two sets of the multiple exemplar instruction (MEI) training and for Participant F following three sets of the MEI training with a drawing component. Unidirectional naming emerged for Participant A and correct speaker responses to unfamiliar stimuli presented during probe sessions increased. An additional intervention session was not implemented as the participant left the school. Similarly, delayed drawing repertoires were observed at criteria levels for Participants D and F following MEI with transcription and untaught drawing responses increased for Participant A though criterion was not achieved with the Novel Probe Set.

Results of the present study indicate that conditioned seeing and bidirectional naming repertoires may be related since increases in delayed drawing responses simultaneously emerged with bidirectional naming responses for participants assigned to the multiple exemplar instruction (MEI) experimental group. Although previous research has demonstrated the effectiveness of MEI in the induction of bidirectional naming repertoires (Cahill & Greer, 2014; Mosca, 2015; Fiorile & Greer, 2007; Gilic & Greer, 2011; Greer et al., 2007; Greer, Stolfi, et al., 2005; Greer & Speckman, 2009, Hawkins, Kingsdorf, Charnock, Szabo & Gautreaux, 2009), it is not clear whether delayed drawing and bidirectional naming emerged for these participants as a function of MEI with an isolated drawing experience component or as a function of the MEI experience as a whole. In addition, while an increase in BiN responses was observed, it is not
clear whether increases in untaught speaker and listener responses to unfamiliar stimuli were functionally related to conditioned seeing or delayed drawing behaviors.

Interestingly, although bidirectional naming did not emerge with participants assigned to the repeated probe control group condition, high rates of correct responding to untaught listener and speaker responses were emitted by two of the three participants during initial probe sessions with a decrease in correct responding observed over subsequent probe sessions. In addition, accuracy in delayed drawing responses to probe stimuli sets were observed across the second and third repeated probe sessions with all three participants in the repeated probe control group. Correct responding then decreased over the fourth and fifth repeated probe sessions for two of the three participants, Participants B and C. Unlike participants in the MEI-experimental group, Participants B and C did not have contact with reinforcement for drawing the unfamiliar stimuli or emitting speaker and listener responses to the stimuli, which may have led to the decrease in correct responding. It should also be noted here that Participant E was not exposed to a fourth or fifth probe session as his counterpart had met criterion on bidirectional naming and delayed drawing repertoires.

For participants in the control group, it is also interesting to note that exposure to the school curriculum, Direct Instruction (DI), did not evoke BiN for unfamiliar stimuli, though it may account for the increase in accurate delayed drawing responses, as DI frequently requires the participants to engage in derived relational responding through teacher guidance (Laurent-Prophete, 2017). Stockard (2010) found that exposure to DI for three years, from first to fourth grade, was crucial in improvement of reading and vocabulary skills, however none of the participants in Experiment I had experienced DI for more than two years by the cessation of the study. Although research has not yet been conducted on delayed drawing responses as
representative of derived relational responding, these findings provide preliminary indication that
delayed drawing responses may potentially represent derived relational responding.

In a series of experiments, Lo (2016) implemented a repeated probe procedure paired
with an additional sensory experience and found increases in untaught listener and speaker
response topographies emerged during subsequent probe sessions. Cao (2016) also found that
bidirectional naming emerged in Chinese with contrived and non-contrived stimuli, as well as
bidirectional naming in English with non-contrived stimuli as a function of the repeated probe
procedure. Although an increase in correct responding to delayed drawing probes emerged for
participants assigned to the repeated probe control group in the present study, correct responding
decreased during subsequent probe sessions and bidirectional naming repertoires did not emerge.
The decrease in correct responding may be attributed to the lack of contact with reinforcement
for engaging in listener and speaker responses to the unfamiliar stimuli and for drawing the
stimuli that participants in the experimental group received during MEI sessions.

Additionally, these findings may also be due to the lack of unidirectional naming
repertoires demonstrated by participants in the repeated probe control group for unfamiliar
stimuli. Research in verbal behavior development and specifically bidirectional naming has
theorized that unidirectional naming may be a cusp in and of itself and that bidirectional naming
cannot emerge until unidirectional naming is induced (Feliciano, 2006; Greer & Speckman,
2009; Tullo Woolslayer, 2013; Speckman et al., 2007). In addition, recent literature suggests
that the establishment of a history of conditioned reinforcement may be a crucial cusp in
development of higher order repertoires, such as incidental language acquisition (Frias, 2017;
Greer & Du, 2015b; Lo, 2016; Longano & Greer, 2015). The MEI experience may have
functioned to condition the previously neutral stimuli as a reinforcer for participants who were exposed to the MEI intervention.

Recent research has also indicated that implementation of a stimulus-stimulus conditioning procedure may lead to the emergence of non-familiar contrived stimuli as a reinforcer (Frias, 2017; Longano & Greer, 2015). The addition of sensory experiences (Frias, 2017; Lo, 2016) paired with naming experiences may also function to establish multiple stimulus control. An increase in correct responding to delayed drawing probes for participants in the repeated probe control condition from the first to third probe sessions may be attributed to an initial history of conditioned reinforcement to the additional sensory experience (drawing), however these increases were not sustained since participants did not experience further conditioning procedures. As such, bidirectional naming also did not emerge.

**Rationale for Experiment II**

Recent studies have identified unidirectional naming as a necessary prerequisite for bidirectional naming and have indicated that establishment of a history of conditioned reinforcement for non-familiar contrived stimuli may lead to the emergence of bidirectional naming repertoires. Additional sensory experiences may also function to condition these stimuli as reinforcers. While assessments for BiN with unfamiliar stimuli were conducted for Experiment I, the investigator found one matched dyad to have unidirectional naming for unfamiliar stimuli as well as a higher number of correct delayed drawing responses than their peers. It appeared multiple stimulus control had been established across listening and speaking; therefore, would the implementation of a learn unit procedure with a drawing component function to establish stimulus control across speaker responses?
Chapter III

EXPERIMENT II

Method

Participants

Two participants were selected from the same setting as Experiment I. During assessments for bidirectional naming (BiN) for unfamiliar stimuli conducted as part of Experiment I, the investigator discovered that Participants G and H demonstrated much stronger unidirectional naming and delayed drawing repertoires for unfamiliar stimuli without direct instruction when compared to their peers. Participants G and H were removed from Experiment I to experience an alternate procedure as stimulus control appeared to have been established across drawing and listener responses. Neither participant demonstrated BiN for unfamiliar stimuli.

As in Experiment I, necessary prerequisite repertoires for the study included teacher presence resulting in instructional control, basic listener literacy, point-to topography, independent tact repertoires, and independent mand repertoires. Participant G textually responded at 60 words per minute or higher (Greer & Ross, 2008); Participant H textually responded at 80 words per minute. In addition, participants also had the following cusps and capabilities (Greer & Speckman, 2009; Rosales-Ruiz & Baer, 1997) in repertoire at the onset of the study: conditioned reinforcement for two-dimensional and three-dimensional stimuli, match-to-sample, generalized imitation, listener literacy and auditory matching. Table 10 provides further description of participants, both of whom were male and functioned at speaker/listener levels of verbal behavior. Both participants in the study had been diagnosed with autism spectrum disorder prior to the onset of the experiment and were exposed to Direct Instruction.
(DI) (Engelmann et al., 1988). See Table 11 for a full list of curricula and instruction each participant experienced throughout the study.

Table 10

*Description of Participants at the onset of Experiment II.*

<table>
<thead>
<tr>
<th>Participant</th>
<th>Age/ Gender/</th>
<th>Level of VB</th>
<th>Current grade level</th>
<th>Test Scores</th>
</tr>
</thead>
<tbody>
<tr>
<td>G</td>
<td>10.5/ Male/</td>
<td>Reader/</td>
<td>3rd grade Math*</td>
<td>Numerical Operations</td>
</tr>
<tr>
<td></td>
<td>ASD/ City</td>
<td>Writer</td>
<td></td>
<td>SS-82</td>
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<tr>
<td></td>
<td></td>
<td></td>
<td>3rd grade Reading*</td>
<td>Reading Comprehension</td>
</tr>
<tr>
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<td></td>
<td></td>
<td></td>
<td>SS-72</td>
</tr>
<tr>
<td>H</td>
<td>9.7/ Male/</td>
<td>Pre-reader/</td>
<td>2nd grade Math*</td>
<td>Math Reasoning</td>
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<td>ASD/ City</td>
<td>Writer</td>
<td></td>
<td>SS-74</td>
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<tr>
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<td></td>
<td></td>
<td>1st grade Reading*</td>
<td>Reading Comprehension</td>
</tr>
<tr>
<td></td>
<td></td>
<td></td>
<td></td>
<td>SS-75</td>
</tr>
</tbody>
</table>

Note: SS refers to Standard Score. ASD refers to Autism Spectrum Disorder.

*Participants assessed by the Wechsler Intelligence Achievement Test®—Third Ed.*
Table 11

Curricula taught to participants as part of daily academic instruction throughout Experiment II.

<table>
<thead>
<tr>
<th>Participant</th>
<th>Examples of Curricula Taught During Experiment</th>
</tr>
</thead>
<tbody>
<tr>
<td>H</td>
<td>Reading Mastery, Spelling Mastery, Connecting Math Concepts, Language for Writing</td>
</tr>
<tr>
<td>G</td>
<td>Reading Mastery, Spelling Mastery, Connecting Math Concepts, Language for Thinking</td>
</tr>
</tbody>
</table>

Setting

The setting for Experiment II was the same as Experiment I.

