Echoic Training and the Acquisition of Bidirectional Naming in Elementary Students

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ABSTRACT

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I conducted 2 studies to investigate the relationship between vocal verbal behavior, specifically, articulation and the production of echoics, and the presence of bidirectional Naming (BiN). In Study 1, I performed a correlational analysis using data collected on (1) responses to bidirectional Naming probes, (2) standard score son an articulation assessment, and (3) scaled scores on a sentence repetition assessment which functioned to measure echoic behavior at the sentence level for 46 early elementary students. The number of correct responses to unfamiliar stimuli using unfamiliar spoken and visual stimuli were measured for bidirectional Naming probes. Student performance on the Goldman-Fristoe Test of Articulation served to measure the participants’ articulation of consonant and consonant cluster sounds in the English language. The Recalling Sentences subtest on the Clinical Evaluation of Language Fundamentals® – Fifth Edition was used to measure the accuracy of participants’ echoic behavior when repeating spoken sentences. Results using a Pearson’s correlation showed that there was no significant correlation between bidirectional Naming and participants’ articulation scores using the Goldman-Fristoe Test of Articulation 3, \( r = .037, p = .808 \). However, there was a significant and overall positive correlation between bidirectional Naming and participant scores from the Recalling Sentences subtest, \( r = .589, p < .001 \).

Following the results of the correlations from Study I, I tested the effects of 2 echoic training interventions on the acquisition of bidirectional Naming in 8 early elementary students that were grouped into matched pairs to form 4 dyads in Experiment I. In each dyad, 1 participant underwent a "verbal echoic” intervention consisting of echoing sentences comprised of grammatically coherent English that had verbal function. The matched participant in the same
dyad went through an “acoustic echoic” intervention that used the same words contained in the sentence echoed by the participant in the verbal echoic intervention but scrambled so that the sentence were syntactically and semantically incoherent and thus, lacked verbal function. Results showed that 5 out of the 8 participants have acquired bidirectional Naming following either echoic condition. More specifically, 4 participants acquired bidirectional Naming after the verbal echoic condition. One other participant acquired bidirectional Naming following the acoustic echoic condition. The implications of the differences in the effectiveness of the two intervention conditions are discussed with regard to the significance of acquiring bidirectional Naming.
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CHAPTER 1
INTRODUCTION TO THE STUDY

How humans acquire and develop complex language has been of interest to researchers in the field of behavior analysis since its inception. From a behavioral perspective, Skinner (1957) focused on identifying the verbal function of language as opposed to its linguistic structure. This included a detailed analysis of fundamental listener and speaker behaviors emitted by individuals within a given verbal community. Behavior analysts theorized that such communicative behaviors are generated as a result of the controlling variables that operate within this community in that a history of reinforcement and the environment selects out verbal behavior, including that of language (Catania, 2001; Greer & Keohane, 2009; Skinner, 1957). From this behavioral standpoint, the development of language is not a biological given but rather arises from contacting multiple contingencies in the environment. In order to better understand the acquisition of language through a behavioral lens, much research has been conducted on the development of word-object relations, specifically regarding the bidirectional Naming (BiN) phenomenon. This extends to the speaker-as-own-listener capability that is theorized to support the development of complex verbal behavior (Barnes-Holmes, Barnes-Holmes, Cullinan, 2000; Greer & Keohane, 2009; Lodhi & Greer, 1989; Horne & Lowe, 1996). Building these language repertoires provides the basis for developing educationally significant behavior that results in learning.