Materials

Materials for Experiment II were the same as those used in Experiment I. During initial probe sessions, Sets 1-4 from Experiment I were used (see Table 4). Subsequently, four additional sets, Sets 5, 6, 7 and 8 (see Table 12) were also assessed during pre-intervention probe sessions which consisted of characters taken from languages unfamiliar to the participants and given one-syllable contrived names. These languages were Korean, Arabic, Chinese, and Bengali.
Table 12

Visual and auditory unfamiliar stimuli for Sets 5, 6, 7 and 8 used for pre- and post-intervention probe sets in Experiment II.

<table>
<thead>
<tr>
<th>Set 5</th>
<th>Set 6</th>
<th>Set 7</th>
<th>Set 8</th>
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<tr>
<td>子</td>
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<td>گ</td>
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</tr>
<tr>
<td>不</td>
<td>ي</td>
<td>ك</td>
<td>❌</td>
<td>❌</td>
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<td>❌</td>
<td>❌</td>
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<td>د</td>
<td>❌</td>
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<td>ق</td>
<td>٦</td>
<td>❌</td>
<td>❌</td>
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<td>Auditory</td>
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<td>Auditory</td>
</tr>
<tr>
<td>Pob</td>
<td>Vox</td>
<td>Biz</td>
<td>Yim</td>
<td>Sook</td>
</tr>
<tr>
<td>Das</td>
<td>Pip</td>
<td>Jup</td>
<td>Puv</td>
<td>Yut</td>
</tr>
<tr>
<td>Mir</td>
<td>Bub</td>
<td>Nom</td>
<td>Quib</td>
<td>Pret</td>
</tr>
<tr>
<td>Cav</td>
<td>Gaw</td>
<td>Paj</td>
<td>Flug</td>
<td>Raz</td>
</tr>
<tr>
<td>Haz</td>
<td>Zan</td>
<td>Tiv</td>
<td>Zad</td>
<td>Vin</td>
</tr>
</tbody>
</table>
Visual and vocal stimuli. Stimuli sets were presented in the same format as in Experiment I. Set 5 consisted of characters taken from the written capital Wubi Xing alphabet; Set 6 consisted of characters from the written lowercase Arabic alphabet; Set 7 consisted of characters from the written lowercase Bengala alphabet; and Set 8 consisted of characters from the written Chinese Zhuyin alphabet and numerals. All stimuli were assigned random nonsensical one-syllable consonant-vowel-consonant (CVC) or consonant-vowel-vowel-consonant (CVVC) words.

Delayed drawing responses. Probe trials for delayed drawing responses were conducted in the same manner as in Experiment I.

Design and Procedure

A multiple probe design (Horner & Baer, 1978) was implemented to test for a presence of delayed drawing for visual contrived unfamiliar stimuli as a component of and speaker responses BiN. See Figure 23 for design sequence.

<table>
<thead>
<tr>
<th>Participant G</th>
<th>Pre-intervention probes conducted for Sets 1-4</th>
<th>Repeated pre-intervention probes conducted for Sets 1-4</th>
<th>Pre-intervention probes conducted for Sets 5-8</th>
<th>Learn unit intervention procedure</th>
<th>Post-learn unit intervention probes conducted</th>
</tr>
</thead>
<tbody>
<tr>
<td>Participant H</td>
<td>Pre-intervention probes conducted for Sets 1-4</td>
<td>Repeated pre-intervention probes conducted for Sets 1-4</td>
<td>Pre-intervention probes conducted for Sets 5-8</td>
<td>Learn unit intervention procedure</td>
<td>Post-learn unit intervention probes conducted</td>
</tr>
</tbody>
</table>

Figure 23. Design sequence of intervention and probe sessions for participants in Experiment II.
Pre-experimental probes to assess for the presence of bidirectional naming with familiar stimuli. Pre-experimental probes were conducted with familiar stimuli in the same manner as in Experiment I.

Pre-experimental probes for unfamiliar stimuli. Pre-experimental probes for non-familiar stimuli were conducted in the same manner as Experiment I for probe sets 1-8 (see Tables 4 and 12). Participants demonstrated unidirectional naming and delayed drawing repertoires to unfamiliar stimuli.

Naming experiences for probe sets. Same as in Experiment I. Naming experiences were conducted for probe sets 1-8 (see Tables 4 and 12) in a sequential fashion (e.g., participants were not exposed to more than one probe set at a time).

Probe sessions to assess for bidirectional naming: Dependent Variable. Probe sessions to assess for BiN were conducted in the same manner as in Experiment I.

Probe sessions to assess for delayed drawing responses: Dependent Variable. Probe sessions to assess delayed drawing responses were conducted in the same manner as in Experiment I. Probe sessions were conducted for each participant across eight contrived, unfamiliar stimuli sets prior to implementation of the intervention. Post-probe sessions were only conducted with Sets 5-8, however, to address the effects of retroactive interference for Sets 1-4.

Learn unit intervention with training sets: Independent Variable. Both participants were exposed to the independent variable, implementation of a learn unit procedure (Albers & Greer, 1991; Greer & Ross, 2008) to establish stimulus control across listener, drawing and speaker responses. During the procedure, participants viewed teaching stimuli sets presented on a Microsoft® PowerPoint™ presentation that differed from sets used during probe sessions.
Teaching stimuli sets consisted of contrived, unfamiliar visual stimuli given one-syllable nonsensical names (see Table 13 for stimuli sets used during operant conditioning procedure).

The participants viewed one stimulus per screen, were given the name of the stimulus, and were required emit an echoic for the name of the stimulus. Participants were then requested to draw the stimulus and repeat the name while drawing.

Learn units (Albers & Greer, 1991) were delivered throughout the intervention such that correct responses were consequted with reinforcement in the form of praise and incorrect responses were consequted with corrections. A correct response consisted of drawing the stimulus with point-to-point correspondence while saying the name of the stimulus; an incorrect response occurred when the participant drew the stimulus incorrectly and/or did not say the name of the stimulus. It was noted throughout the session when the participant emitted the name of the stimulus before the experimenter could give the initial echoic. Mastery criteria was 100% across one session or 90% across two consecutive sessions.
Table 13

*Visual and auditory unfamiliar stimuli used for learn unit intervention sets used throughout Experiment II.*

<table>
<thead>
<tr>
<th>Set 1</th>
<th>Set 2</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>Visual</strong></td>
<td><strong>Visual</strong></td>
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<tr>
<td>ز</td>
<td>د</td>
</tr>
<tr>
<td>ﱵ</td>
<td>ﱲ</td>
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<tr>
<td>ﱫ</td>
<td>ﯽ</td>
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<tr>
<td>ﱳ</td>
<td>ﯽ</td>
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<tr>
<td>ﱬ</td>
<td>ﯽ</td>
</tr>
<tr>
<td>ﱭ</td>
<td>ﯽ</td>
</tr>
<tr>
<td><strong>Auditory</strong></td>
<td><strong>Auditory</strong></td>
</tr>
<tr>
<td>Zim</td>
<td>Muz</td>
</tr>
<tr>
<td>Yer</td>
<td>Bey</td>
</tr>
<tr>
<td>Res</td>
<td>Nox</td>
</tr>
<tr>
<td>Rit</td>
<td>Vit</td>
</tr>
<tr>
<td>Wex</td>
<td>Das</td>
</tr>
</tbody>
</table>
Post-probe sessions for bidirectional naming and delayed drawing. After mastery criterion was achieved with operant conditioning intervention sets, post-intervention probe sessions were conducted using probe Sets 5, 6, 7 and 8. Procedure and criteria were the same as in Experiment I. When criteria were met across probe sets, responding to novel stimuli were assessed.

Data Collection

Data collection was the same as in Experiment I.

Interobserver and Interscorer Agreement

Interobserver agreement (IOA) for the listener and speaker responses to probe sessions testing for the presence of BiN. IOA for echoics emitted by participants during naming experiences were also conducted using trial-by-trial IOA (Cooper, Heron & Heward, 2007). Interscorer agreement (ISA) was calculated for delayed drawing responses. IOA and ISA procedures were conducted in the same manner as in Experiment I. See Tables 14 and 15 for IOA and ISA data.

Across both participants, 55% of naming experiences were calculated for IOA with 100% agreement; 62.5% of probe sessions were calculated for with 87.5% agreement and 41.5% of intervention sessions were calculated for 92.5% agreement. ISA was calculated for 70% of probe sessions with 100% agreement across both participants for drawing.
Table 14

*Interobserver agreement calculated across probe and intervention sessions for participants in Experiment II.*

<table>
<thead>
<tr>
<th>Participant</th>
<th>Percentage of Naming Sessions with IOA</th>
<th>Calculated IOA</th>
<th>Percentage of Probe Sessions with IOA</th>
<th>Calculated IOA*</th>
<th>Percentage of Intervention Sessions with IOA</th>
<th>Calculated IOA**</th>
</tr>
</thead>
<tbody>
<tr>
<td>G</td>
<td>50%</td>
<td>100%</td>
<td>80%</td>
<td>85%</td>
<td>45%</td>
<td>95%</td>
</tr>
<tr>
<td>H</td>
<td>60%</td>
<td>100%</td>
<td>45%</td>
<td>90%</td>
<td>38%</td>
<td>90%</td>
</tr>
</tbody>
</table>

*Range of calculated IOA for probe sessions was 80%-100%.

**Range of calculated IOA for intervention sessions was 90%-100%.
Table 15

*Interscorer agreement calculated for delayed drawing responses across probe session for participants in Experiment II.*

<table>
<thead>
<tr>
<th>Participant</th>
<th>Percentage of Probe Sessions</th>
<th>Calculated ISA with ISA</th>
</tr>
</thead>
<tbody>
<tr>
<td>G</td>
<td>60%</td>
<td>100%</td>
</tr>
<tr>
<td>H</td>
<td>80%</td>
<td>100%</td>
</tr>
</tbody>
</table>

Note: Interscorer agreement was calculated across four independent scorers and the experimenter (total of five scorers). The calculated interscorer agreement column represents mean agreement across all five observers.

**Results**

**Bidirectional Naming Probes for Unfamiliar Stimuli**

During the first pre-intervention probe for sets 1-4, Participant G emitted 30 total correct listener responses (mean= 7.5, range 4-10) and 13 total correct speaker responses (mean 3.25, range 1-6) (Figures 24 and 25) out of 40 opportunities; during the second pre-intervention probe for Sets 1-4, he emitted 26 total correct listener responses (mean= 6.5, range 5-8) and 7 total correct speaker responses (mean 1.75, range 0-3) indicating the presence of unidirectional naming in repertoire. Participant H emitted 26 total correct listener responses (mean= 6.5, range
4-8) and 12 total correct speaker responses (mean 3.0, range 2-4) (Figures 24 and 25) during the first pre-intervention probe for sets 1-4; in the second pre-intervention probe for Sets 1-4, he emitted 21 total correct listener responses (mean= 5.25, range 5-8) and 1 total correct speaker response (mean 1.75, range 0-3) also indicating the emergence of unidirectional naming in repertoire for Participant D.

During the pre-learn unit intervention probe for Sets 5-8, Participant G emitted 18 total correct listener responses (mean 4.5, range 2-6) and 17 total correct speaker responses (mean= 4.25, range 2-4) (Figures 24 and 25). Participant H emitted 22 total correct listener responses (mean= 5.5, range 5-6) and 10 total correct speaker responses (mean= 2.0, range 1-4) (Figures 24 and 25) during the initial pre-intervention probe for Sets 5-8 and 21 total correct listener responses (mean= 5.25, range 4-7) and 13 total correct speaker responses (mean= 3.25, range 2-5) during the second pre-intervention probe.

Following the first learn unit intervention, Participant G emitted 26 total correct listener responses (mean= 6.5, range 4-9) and 21 total correct speaker responses (mean= 5.25, range 1-8) (Figures 24 and 25) during post-intervention probes and 32 total correct listener responses (mean= 8.0, range 7-9) and 27 total correct speaker responses (mean= 6.75, range 507) during the second post-intervention probe. Participant H emitted 28 total correct listener responses (mean= 7.0, range 5-10) and 23 total correct speaker responses (mean= 5.75, range 5-6) (Figures 12 and 13) during the first post-learn unit intervention probe session. He emitted 36 total correct listener responses (mean= 9.0, range 8-10) and 32 total correct speaker responses (mean= 8.0, range 5-10) during the second probe session. Following mastery of two intervention sets, participants were assessed for BiN repertoires with novel unfamiliar stimuli. Both Participants G
and H emitted 8 correct listener responses and 7 correct speaker responses, indicating the presence of BiN.

Figure 24. Participants’ correct responses to bidirectional naming probes in Experiment II per stimuli set for probe sets 1-4 as well as novel sets.

Note: Numbers above each set of data indicate correct responding per stimuli set, i.e., 1= Set 1; 2= Set 2; 3= Set 3; 4= Set 4, etc.
Figure 25. Total sum of participants correct responses to bidirectional naming probes in Experiment II for Sets 1-4 and Sets 5-8.
**Delayed Drawing Probes for Unfamiliar Stimuli**

During the first and second pre-intervention probes conducted for Sets 1-4, Participant G emitted 9 (mean= 2.25, range 1-3) and 15 (mean= 3.75, range 2-5) total correct responses out of 20 opportunities (5 per stimuli set) (Figures 26 and 27), respectively. Participant G emitted 14 (mean= 2.25, range 3-4) and 20 (mean= 5) total correct responses, respectively (Figures 26 and 27), during the first and second pre-intervention probes for Sets 1-4. During the initial pre-intervention probe for delayed drawing responses for Sets 5-8, Participant G emitted 12/20 (mean= 3.0, range 2-4) total correct responses; during the first pre-intervention probe for Sets 5-8, Participant H emitted 16/20 (mean= 4.0, range 3-5) total correct responses and 20/20 total correct responses during the second pre-intervention probe indicating delayed drawing repertoires had emerged for Participant H with Sets 5-8 (Figures 26 and 27).

In the first post-learn unit intervention probe session, Participant G emitted 11/20 correct delayed drawing responses (mean= 2.75, range 1-4) and 14 correct delayed drawing responses (mean= 3.5, range 2-4) in the second post-learn unit intervention probe session (Figures 26 and 27). Participant H emitted 20/20 correct delayed drawing responses (mean= 5.0) for sets 5-8 during first and second post-learn unit probe sessions (Figures 14 and 15). Probes for delayed drawing were conducted with novel unfamiliar probe sets of stimuli following the second post-learn unit intervention sets. Participants G and H emitted 4/5 and 5/5 correct responses respectively, indicating criterion-level responding for delayed drawing repertoires.
Figure 26. Participants’ correct responses to delayed drawing probes conducted in Experiment II per stimuli set.

Note: Numbers above each set of data indicate correct responding per stimuli set, i.e., 1 = Set 1; 2 = Set 2; 3 = Set 3; 4 = Set 4, etc.
Figure 27. Total sum of participants’ correct responses to delayed drawing probe sessions during Experiment II for probe sets 1-8.
**Intervention Sessions**

Participants G and H were both exposed to two sets of learn unit interventions. Participant G met criterion on Set 1 in five sessions and Set 2 in three sessions (Figure 28). Participant H met criterion on both Sets 1 and 2 in three sessions (Figure 29).

Figure 28. Participant G correct responses to learn unit intervention sessions.
Figure 29. Participant H correct responses to learn unit intervention sessions.
Discussion

Experiment II sought to investigate whether implementation of a learn unit procedure with a drawing response would lead to the presence of bidirectional naming (BiN) for unfamiliar stimuli with students who demonstrated unidirectional naming and delayed drawing responses with these stimuli. Results of this experiment indicated an increase in untaught speaker and listener responses across probe and novel stimuli sets for unfamiliar stimuli following the learn unit procedure, indicating that multiple control across speaker, listener, and drawing responses was established for Participants G and H.

The presence of BiN with unfamiliar stimuli following the intervention corresponds to literature indicating that establishment of conditioned reinforcement for non-familiar stimuli may lead to a language explosion, as described by Greer and Longano (2010) and Longano and Greer (2015). When this occurs, children with autism are able to hear the name of an object “That’s my shoe!” and are subsequently able to identify the object as a speaker and listener (“I see your shoe!” and “My shoe is the same as your shoe because they are both shoes!”) without direct instruction. Language does not need to be taught directly and BiN relations are evoked as a function of derived relational responding.

Establishing a history of conditioned reinforcement may be the key to higher order verbal development (Greer & Du, 2015b), including observing responses to faces and voices (Maffei et al., 2014) as well as academic instructional stimuli (Du et al., 2015; Greer & Han, 2015; Speckman et al., 2017) which are considered pre-verbal foundational repertoires (Greer, 2008; Greer & Ross, 2008; Greer & Speckman, 2009). It may also be an integral component in the establishment of multiple control across speaker, listener and drawing responses. Further, the addition of another sensory experience paired with observing a visual stimulus simultaneously
with an auditory stimulus (i.e., multiple experiences) may lead to the emergence of bidirectional naming (Lo, 2016), however this experience may be insufficient without first establishing a history of conditioned reinforcement for observing (Frias, 2017; Longano & Greer, 2015).

Delayed drawing responses also increased for participants following the intervention, however both participants had demonstrated strong delayed drawing repertoires prior to implementation of the conditioning procedure. Therefore, it can be argued that delayed drawing or conditioned seeing was already in repertoire for these participants and did not emerge as a function of the learn unit procedure. In addition, the role of the echoic is unclear throughout Experiment II. Literature suggests that the echoic and engagement in overt echoic behavior may function to condition covert echoic behavior (Longano, 2008), which can also be a source of reinforcement for bidirectional naming (Horne & Lowe, 1996). By requiring and reinforcing echoic behavior during the conditioning intervention, as well as delivering reinforcement for saying and drawing the stimulus correctly, the source of reinforcement for development of bidirectional naming repertoires in this study is ambiguous.

**Rationale for Experiment III**

While the present study identified the learn unit as a possible intervention to establish multiple stimulus control across BiN responses, it is not yet clear whether this procedure would be successful with children with autism who do not demonstrate unidirectional naming or delayed drawing responses for unfamiliar stimuli.