Background

Measurements of Learning

In order to assess for effective teaching that leads to student learning, behavior analysts in Comprehensive Application of Behavior Analysis to Schooling (CABAS®) schools utilize the
learn unit as their primary measure of instruction (Albers & Greer, 1991). It encompasses interlocking teacher and student operants that act as a fundamental unit of pedagogy (Albers & Greer, 1991; Greer & McDonough, 1999). Since a single learn unit is a measurement of one learning interaction between the student and teacher, the measure of overall learning can be determined by calculating the number of learn units needed to meet one instructional objective or criterion. Research using this measurement has determined that there are differences between rates of learning as measured by the number of learn units to criterion in students with and without the BiN capability (Geer, Corwin, & Buttigieg, 2011; Hranchuk, Greer, & Longano, 2018). Students with the BiN capability acquire language incidentally and can access instruction in different ways. They demonstrated a higher rate of learning and did not require direct instruction to acquire novel operants (Greer et al., 2011; Hranchuk et al, 2018). The topography of instruction is also affected by the presence of BiN in students. Hranchuk et al., (2018) found that students with BiN learn through a teacher model which can be a more efficient mode of instruction, especially in classrooms where there are high teacher-student ratios and lack of opportunities for individual instruction. Therefore, the acquisition of BiN is considered a verbal developmental milestone that gives rise to a new learning capability resulting in an accelerated rate of learning and language development (Horne & Lowe, 1996; Greer & Ross, 2008).

Since research has highlighted the significance of BiN in learning, I first conducted an correlation study to investigate the presence of the BiN phenomena as it relates to speech articulation and the production of echoics, two areas of interest which previous research suggests may be connected to BiN (Cao, 2016; Horne & Lowe, 1996; Longano & Greer, 2014). Then, I compared the effectiveness of two echoic treatments on the acquisition of BiN in elementary students who did not have the capability in repertoire in Experiment I.
Bidirectional Naming

According to verbal behavior theorists, the development of language is rooted in the interactions between listener and speaker behavior within an environmental context. BiN is theorized to be a joining of listener and speaker behavior that results in an individual becoming truly “verbal” (Greer & Longano, 2010; Greer, Pohl, Du, & Moschella, 2017; Horne & Lowe, 1996). This stage in verbal development is characterized by a new learning capability resulting in an exponential increase in language and vocabulary (Greer & Longano, 2010). It occurs when an individual incidentally learns the name of novel stimuli that they encounter in his or her environment without the need for direct instruction. For example, a child may stumble upon a stingray, an animal that he or she has never seen before, and someone can say “oh, that’s a stingray.” Following that experience, a child with BiN has learned what the name of that animal is and will call it a “stingray” if she or he sees it again or point it out if someone else asks where the stingray is. The key relation that occurs is the joining of the listener and speaker responses so that an individual emits both responses even if he or she was exposed to or taught a response in only one topography. This fusion allows for an accelerated rate of language acquisition and is also critical to the development of more advanced verbal relations. When considering the presence of BiN in education, it is fundamental in overall learning and accessing academic curricula.

Prior to this joining of speaker and listener responses, listener and speaker repertoires are initially independent of each other (Greer et al., 2007; Skinner, 1957). Students who reliably emit listener behavior (i.e., a selection response) after incidentally learning a novel word demonstrate the listener half or unidirectional Naming (UniN). This listener repertoire commonly emerges before the speaker component of BiN (i.e., incidental learning of speaker
responses for novel stimuli). Full BiN emerges when there is a joining of both repertoires in a way that there is a bidirectional relation (i.e., exposure to a stimulus in one response topography results in the incidental emergence of the other response topography). Students who do not have BiN in repertoire, may require separate instruction in both topographies. For example, they might have to be taught to recognize the number “3” and taught to select if after hearing a direction, “which number is three?” and also be taught to say “three” after being shown the visual representation “3.” Individuals typically demonstrate BiN around toddlerhood, however, it is important to consider that is it not necessarily age but also experience that leads to verbal development for many individuals (Gilic & Greer, 2011; Greer et al., 2017; Hart & Risley, 1995; Horne & Lowe, 1996). Exposure to these multiple language experiences may enhance the likelihood of acquiring verbal cusps and capabilities.

**Language Acquisition and Bidirectional Naming (BiN)**

The processes involved in learning new names for stimuli that are encountered and building those critical relations between listener and speaker behavior result in the acquisition of language or verbal behavior. It is important to consider that these relation do not develop in isolation. Rather, it results from a multitude of environment experiences. Research on language development highlights the connection between language exposure and language acquisition (Hart & Risely, 1995). Hart and Risley (1995) found that the language spoken in the homes of 48 families varied in both the amount of words used and also the type of words said. Families with lower socio-economic backgrounds differed from higher socio-economic backgrounds by almost 3 million words. These data then predicted the level of IQ and language ability of the same children by the time they were in preschool. Since caregiver-child relationships typically
form the early language experiences at the beginning of verbal development in many individuals, it stands to reason that environment has a large impact on learning.

The language development of students who come from linguistically impoverished backgrounds or those that have developmental disabilities may take a different trajectory resulting in the possibility of missing cusps or capabilities. Researchers theorize that one of these critical capabilities is BiN (Horne & Lowe, 1996; Miguel, 2016). Instead of the natural progression of BiN emerging through contacting a multitude of listener and speaker exchanges in the environment, students without BiN in repertoire may present with separate listener and speaker behaviors. Additionally, there may be prerequisites to the acquisition of BiN that some students are missing.

**Echoic Behavior**

When Horne and Lowe (1996) first introduced Naming as a higher order behavioral cusp, they included the role of echoic behavior as potentially serving to establish the Naming relation. Skinner (1957) first described echoics as “verbal behavior in which the form is controlled by previously heard speech” (p. 40). This verbal, duplicative, response is commonly described as having point-to-point correspondence with the initial auditory stimulus (Cooper, Heron, & Heward, 2007; Greer & Ross, 2008). It is important to note that the echoic response serves a verbal function in that the production of the response corresponds not only with the initial auditory stimulus but also with the referent stimulus and is reinforced by generalized or prosthetic reinforcers. Initially, a child’s caregiver reinforces echoic behavior by delivering praise or attention and through these repeated pairings, the reinforcement may shift to the emission of duplicative behavior that corresponds to the matching stimulus. This is to be distinguished from parroting behavior, which does not have a verbal function and is solely the
production of auditory stimuli that is maintained by automatic reinforcers (i.e., hearing the echoed word). The verbal function in echoic behavior potentially serves an important function in forming BiN relations.

When a child with BiN in repertoire observes a novel stimulus and learns the name for that stimulus, consider the series of events that occurs when he or she initially joins the listener and speaker repertoires. First, the child may see a stingray, an animal that he or she has never encountered before. That child then asks a caregiver what that animal is, and the caregiver says, “a stingray.” The child hears the words, then may emit either an overt echoic response while observing the stimulus and says aloud, “a stingray,” or the child may emit a covert echoic response and thinks “a stingray”. This echoic response serves to potentially join the listener and speaker responses and may serve to reinforce the bond between the observing responses of seeing, hearing, and saying (Horne & Lowe, 1996; Longano & Greer, 2014).

Cao and Greer (2019) determined through two experiments that echoic training with monolingual English-speaking students who could not previously echo or accurately articulate Chinese speech sounds, resulted in the acquisition of BiN using Chinese words only after completing echoic training on accurately producing Chinese speech sounds. The results of this particular study suggested that accurate echoic production for speech sounds serves to condition the previously unfamiliar auditory stimuli and reinforce the correspondence between the listener and speaker responses.

Results from series of studies using an auditory match-to-sample intervention provide additional research on how correspondence in listening affects the accuracy of echoic behavior, articulation of speech sounds, and the acquisition of UniN (Choi, Greer, & Keohane, 2015; Du, Speckman, Medina, & Cole-Hatchard, 2017; Speckman-Collins, Lee Park, & Greer, 2007). This
auditory matching intervention consists of participants matching a progression of sounds to words to sentences that require finer and finer listener discriminations. For example, the basic match-to-sample responses include matching sounds using no sound as an the non-exemplar and progressing to matching words using another word with a same ending as the non-exemplar. In the advanced phase, participants match sentence-length phrases with sentences that differ only in one word as the non-exemplar. Following this intervention, participants increased the number of correct echoics emitted as well as the accuracy in the articulation of the echoics (Du et al., 2017). Individuals that lack the BiN repertoire may be missing prerequisite listener and/or speaker repertoires that also includes the lack of or faulty echoic behavior.