Additionally, by requiring the participants to emit an echoic throughout the intervention, the role of the echoic as a source of reinforcement for BiN is not clear in this study. The subsequent experiment addresses these limitations by eliminating the echoic. It will further investigate the implementation of the learn unit procedure as an intervention to induce BiN and
delayed drawing responses for unfamiliar stimuli with four participants who do not have unidirectional naming or delayed drawing repertoires for unfamiliar stimuli in repertoire.
Chapter IV

EXPERIMENT III

Method

Participants

Participants from Experiment III were the same participants who participated in the control group in Experiment I (Participants B, C, and E) with the addition of a fourth participant (Participant I). See Table 16 for participant information. All participants received academic instruction, as described in the previous experiments (see Table 17 for curricula information). Necessary prerequisite cusps and capabilities were the same as in the previous experiments.
Table 16

_Description of Participant I at the onset of Experiment III._

<table>
<thead>
<tr>
<th>Participant</th>
<th>Age/ Gender/</th>
<th>Level of VB</th>
<th>Current grade level</th>
<th>Test Scores</th>
</tr>
</thead>
<tbody>
<tr>
<td>B</td>
<td>11.5/ Male/</td>
<td>Reader/</td>
<td>4&lt;sup&gt;th&lt;/sup&gt; grade Math***</td>
<td>Calculation SS-102</td>
</tr>
<tr>
<td></td>
<td>ASD/ City</td>
<td>Writer</td>
<td>2&lt;sup&gt;nd&lt;/sup&gt; grade Reading***</td>
<td>Letter-Word Recognition SS-100</td>
</tr>
<tr>
<td>C</td>
<td>10.4/ Male/</td>
<td>Reader/</td>
<td>2&lt;sup&gt;nd&lt;/sup&gt; grade Math*</td>
<td>Math Reasoning SS-118</td>
</tr>
<tr>
<td></td>
<td>ASD/ City</td>
<td>Writer</td>
<td>2&lt;sup&gt;nd&lt;/sup&gt; grade Reading*</td>
<td>Reading Comprehension SS-89</td>
</tr>
<tr>
<td>E</td>
<td>11.4/ Male/</td>
<td>Reader/</td>
<td>2&lt;sup&gt;nd&lt;/sup&gt; grade Math*</td>
<td>Math Reasoning SS-82</td>
</tr>
<tr>
<td></td>
<td>ASD/ Suburb</td>
<td>Writer</td>
<td>4&lt;sup&gt;th&lt;/sup&gt; grade Reading*</td>
<td>Reading Comprehension SS-119</td>
</tr>
<tr>
<td>I</td>
<td>9.6/ Male/</td>
<td>Reader/</td>
<td>3&lt;sup&gt;rd&lt;/sup&gt; grade Math*</td>
<td>Math Reasoning SS-69</td>
</tr>
<tr>
<td></td>
<td>ASD</td>
<td>Writer</td>
<td>3&lt;sup&gt;rd&lt;/sup&gt; grade Reading*</td>
<td>Reading Comprehension SS-71</td>
</tr>
</tbody>
</table>
Note: SS refers to Standard Score. ASD refers to Autism Spectrum Disorder.

*Participants assessed by the Wechsler Intelligence Achievement Test®—Third Ed.
Table 17

Curricula taught to Participant I as part of his daily academic instruction throughout Experiment III.

<table>
<thead>
<tr>
<th>Participant</th>
<th>Examples of Curricula Taught During Experiment</th>
</tr>
</thead>
<tbody>
<tr>
<td>B</td>
<td>Reading Mastery, Spelling Mastery, Connecting Math Concepts, Language for Thinking</td>
</tr>
<tr>
<td>C</td>
<td>Reading Mastery, Spelling Mastery, Connecting Math Concepts, Language for Writing</td>
</tr>
<tr>
<td>E</td>
<td>Scott Foresman Social Studies, Scott Foresman Science, Instructional Trials for Reading, Math, Spelling</td>
</tr>
<tr>
<td>I</td>
<td>Reading Mastery, Spelling Mastery, Connecting Math Concepts, Language for Thinking</td>
</tr>
</tbody>
</table>

Setting

The setting for Experiment III was the same as Experiments I and II.

Materials

Materials for Experiment III were the same as those used in Experiment II, however only two probe sets were tested instead of four. See Table 18 for probe and novel probe stimuli sets used throughout Experiment III; see Table 19 for intervention stimuli sets.
Table 18

*Visual and auditory unfamiliar stimuli implemented for pre- and post-intervention probe sessions as well as novel probe sets used during Experiment III.*

<table>
<thead>
<tr>
<th>Set 1</th>
<th>Set 2</th>
<th>Novel Set 1</th>
<th>Novel Set 2</th>
</tr>
</thead>
<tbody>
<tr>
<td>Visual</td>
<td>Visual</td>
<td>Visual</td>
<td>Visual</td>
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<tr>
<td>子</td>
<td>لا</td>
<td>ظ</td>
<td>ِ</td>
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<td>不</td>
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<tr>
<td>水</td>
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<tr>
<td>Auditory</td>
<td>Auditory</td>
<td>Auditory</td>
<td>Auditory</td>
</tr>
<tr>
<td>Pob</td>
<td>Vox</td>
<td>Sook</td>
<td>Lep</td>
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<tr>
<td>Das</td>
<td>Pip</td>
<td>Yut</td>
<td>Drup</td>
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<tr>
<td>Mir</td>
<td>Bub</td>
<td>Pret</td>
<td>Vej</td>
</tr>
<tr>
<td>Cav</td>
<td>Gaw</td>
<td>Raz</td>
<td>Baz</td>
</tr>
<tr>
<td>Haz</td>
<td>Zan</td>
<td>Vin</td>
<td>Ref</td>
</tr>
</tbody>
</table>
Table 19

*Visual and auditory unfamiliar stimuli used for learn unit intervention sets used throughout Experiment III.*

<table>
<thead>
<tr>
<th>Set 1</th>
<th>Set 2</th>
<th>Set 3</th>
</tr>
</thead>
<tbody>
<tr>
<td>Visual</td>
<td>Visual</td>
<td>Visual</td>
</tr>
<tr>
<td>ز</td>
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<td>ش</td>
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<td>Auditory</td>
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<td>Zim</td>
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<td>Res</td>
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<td>Paj</td>
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<td>Wex</td>
<td>Das</td>
<td>Tiv</td>
</tr>
</tbody>
</table>
Design and Procedure

A multiple probe design (Horner & Baer, 1978) was implemented to test for delayed drawing and bidirectional naming responses (BiN) with unfamiliar stimuli. All participants were assessed for the presence of BiN and delayed drawing with unfamiliar stimuli prior to implementation of the intervention. Participant E was then exposed to the learn unit intervention and probes were conducted following mastery of each intervention set. After criteria were met for BiN and delayed drawing with probe stimuli sets, Participant C was exposed to a second probe session after which he began the intervention. After Participant C met criteria on BiN and delayed drawing with unfamiliar stimuli during probe sessions, Participant B experienced another probe session and so on. See Figure 30 for design sequence.
<table>
<thead>
<tr>
<th>Participant</th>
<th>Pre-intervention probes conducted for Sets 1 and 2</th>
<th>Learn unit intervention</th>
<th>Post-learn unit intervention probes conducted</th>
<th>Pre-intervention probes conducted for Sets 1 and 2</th>
<th>Learn unit intervention</th>
<th>Post-learn unit intervention probes conducted</th>
<th>Pre-intervention probes conducted for Sets 1 and 2</th>
<th>Learn unit intervention</th>
<th>Post-learn unit intervention probes conducted</th>
<th>Pre-intervention probes conducted for Sets 1 and 2</th>
<th>Learn unit intervention</th>
<th>Post-learn unit intervention probes conducted</th>
</tr>
</thead>
<tbody>
<tr>
<td>E</td>
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<td>C</td>
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</tbody>
</table>

Figure 30. Design sequence of intervention and probe sessions for participants in Experiment II.

**Pre-experimental probes to asses for the presence of bidirectional naming with familiar stimuli.** Pre-experimental probes were conducted with familiar stimuli for Participant I in the same manner as in Experiment I. Participants E, C and B had previously been assessed in Experiment I. All participants demonstrated BiN with familiar stimuli.

**Pre-experimental probes for contrived or unfamiliar stimuli.** Pre-experimental probes for non-familiar stimuli were conducted in the same manner as Experiment I for Probe
Sets 1 and 2 (see Table 18). No participants demonstrated BiN and delayed drawing with unfamiliar stimuli.

**Naming experiences for probe sets.** Same as in Experiments I and II. Naming experiences were conducted for Probe Sets 1 and 2 (see Table 18) in a sequential fashion (e.g., participants were not exposed to more than one probe set at a time).

**Probe sessions to assess for bidirectional naming: Dependent Variable.** Probe sessions to assess for bidirectional naming were conducted in the same manner as in Experiments I and II. Probe trials were not consequated.

**Probe sessions to assess for delayed drawing responses: Dependent Variable.** Probe sessions to assess delayed drawing responses were conducted in the same manner as in Experiment I for probe sets 1 and 2 (see Table 18). Probe sessions were not consequated.

**Learn Unit: Independent Variable.** The learn unit intervention procedure was implemented as described in Experiment II, however the participants were not required to echo the name of the stimulus when the vocal stimulus was delivered. Reinforcement was not given if the participants emitted an echoic and the name of the stimulus was not presented if the participants independently tacted the stimulus within two seconds of its presentation. See Table 19 for stimuli sets implemented during intervention sessions.

**Post-probe sessions for bidirectional naming and delayed drawing.** Post-probe sessions were conducted for probe sets 1 and 2 following criterion on learn unit intervention sessions.

**Novel probe sessions.** Participants who demonstrated criterion-level or near criterion-level responding to BiN and delayed drawing probes were then exposed to novel probe sets.