**Need for Research Study**

Students for whom BiN has not emerged do not have the same learning opportunities as those who have BiN in repertoire. Studies have shown that the presence or absence of BiN in students affects not only their rate of language acquisition but also the modality and efficiency of how they are taught (Greer et al., 2011; Hranchuk et al, 2018). Not only is there an educational significance for BiN, it is also necessary for the development of higher-order verbal relations (Greer & Ross, 2008; Greer et al., 2018). Results from previous single-subject studies have shown improvements in accuracy of echoics, articulation, and also emergence of UniN following listener discrimination training and echoic training (Cao & Greer, 2019; Chavez-Brown, 2005; Choi et al., 2015; Du et al., 2017; Speckman-Collins et al., 2007). However, there has not yet been research utilizing group study measures and analyses to determine if there is a correlation between echoic behavior, articulation, and the presence of BiN. Additionally, if there is a correlation between the variables, can there also be a casual relation; in such that an effective
intervention can be devised based on one of the aforementioned variables that can serve to induce BiN?

**Purpose of Study**

The purpose of Study I was to determine the relationships between echoic behavior, articulation of speech sounds, and the presence of BiN. Furthermore, I sought to test the relations of all the components of BiN, including the listener half (UniN), the speaker half, and full BiN. This was to provide a more thorough analysis of the separate relations that may or may not be joined across all participants. It also reflects the possibility that there may be varying degrees of relations between the components of BiN, echoic behavior, and articulation. Based on the results of Study I, Experiment I sought to compare the effectiveness of two echoic interventions on the induction of BiN. They consisted of echoing given sentences that were either meaningful, in other words had verbal functions of language, or sentences in which the words were scrambled and out of order so that there was no meaning or verbal function.

**Nature of the Study**

In Study I, I used the *Goldman-Fristoe Test of Articulation 3 (GFTA-3)* as the articulation measure. The *GFTA-3* was selected because of its availability in the experimental setting and also because it is widely used by speech-language pathologists to assess for irregularities in articulation. Only the *Sounds-in-Words* subtest was used to assess for the accurate production of initial, medial, and final phonemes. The standard mean for the *GFTA-3* is 100 with a standard deviation of 15. Accuracy in production of echoic responses was measured using the *Recalling Sentences* subtest on the *Clinical Evaluation of Language Fundamentals® – Fifth Edition (CELF®-5)*. It consists of 26 sentences that increase in length and grammatical complexity. The average mean score for the subtest is 10. Participants have one chance to hear the sentence read
aloud by the experimenter and then duplicate the corresponding echoic response. In contrast to previous studies in which echoic responses were measured at the word level, the decision to use this subtest was based on the assessment’s function as a measure of language skills for students in addition to measuring the production of accurate echoics (Klem et al., 2015; Moll, Hulme, Nag & Snowling, 2015; Polišenská, Chiat, & Roy, 2015). An additional rationale as to the selection of these assessments were based on the means of calculating a standard or scaled score for the purposes of data analysis. A more thorough analysis for BiN was produced by including each component of BiN (e.g., UniN and the speaker half of BiN) as well as the overall degree of BiN. As echoic responses and articulation both involve listener and speaker repertoires, I sought to determine if there was a difference in the relationships among the components of BiN and responses to the *GFTA-3* and *CELF®-5*. 
CHAPTER II
REVIEW OF THE LITERATURE

This study explores the relations between degrees of BiN (i.e., UniN, the speaker component of BiN, and full BiN), and related repertoires of accurate speech articulation, and sentence-length echoic responses using standardized assessments. In this literature review, I will detail what it means to be verbal by reviewing the sequential acquisition of verbal behavioral cusps as described by verbal behavior development theory. I will then discuss the integration of listener and speaker behavior and its relation to higher-order verbal behavior. Finally, I will review the conceptual and applied research on the bidirectional Naming phenomenon and discuss its possible sources of reinforcement and relate it to the current study.

Verbal Behavior Development

From Skinner’s theory on the development of language through behavioral processes, researchers have identified a sequence of specific verbal repertoires that result in the acquisition of developmental cusps leading to individuals who function as fully verbal members of their community (Bijou and Baer, 1961; Greer & Du, 2015; Greer & Keohane, 2006; Greer & Longano, 2010; Greer & Speckman, 2009; Rosales-Ruiz & Baer, 1996). Beginning with preverbal foundational cusps, each stage moves toward higher-order verbal behavior which include listener, speaker, speaker-as-own-listener, reader and writer, and self-editing cusps and cusps that are new learning capabilities (Greer & Ross, 2008). Following the onset of a developmental cusp, individuals can come in contact with new contingencies in their environment that can in turn accelerate their learning and create new relations among stimuli that they otherwise could not before (Greer & Speckman, 2009). Verbal Behavior Development
Theory (VBDT) also provides for a behavioral account of language acquisition and the learning of new repertoires that allow individuals to expand their community of reinforcers.