**Data Collection**
Data collection was the same as in Experiment II.

**Interobserver and Interscorer Agreement**

Interobserver agreement (IOA) and interscorer agreement (ISA) were conducted in the same manner as in Experiments I and II. Across all participants in Experiment III, a mean of 55% of naming experiences were calculated for IOA with 97.5% agreement (range 90%-100%); mean of 70% of probe sessions were calculated with 90% agreement (range 85%-95%); a mean of 41.25% of intervention sessions were calculated with 87.5% agreement (range 80%-95%). ISA agreement across all participants for delayed drawing responses during probe sessions was 95% with a mean of 77.5% of sessions calculated (range 60%-90%). See Tables 20 and 21 for IOA and ISA data per participant.
Table 20

*Interobserver agreement calculated across probe and intervention sessions for participants in Experiment III.*

<table>
<thead>
<tr>
<th>Participant</th>
<th>Percentage of Naming Sessions with IOA</th>
<th>Calculated IOA</th>
<th>Percentage of Probe Sessions with IOA</th>
<th>Calculated IOA*</th>
<th>Percentage of Intervention Sessions with IOA</th>
<th>Calculated IOA</th>
</tr>
</thead>
<tbody>
<tr>
<td>B</td>
<td>70%</td>
<td>90%</td>
<td>80%</td>
<td>90%</td>
<td>50%</td>
<td>90%</td>
</tr>
<tr>
<td>C</td>
<td>40%</td>
<td>100%</td>
<td>70%</td>
<td>90%</td>
<td>42%</td>
<td>85%</td>
</tr>
<tr>
<td>E</td>
<td>50%</td>
<td>100%</td>
<td>60%</td>
<td>85%</td>
<td>33%</td>
<td>80%</td>
</tr>
<tr>
<td>I</td>
<td>60%</td>
<td>100%</td>
<td>70%</td>
<td>95%</td>
<td>40%</td>
<td>95%</td>
</tr>
</tbody>
</table>

*Range of calculated IOA for probe sessions was 85%-95%.

**Range of calculated IOA for intervention sessions was 80%-95%.
Table 21

*Interscorer agreement calculated for delayed drawing responses across probe session for participants in Experiment III.*

<table>
<thead>
<tr>
<th>Participant</th>
<th>Percentage of Probe Sessions with ISA</th>
<th>Calculated ISA</th>
</tr>
</thead>
<tbody>
<tr>
<td>B</td>
<td>80%</td>
<td>100%</td>
</tr>
<tr>
<td>C</td>
<td>60%</td>
<td>90%</td>
</tr>
<tr>
<td>E</td>
<td>80%</td>
<td>90%</td>
</tr>
<tr>
<td>I</td>
<td>90%</td>
<td>100%</td>
</tr>
</tbody>
</table>

Note: Interscorer agreement was calculated across four independent scorers and the experimenter (total of five scorers). The calculated interscorer agreement column represents mean agreement across all five observers.

**Results**

**Bidirectional Naming Probes for Unfamiliar Stimuli**

During pre-learn unit intervention probe sessions, Participant E emitted 3/10 correct listener responses and 2/10 correct speaker responses for Set 1; 5/10 correct listener responses and 1/10 correct speaker responses for Set 2 (Figure 31). The total sum for correct listener and
speaker responses emitted by Participant E for Sets 1 and 2 during the pre-learn unit probe session was 8/20 and 3/20 respectively (Figure 32).

Following the first learn unit intervention session, Participant E emitted 9/10 correct listener responses and 5/10 correct speaker responses during probe sessions for both Sets 1 and 2 (Figure 31); during the second post-learn unit intervention probe session Participant E emitted 4/10 correct listener responses and 6/10 correct speaker responses for Set 1, 7/10 correct listener responses and 7/10 correct speaker responses for Set 2. He emitted 9/10 correct listener responses and 10/10 correct speaker responses for Set 1, 10/10 correct listener responses and 10/10 correct speaker responses for Set 2 during the third post-learn unit intervention probe. A decision was made to test for bidirectional naming repertoires with a novel unfamiliar stimuli set and Participant E emitted 9/10 correct listener responses and 3/10 correct speaker responses indicating only unidirectional naming had emerged. Following a fourth learn unit intervention set, Participant E emitted 10/10 correct listener and speaker responses with the first set of novel unfamiliar stimuli and 10/10 correct listener response and 8/10 correct speaker responses to a second set of novel unfamiliar stimuli indicating the emergence of bidirectional naming. Total sum of correct listener and speaker responses for Sets 1 and 2 per probe sessions are as follows: 18/20, 12/20; 12/20, 14/20, and 19/20, 20/20 for first, second and third post-intervention probes respectively (Figure 32). Total sum data were not calculated for novel probe sets.

During the first pre-learn unit probe session for Participant C, he emitted 5/10 correct listener responses and 5/10 correct speaker responses for Set 1; 5/10 correct listener responses and 1/10 correct speaker responses for Set 2 (Figure 31). The total sum for correct listener and speaker responses emitted by Participant C for Sets 1 and 2 during the first pre-learn unit probe session was 10/20 and 6/20, respectively (Figure 32). A second pre-intervention probe was also
conducted with Participant C. During this session he emitted 4/10 correct listener responses and 3/10 correct speaker responses for both Set 1 and Set 2 (Figure 31). The total sum for correct listener and speaker responses emitted by Participant C for Sets 1 and 2 during the pre-learn unit intervention probe session was 10/20 and 10/20 respectively (Figure 32).

Following the learn unit intervention, Participant C emitted 6/10 correct listener responses and 2/10 correct speaker responses during probe sessions for Set 1; 5/10 correct listener responses and 2/10 correct speaker responses for Set 2 (Figure 31); during the second post-learn unit intervention probe session Participant C emitted 8/10 correct listener responses and 8/10 correct speaker responses for Set 1, 5/10 correct listener responses and 4/10 correct speaker responses for Set 2. He emitted 10/10 correct listener responses and 10/10 correct speaker responses for both Sets 1 and 2 during the third post-learn unit intervention probe. A decision was made to test for BiN repertoires with a novel unfamiliar stimuli set and Participant C emitted 9/10 correct listener responses and 8/10 correct speaker responses indicating the emergence of BiN. The total sum of correct listener and speaker responses for Sets 1 and 2 per probe sessions are as follows: 11/20, 4/20; 13/20, 12/20, and 20/20, 20/20 for first, second and third post-intervention probes respectively (Figure 32).

Participant B emitted 5/10 correct listener and speaker responses for Set 1 during the first pre-intervention probe session; 5/10 correct listener responses and 2/10 correct speaker responses for Set 2 (Figure 31). The total sum for correct listener and speaker responses emitted by Participant I for Sets 1 and 2 during the first pre-learn unit intervention probe session was 10/20 and 4/20 respectively (Figure 32). A second pre-intervention probe was also conducted with Participant B. During this session, Participant I emitted 4/10 correct listener responses and 3/10 correct speaker responses for Set 1; 2/10 correct listener and speaker responses for Set 2 (Figure
31). The total sum for correct listener and speaker responses emitted by Participant B for Sets 1 and 2 during the pre-learn unit probe session was 6/20 and 5/20 respectively (Figure 32).

Following the first learn unit intervention session, Participant B emitted 3/10 correct listener responses and 3/10 correct speaker responses during probe sessions for Set 1 and 2/10 correct listener responses and 3/10 correct speaker responses for Set 2 (Figure 31); during the second post-learn unit intervention probe session, Participant B emitted 3/10 correct listener responses and 4/10 correct speaker responses for Set 1, 4/10 correct listener responses and 2/10 correct speaker responses for Set 2. He emitted 5/10 correct listener responses and 5/10 correct speaker responses for Set 1, 4/10 correct listener responses and 3/10 correct speaker responses for Set 2 during the third post-learn unit intervention probe. During the fourth post-learn unit intervention probe session, Participant B emitted 9/10 correct listener responses and 9/10 correct speaker responses during probe sessions for Set 1; 9/10 correct listener responses and 10/10 correct speaker responses for Set 2. A decision was then made to test for BiN repertoires with a novel unfamiliar stimuli set and Participant B emitted 9/10 correct listener responses and 9/10 correct speaker responses indicating the emergence of BiN. Total sum of correct listener and speaker responses for Sets 2 per probe sessions are as follows: 5/20, 6/20; 8/20, 7/20; 9/20, 8/20; and 18/20, 19/20 for the first, second, third and fourth post-intervention probes respectively (Figure 32).

Participant I emitted 4/10 correct listener responses and 0/10 correct speaker responses for Set 1 during the first pre-intervention probe session; 10/10 correct listener responses and 2/10 correct speaker responses for Set 2 (Figure 31). The total sum for correct listener and speaker responses emitted by Participant I for Sets 1 and 2 during the first pre-learn unit intervention probe session was 14/20 and 2/20 respectively (Figure 32). A second pre-intervention probe was
also conducted with Participant I. During this session, Participant I emitted 9/10 correct listener responses and 1/10 correct speaker responses for Set 1; 6/10 correct listener responses and 4/10 correct speaker responses for Set 2 (Figure 31). The total sum for correct listener and speaker responses emitted by Participant I for Sets 1 and 2 during the pre-learn unit probe session was 15/20 and 6/20 respectively (Figure 32). 

Following the first learn unit intervention session, Participant I emitted 8/10 correct listener responses and 3/10 correct speaker responses during probe sessions for Set 1; 8/10 correct listener responses and 5/10 correct speaker responses for Set 2 (Figure 31); during the second post-learn unit intervention probe session, Participant C emitted 7/10 correct listener responses and 8/10 correct speaker responses for Set 1, 7/10 correct listener responses and 6/10 correct speaker responses for Set 2. He emitted 10/10 correct listener responses and 10/10 correct speaker responses for both Sets 1 and 2 during the third learn unit intervention probe. A decision was made to test for BiN repertoires with a novel unfamiliar stimuli set and Participant I emitted 10/10 correct listener responses and 8/10 correct speaker responses indicating the emergence of BiN. Total sum of correct listener and speaker responses for Sets 2 per probe sessions are as follows: 16/20, 8/20; 14/20, 14/20; and 20/20, 20/20 for first, second and third post-intervention probes respectively (Figure 32).
Figure 31. Participants correct responses to bidirectional naming probes conducted pre- and post-learn unit interventions implemented throughout Experiment III for probe sets 1 and 2 as well as novel sets.
Figure 32. Total sum of participants correct responses to bidirectional naming probes conducted pre-and post-learn unit intervention procedures for probe sets 1 and 2.
Delayed Drawing Probes for Unfamiliar Stimuli

During the initial pre-learn unit intervention probe session, Participant E emitted 1/5 and 0/5 correct delayed drawing responses for Sets 1 and 2 respectively (Figure 33); total sum of correct responses was 1/10 (Figure 34). During post-learn unit intervention probe 1, Participant E emitted 2/5 correct delayed drawing responses to both Sets 1 and 2 (Figure 33); during post-learn unit intervention probe 2, 3/5 correct response to Set 1 and 1/5 correct responses to Set 2 were emitted; during post-learn unit intervention probe 3, 5/5 correct response to both Sets 1 and Sets 2 were emitted. Following mastery of the third post-learn unit intervention probe, a probe for delayed drawing responses with a novel set of unfamiliar stimuli was conducted and Participant E emitted 2/5 correct responses indicating delayed drawing repertoires had not yet emerged. During the fourth post-learn unit probe, data were only collected on novel stimuli sets as Participant E had previously emitted criteria-level responding for Probe Sets 1 and 2.

Participant E emitted 4/5 correct responses to Novel Set 1 and 3/5 correct responses to Novel Set 2. Total sum of correct delayed drawing responses or the first, second and third post-learn unit intervention probes are as follows: 4/10, 4/10 and 8/10 (Figure 34). Total sum data were not calculated for novel sets.

During the initial pre-learn unit intervention probe for Participant C 2/5 and 1/5 correct delayed drawing responses were emitted respectively for Sets 1 and 2 (Figure 33). A second pre-learn unit intervention probe was also conducted for Participant C, during which he emitted 4/10 correct delayed drawing responses to Set 1 and 3/10 correct delayed drawing responses to Set 2. Total sum of correct responses was 3/10 and 7/10 for the first and second pre-learn unit intervention probe, respectively (Figure 34). During the first post-learn unit intervention probe, Participant C emitted 3/5 correct delayed drawing responses to Set 1 and 2/5 correct delayed
drawing response for Set 2 (Figure 33); during the second post-learn unit intervention probe 3/5 correct responses to both Sets 1 and 2 were emitted; during the third post-learn unit intervention probe 5/5 correct response to both Sets 1 and Sets 2 were emitted. BiN responses were then assessed for Participant C with Novel Set 1 and emitted 5/5 correct delayed drawing responses indicating the presence of delayed drawing. Total sum data during the first, second and third post-learn unit intervention probe sessions for Participant C are as follows: 5/10, 6/10, 10/10 respectively (Figure 34).

During the initial pre-learn unit probe for Participant B, 2/5 and 1/5 correct delayed drawing responses were emitted for Sets 1 and 2 (Figure 33). A second pre-learn unit intervention probe was also conducted for Participant B, during which he emitted 1/10 correct delayed drawing responses to Set 1 and 1/10 correct delayed drawing responses to Set 2. Total sum of correct responses was 3/10 for both the first and second pre-learn unit intervention probe sessions (Figure 34). Participant B emitted 1/5 correct delayed drawing responses to Set 1 and 2/5 correct delayed drawing responses to Set 2 (Figure 33) during post-learn unit intervention probe 1; during the second post-learn unit intervention probe 2/5 correct responses to both Set 1 and Set 2 were emitted; during the second post-learn unit intervention probe 2/5 correct response to Set 1 and 3/5 correct delayed drawing responses to Set 2 were emitted. During the post-learn unit intervention probe 4, 4/5 correct responses to both Set 1 and Set 2 were emitted. Following the fourth post-learn unit intervention probe, probes for delayed drawing responses to Novel Set 1 were assessed with Participant B. Data indicated 4/5 correct delayed drawing responses, indicating the presence of delayed drawing. Total sum data for Sets 1 and 2 during the first, second, third and fourth post-learn unit intervention probe sessions were 3/10, 4/10, 5/10, 8/10 respectively (Figure 34).
During the initial pre-intervention probe session for Participant I, 4/5 and 2/5 correct delayed drawing responses were emitted for Sets 1 and 2 (Figure 33). A second pre-intervention probe was conducted for Participant I, during which he emitted 3/10 correct delayed drawing responses to Set 1 and 3/10 correct delayed drawing responses to Set 2. Total sum of correct responses were 7/10 and 5/10 for the first and second pre-learn unit intervention probe sessions (Figure 34). During the first post-learn unit intervention probe, Participant I emitted 5/5 correct delayed drawing responses to Set 1 and 3/5 correct delayed drawing response to Set 2 (Figure 33). During the second post-learn unit intervention probe, 5/5 correct responses to both Sets 1 and 2 were emitted and during post-learn unit intervention probe 3 (implemented as Participant I had not yet met criteria on BiN probes), 5/5 correct response to both Sets 1 and Sets 2 were again emitted. Delayed drawing responses to Novel Set 1 were then assessed with Participant I, who emitted 5/5 correct responses indicating the presence of delayed drawing. Total sum data for Sets 1 and 2 were 8/10, 10/10, 10/10 respectively (Figure 34) during post-learn unit intervention probes 1, 2, and 3.
Figure 33. Participants correct response to delayed drawing probes per set conducted pre-and post-learn unit intervention probes for probe sets 1 and 2, as well as novel sets.
Figure 34. Total sum of participants’ correct responses to delayed drawing probes conducted pre- and post-learn unit intervention sessions for probe sets 1 and 2.
Intervention

Participant E experienced four sets of learn unit interventions and met criterion on Sets 1, 2 and 4 in four sessions (Figure 35). He met criterion on Set 3 in three sessions. Participant C was exposed to three sets of stimuli during learn unit intervention sessions. He met Set 1 in six sessions and Sets 2 and 3 in three sessions (Figure 36). Participant B was exposed to four sets stimuli during learn unit intervention sessions and met Set 1 in 12 sessions (Figure 37), Set 2 in four sessions, Set 3 in six sessions and Set 5 in four sessions. Participant I experienced three learn unit intervention sets and met Sets 1 and 3 in three sessions and Set 2 in four sessions (Figure 38).

![Figure 35. Correct responses to learn unit intervention sets emitted by Participant E.](image)
Figure 36. Correct responses to learn unit intervention sets emitted by Participant C.
Discussion

Experiment III further investigated the learn unit procedure in the establishment of multiple stimulus control across listening, speaking, and drawing. Following the learn unit procedure, Participants B, C, E, and I demonstrated untaught listener and speaker responses, as well as delayed drawing responses to unfamiliar stimuli indicating the presence of bidirectional naming (BiN) and conditioned seeing. After implementation of the intervention, a single naming experience was sufficient in establishing multiple control for unfamiliar stimuli such that the stimuli evoked untaught point-to, intraverbal, and drawing responses, which is crucial in language development.
While research exists on the success of multiple exemplar instruction (MEI) and stimulus-stimulus pairing procedures as functionally related to the development of untaught speaker and listener repertoires (Frias, 2017; Gilic & Greer, 2011; Greer & Longano, 2010, Longano & Greer, 2015), implementation of a learn unit procedure has not yet been investigated as a source for the establishment of conditioned reinforcement for observing.

Longano and Greer (2015) observed that implementation of a stimulus-stimulus conditioning intervention, in which visual and auditory stimuli were presented simultaneously while reinforcing stimuli were delivered, was successful in inducing BiN for three preschool participants with and without diagnoses of autism. Longano and Greer (2015) argued that these pairings functioned to condition stimuli for observing auditory and visual stimuli such that the participants were observing both simultaneously. This, in turn, caused speaker and listener repertoires to be joined within the skin which is the beginning of a learner becoming truly verbal (Greer & Speckman, 2009). Implementation of the learn unit procedure in the present study required participants to observe the visual stimulus (picture of the symbol), attend to the auditory stimulus (name of the symbol) and emit a transcription response (drawing the symbol). When all of these responses were joined within one learn unit, the participant was able to successfully draw the stimulus with point-to-point correspondence while emitting the name of the stimulus. Drawing may have becoming a reinforcing response for these participants such that, when paired with unfamiliar auditory and visual stimulus, the response functioned to establish observing responses to these stimuli, which caused the symbols (unfamiliar stimuli) to acquire multiple stimulus control across responses.

Multiple teaching sessions were required across all participants before bidirectional naming and delayed drawing repertoires emerged, indicating that multiple conditioning
experiences may be necessary to condition stimuli as a reinforcer. The present study also provides additional evidence of conditioned seeing as a component of BiN for unfamiliar stimuli since delayed drawing repertoires increased in conjunction with BiN for unfamiliar stimuli with participants who did not initially demonstrate unidirectional naming.

It is interesting to note that some participants in the study correctly emitted at least two delayed drawing responses without demonstrating the speaker half of bidirectional naming. Three of the participants in Experiment III had also experienced the repeated probe condition in the first experiment. For these participants, this may provide further evidence that exposure to repeated probes with an additional experience may have functioned to establish a history of conditioned reinforcement for observing responses to unfamiliar stimuli. This exposure, however, was insufficient in evoking BiN responses to these stimuli without multiple opportunities for pairings, which then occurred when participants experienced the learn unit intervention.
CHAPTER V

GENERAL DISCUSSION

Primary Findings

Experiment I expanded on Shanman’s (2013) findings and investigated whether a functional relationship exists for the presence of bidirectional naming (BiN) for unfamiliar stimuli and conditioned seeing. Additionally, it investigated whether BiN for unfamiliar stimuli and conditioned seeing would be induced for participants following the implementation of multiple exemplar instruction (MEI) (Greer, Stolfi, et al., 2005) with a drawing response. Implementation of MEI with drawing on the presence of BiN and delayed drawing for unfamiliar stimuli with an MEI-experimental group was compared with a control group consisting of participants who received the school curriculum, Direct Instruction (DI), and matched repeated probes. Evidence has indicated DI leads to increases in language development (Shillinsburg et al., 2015); previous research has indicated repeated probes may function to condition unfamiliar stimuli as a reinforcer leading to an increase in untaught speaker and listener responses (Lo, 2016). Results of the first experiment indicate BiN for unfamiliar stimuli and conditioned seeing, represented by delayed drawing responses, increased to criterion level (80% correct) responding for two participants in the MEI-experimental group. Unidirectional naming, or the listener component of naming, emerged for one participant who experienced MEI. Correct drawing responses also increased.

Untaught listener, speaker, and drawing responses to unfamiliar stimuli initially increased slightly for participants in the DI and repeated probe control group but subsequently decreased, indicating BiN for unfamiliar stimuli and conditioned seeing were not present by the end of the study. These data indicate that conditioned seeing may be an integral component in BiN and
thus extremely important in language development, and that these verbal repertoires may be induced through multiple experiences.

Experiment II investigated the effect of a learn unit procedure requiring participants to attend to vocal and visual unfamiliar stimuli, while echoing and drawing the stimuli, on the establishment of BiN. Two participants who were originally part of Experiment I were selected as they demonstrated unidirectional naming for unfamiliar stimuli and the presence of delayed drawing responses during probe sessions. For these participants, multiple control had been established across listener and drawing responses but a relation had not been formed with speaker responses. Based on previous research investigating stimulus-stimulus pairing procedures on the presence of BiN (Frias, 2017; Longano & Greer, 2015), it was hypothesized that implementation of the learn unit may establish multiple stimulus control across speaker responses, listener, and drawing responses. Results of the study indicated the presence of BiN following the conditioning procedure, indicating participants were now able to respond to unfamiliar stimuli as a speaker (e.g., name these stimuli) as well as respond as a listener (point, draw). The role of the echoic in BiN development for unfamiliar stimuli is unclear in this study, however, as participants were required to echo the name of the stimulus to in order to complete the learn unit.

The third experiment also implemented the learn unit procedure, however participants were not required to emit the echoic throughout the intervention. As in Experiments I and II, participants in Experiment II were diagnosed with autism. Unlike the participants in Experiment II, however, participants in Experiment III did not have unidirectional naming for unfamiliar stimuli or delayed drawing responses in repertoire. Results of the study indicated the presence of BiN with unfamiliar stimuli and delayed drawing following the learn unit procedure, indicating
the establishment of multiple stimulus control across listener, speaker, and drawing responses as a function of teaching the participants to attend to the visual and vocal stimuli while simultaneously drawing the stimuli.

**Implications**

In the first experiment, MEI was successful in inducing BiN with unfamiliar stimuli and delayed drawing responses. In the subsequent experiments, learn unit presentations successfully induced BiN for unfamiliar stimuli and conditioned seeing as evidenced by delayed drawing responses. These data indicate that multiple stimulus control was established (Greer & Speckman, 2009) across speaker, listener, and drawing responses. Participants were not able to reliably name, point-to, and/or draw unfamiliar stimuli prior to the intervention, but were able to successfully do so following the intervention. Further, these data suggest that BiN may be joined with conditioned seeing such that children must be able to evoke an image of a stimulus to successfully respond to it as a listener and speaker without direct instruction.

An additional sensory experience (e.g., drawing) may have functioned to establish a history of conditioned reinforcement for unfamiliar stimuli, as has been observed in previous studies (Frias, 2017; Lo, 2016), which is vital in establishing pre-verbal foundational cusps (Greer & Ross, 2008; Greer & Speckman, 2009). In turn this allows for complex language development (Greer & Du, 2015b). This is of particular importance for children with autism as verbal behavior is truly a social behavior (Greer & Du, 2015b; Skinner, 1957). Discussed earlier, children with autism frequently demonstrate impairments in social and communication skills and must be taught to attend to voices, faces and other verbal stimuli in their environment before language can develop further.
Additionally, this study introduced drawing as a component of MEI instruction and investigated the presence of BiN following MEI with drawing. It is interesting to note that both participants in Experiment II demonstrated the presence of unidirectional naming for unfamiliar stimuli and delayed drawing repertoires, but did not demonstrate the speaker component of BiN. These findings differ from previous research in which the speaker component of BiN was correlated with conditioned seeing (Shanman, 2013) but relate to the findings reported by Lo (2016) in which the listener component of BiN led to multiple stimulus control for visual stimuli, auditory speech stimuli, and auditory non-speech stimuli. The relation formed between drawing and listener responses may be due to a strong history of conditioned reinforcement for drawing behavior with both participants. In the same way conditioning faces as a reinforcer selects out observing responses to faces for children for whom faces were previously an unconditioned reinforcer (Maffei et al., 2014), conditioned reinforcement for drawing, once established, may have functioned to select out observing responses to unfamiliar unconditioned stimuli. Multiple control was then established across point-to and drawing for these participants. Finally, it should be noted that BiN for familiar stimuli was present with all participants, however the presence of BiN for familiar stimuli was not indicative of BiN with unfamiliar stimuli, indicating these repertoires may not be joined.

**Educational Implications**

The emergence of untaught listener and speaker responses following one naming experience is a pivotal cusp in language development. Although typically developing children are able to attend to vocal and visual stimuli in the environment simultaneously and inherently, this is not necessarily present in children diagnosed with autism without direct instruction. Therefore, to learn new words, some children with autism are dependent upon caregivers and are
not able to function independently. In many cases, children with autism must establish a history of conditioned reinforcement for attending to verbal stimuli in the environment, which will in turn reinforce and evoke observing responses to vocal verbal discriminative stimuli. These behaviors must be taught or learned through conditioning procedures.

The role of conditioned seeing in language development has not been thoroughly investigated, but likely plays an important role in learning and comprehension, as evidenced by Mercorella (2017). For complex learning to occur, I argue that conditioned seeing and BiN with unfamiliar stimuli must be present in children with autism. While all the participants in the study demonstrated BiN with familiar stimuli, or stimuli with which they have a history of reinforcement, they did not demonstrate BiN with unfamiliar stimuli, stimuli with which they did not have a history of reinforcement. It can then be argued that instructional material consists primarily of unfamiliar stimuli which have not been established as conditioned reinforcers, therefore students will not attend to this instruction until the material functions as a conditioned reinforcer. For example, a student may textually respond to the word “dog” in a book, but does not subsequently identify “dog” when he sees a picture of a dog; this behavior is not verbal. Skinner (1957) described textual behavior as reading without understanding what is being read; comprehension or understanding occurs when textually responding to letters, words, and phrases involves other verbal operants. To use the previous example, after visiting an animal shelter the student reads “dog” above a dog’s kennel and his caregiver says, “You are right! That is a dog.” When the behavior of textually responding to “dog” with an actual dog present was reinforced by his caregiver, “dog” became a conditioned reinforcer. The student is then able to read “dog” and identify pictures of dogs in different settings; reading “dog” has become verbal. In a similar way, when instructional stimuli are established as reinforcers, learning occurs more rapidly and
without direct instruction (Du et al., 2015; Maffei et al., 2014; Greer & Han, 2015; Longano & Greer, 2015; Speckman et al., 2017).

Results of this study also suggest that the Direct Instruction (DI) curriculum in and of itself may not be sufficient to evoke derived relations in children with autism and additional multiple experiences may be required for some children (Frias, 2017; Lo, 2016). Although Shillinsburg et al. (2015) found that language skills increased in children with autism following the DI curriculum Language for Learning, it should be noted that probes for language skills were conducted only with the Language for Learning assessment tests. While Laurent-Prophete (2017) did find that derived relations, understanding of metaphors, and reading comprehension skills increased following the DI curriculum Corrective Reading, it should be noted that this study was conducted with typically developing children.

Results of these experiments also add to findings that different conditioning procedures might function to establish conditioned reinforcement which may lead to multiple stimulus control (Greer & Han, 2015; Longano & Greer, 2015). According to Greer and Han (2015), “…Pavlovian, operant or implicit respondent—operant interlocking histories may establish conditioned reinforcers” (p. 2). Finally, implementation of a repeated probe condition may be insufficient in establishing a history of conditioned reinforcement for unfamiliar stimuli without an added experience. To put this another way, children may not remember what they have learned about the Civil War from their printed texts, but may recall after a visit to Gettysburg!

**Limitations**

Across all studies, a different psychological and/or placement assessment was implemented which made comparison between participants more difficult. In addition, due to the nature of the investigator’s role in the instructional settings, the number of learn units
participants received throughout the day were not controlled. It is possible some participants received more or less DI learn units than others which may have impacted the outcome in Experiment I. Participants in the MEI-experimental group were frequently exposed to two MEI sessions per day for a total of 180 learn units which were conducted in addition to academic DI instruction. Participants in the control group on any given day may have received fewer or more learn units overall, as their teachers did not account for number of learn units delivered through MEI instruction when delivering DI.

In the second experiment, participants were required to repeat the names of the stimuli for a correct response, which did not allow the investigator to assess the role of the echoic as related to the presence of BiN for unfamiliar stimuli. In addition, the procedure combined stimulus-stimulus pairing with learn unit procedures. While BiN for unfamiliar stimuli did emerge, it is not clear whether the classical conditioning (stimulus-stimulus pairing procedure) or operant conditioning as part of the learn unit procedure functioned as a source of reinforcement for BiN behavior (Longano, 2008). Although the third experiment rectified this limitation in Experiment III, data on echoics were not collected during the intervention sessions during Experiment III which is in turn another limitation of the study. Data collection on the echoic throughout intervention sessions would have allowed for further investigation of the source of reinforcement in the establishment of BiN for unfamiliar stimuli (Longano, 2008; Lowenkron, 1996). If the instances of overt echoic behavior had increased throughout intervention sessions, the investigator would be better able to analyze whether a relationship formed between the conditioning procedure and echoic responses.

All experiments would also have benefited from additional participants, particularly Experiment II. Working with participants who demonstrated unidirectional naming for
unfamiliar stimuli and delayed drawing responses would have allowed for further investigation on the stimulus relation that formed for these participants between listener (point-to) and drawing responses. As discussed previously, these findings differ from Shanman (2013) necessitating further investigation into the experiences that evoked multiple control.

Additionally, it would have been beneficial to include participants from various socio-economic backgrounds. Hart and Risley (1995) found that children from a lower socio-economic background were exposed to fewer words and therefore acquired language at a slower rate than their counterparts from higher socio-economic backgrounds. Having participants with similar demographics does not allow for analysis across socio-economic class and therefore did not provide generalization across different populations.

**Future Research**

Based on these limitations, future research should consider comparing MEI with a drawing response versus DI on the induction of BiN with unfamiliar stimuli when number of learn units received are controlled. Future research should also investigate whether implementation of a DI curriculum would lead to BiN with unfamiliar stimuli and therefore multiple stimulus control with children with autism. Previous research has assessed language development following implementation of a complete DI curriculum with children with autism diagnoses as evidenced by DI assessment batteries (Shillinsburg et al., 2017), as well as following brief exposure to DI but has not yet tested for BiN with familiar or unfamiliar stimuli with brief or full exposures to DI language curricula.

In addition, BiN and conditioned seeing should be further investigated with familiar and unfamiliar stimuli since data from this study indicate these may be different verbal milestones or cusps for participants diagnosed with autism. It is possible that exposure to stimuli when paired...
with an additional sensory experience (i.e., eating a fruit while hearing its name) functions to condition observing responses for these stimuli, which in turn evokes the listener component of BiN, leading to multiple stimulus control. It would also be interesting to assess whether conditioned seeing joins BiN following an MEI intervention that did not include a drawing response. This would provide further evidence regarding whether conditioned seeing and BiN are inherently joined or are separate milestones. In reference to the Civil War example described earlier, the applied significance of conditioned seeing must also be investigated. Mercorella (2017) was among the first to investigate this by testing for the presence of conditioned seeing as related to reading comprehension repertoires, however it would be beneficial to expand this research by investigating whether the induction of conditioned seeing would affect understanding and comprehension outside of the instructional setting.

**Conclusion**

Examination of the role of conditioned seeing as related to language development and other higher-order verbal milestones continues to be needed. The current study provides evidence that conditioned seeing is related to incidental language acquisition and that these repertoires may be evoked as a function of MEI and learn unit procedures. It is important to continue investigating ways in which multiple stimulus control is acquired through language advancements as complex language is inextricably linked with social learning (Greer & Du, 2015b, p. 2). For the participants in this study, data indicate that BiN for unfamiliar stimuli and conditioned seeing became operant behaviors; therefore, a single naming experience evoked multiple stimulus control, a phenomenon which enables increased independence and allows the learner to continually access social reinforcement contingencies.
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APPENDICES

APPENDIX A: DEFINITION OF TERMS

Definition of terms

1. *Autism or Autism Spectrum Disorder (ASD)*
   
   Developmental disability that is characterized by deficits in social-communication behaviors and is frequently presented with repetitive, stereotypical behaviors (American Psychiatric Association, 2013)

2. *Bidirectional naming (BiN)*
   
   The speaker-listener bidirectional relation that is present without direct instruction after exposure to a single stimulus or naming experience. Formerly described as *naming*, full naming, and *Naming* (Miguel, 2016)

   a) *BiN with familiar stimuli*: untaught listener and speaker responses that are evoked by a single naming experience without direct instruction for a stimulus class a learner has been exposed to in his or her environment but has not been directly taught, such as unknown exotic animals. In other words, stimuli with which the learner has a history of reinforcement

   b) *BiN with unfamiliar stimuli*: untaught listener and speaker responses that are evoked by a single naming experience without direct instruction for a stimulus class a learner has not previously been exposed to in his or her environment and has not been directly taught, such as character alphabets in an unknown language. In other words, stimuli with which the learner does not have a history of reinforcement

3. *Conditioned reinforcement*
Establishment of neutral stimuli as a reinforcer through classical or operant conditioning (i.e., neutral stimulus is paired with an unconditioned or conditioned reinforcer) until the neutral stimulus itself becomes a reinforcer (Cooper et al., 2007; Greer & Du, 2015b)

4. **Conditioned seeing**

The behavior of seeing an image within one’s skin, in the absence of the physical stimulus that the image represents (Skinner, 1953). Presence of conditioned seeing in this study was assessed through *delayed drawing* responses (Mercorella, 2017, Shanman, 2013)

5. **Direct Instruction (DI)**

Use of research-based, explicit (i.e., scripted) teaching techniques that incorporates modeling, repetition until mastery, and teacher-guided instruction (Engelmann, Becker, Carnine, & Gersten, 1988)

6. **Fast mapping**

Presented by developmental psychologists, it is a hypothesized cognitive process in which a new concept or word is learned from a single exposure (Swingley, 2010)

7. **Multiple control or multiple stimulus control (of verbal behavior)**

A single verbal response is a function of more than one variable (*convergent multiple control*) and more than one antecedent becomes a source of control (*divergent multiple control*). When multiple stimulus control is present, a single stimulus can evoke more than one response or a response is controlled by multiple antecedents. Derived relations have formed (Cooper et al., 2007; Lo, 2016)

8. **Multiple exemplar instruction (MEI)**
Instruction that provides the learner with a variety of stimulus conditions, response variations and response topographies to develop stimulus controls across response forms (Cooper, Heron & Heward, 2007). In verbal behavior literature, MEI has frequently been implemented to induce BiN through rotation of match, point-to, intraverbal and tact responses (Greer, Stolfi, Chavez-Brown, & Rivera-Valdes, 2005)

9. *Multiple probe design with simultaneous treatment condition*

Variation of the multiple baseline design that features intermittent measures during baseline and returns to baseline (Cooper et al., 2007). The simultaneous treatment condition compares two or more different treatments at the same time, allowing for comparison (Kazdin & Hartmann, 1978). In this study, participants in the control group experienced DI while participants in the experimental group experienced MEI.

10. *Operant behavior*

Behavior that is selected and maintained as a function of consequences when a discriminative stimulus is reliably present (Skinner, 1938).

11. *Operant conditioning*

“Process by which operant learning occurs; consequences (stimulus changes immediately following responses) result in an increased (reinforcement) or decreased (punishment) frequency of the same type of behavior under similar motivational and environmental conditions in the future” (Cooper, Heron & Heward, 2007).

12. *Relational Frame Theory (RFT)*
Language development and higher order cognition consists of formation of bidirectional relations between stimuli until arbitrarily applicable derived relational responding is formed (Hayes, 1994)

13. **Repeated probes**

Presentation of probe sessions on a recurring basis. Research has indicated repeated probes may function to condition unfamiliar stimuli as a reinforcer, leading to BiN (Lo, 2016). In this study, participants in the control group in Experiment I experienced repeated probes that were matched for probe sessions participants in the MEI-experimental group experiences

14. **Slow mapping**

Presented by developmental psychologists, it is a hypothesized cognitive process in which words acquire deeper meanings and a stronger memory of a word is formed following additional experiences in a meaningful environment (Swingley, 2010)

15. **Stimulus equivalence (SE)**

Emergence of untrained or derived relationships following the reinforcement of responses to other stimulus-stimulus relations (Sidman, 1971). Properties are as follows: reflexivity (A=A), symmetry (A=B, therefore B=A) and transivity (A=B and B=C, therefore A=C)

16. **Unidirectional naming**

Listener component of bidirectional naming. Research indicates this must be present before BiN emerges. Use of the term unidirectional naming is proposed in this study

17. **Verbal behavior**
Operant behavior that is reinforced by the mediation of others (Skinner, 1957). This conceptual theory paved the way for behavior analysts to operationalize and study language development

18. *Verbal Behavior Development Theory (VBDT)*

Complex language and higher-order cognitive development emerges as a function of newly learned cusps and capabilities that allow the learner to new operants and emergent relations (Greer & Keohane, 2006; Greer & Ross, 2008)
Appendix B: Sample Data Sheet used during Probe Sessions

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Appendix C: Sample Stimuli Presentations
Appendix D: Example of Drawing Responses emitted During Intervention
Appendix E: Example of Drawing Responses emitted During Probe Sessions Before Intervention
Appendix F: Example of Drawing Responses emitted During Probe Sessions After Intervention