This progression of behaviors that leads one to become verbal follows a hierarchical series of behavioral stages which has recently been described as resulting in a “behavioral metamorphosis” (Greer, Pohl, Du, & Moschella, 2017). This evolution of verbal behavior parallels that of biological development but is not a result of anatomical maturation but rather from contacting environmental contingencies that lead to behavioral change within an organism. Greer et al., (2017) described four stages of verbal developmental milestones that function as behavioral metamorphosis: (1) pre-verbal foundational cusps, (2) listener behavior, (3) speaker behavior, and (4) the joining of listener and speaker behavior. This sequence can act as a guideline for the progression of more advanced repertoires that dictates the trajectory of individuals who ultimately acquire the cusps and capabilities that lead to the establishment of higher-order operants. Essentially, this results in the integration of listener and speaker behavior, which is the basis for complex emergent behavior resulting in becoming verbal and functioning as an independent individual within a community.

Defining these stages of verbal development facilitates the identification of the presence or absence of these milestones in individuals and thus potentially identifies specific interventions for those who are lacking these fundamental cusps and capabilities. Individuals who had a variety of experiences and were exposed to a language-rich environment are more likely to have the opportunity to acquire these verbal cusps and capabilities while those with more limited language experiences may not have come in contact with those key contingences that lead to the development of these milestones (Hart & Risely, 1995). Additionally, individuals with phylogenetic delays or disabilities may be missing certain cusps or capabilities that do not arise
from typical contingencies but instead require interventions that result in their acquisition. By identifying these discrete milestones and the cusps and capabilities within each, specific deficits can be targeted for intervention and the potential learning outcomes for those individuals can be transformed.

**Preverbal Foundational Cusps**

The emergence of preverbal foundational cusps typically occurs in utero and during infancy (Greer et al., 2017). Cusps include orienting to others’ voices and faces, generalized identity matching, and “capacity for sameness” across senses (Du, Broto, & Greer, 2015; Frias, 2017; Greer & Han, 2015; Greer, Pistoljevic, Cahill, & Du, 2011; Maffei, Singer-Dudek, & Keohane, 2014.) These initial responses in which individuals make connections to environmental stimuli by engaging with their primary senses form a history of reinforcement for early observing behavior. Thus, while they do not have verbal function, the establishment of these cusps have an enormous effect on the development of language infrastructures or more advanced verbal relations because they provide the basic prerequisite repertoires necessary to interact within the verbal community.

Hearing the voice of his or her mother while in the womb acts to condition a child’s listening response so that voices become a conditioned reinforcer (DeCasper & Spence, 1987; Greer, et al., 2011; Schlinger, 1995). This history of reinforcement and pairing of stimuli then selects out the listening behavior of the child establishing orienting to voices as a conditioned reinforcer. Subsequently, when voices are conditioned, it then leads to the potential for following vocal directions or attending to praise or social approvals. Orienting to others’ faces or presence of others is another preverbal cusp where individuals will look at other people or attend to the presence of adults or peers in their vicinity, increasing social behavior (Maffei et al.,
Orienting to others also enables individuals to become more part of a social community and leads to more advanced interactions with other individuals that can potentially function as conditioned reinforcement for social or verbal behavior.

Generalized identity matching is another foundational cusp in which individuals can match novel stimuli with an exemplar. When an individual has generalized identity matching in repertoire, it indicates that three-dimensional (3D) and two-dimensional (2D) stimuli function as conditioned reinforcers which leads to learning through visual discrimination (Greer & Ross, 2008; Greer et al., 2017). This fundamental observing response can also occasion other significant new learning possibilities such as looking at print stimuli or interacting with objects in the environment and thus accelerate learning opportunities when responding to these stimuli (Du et al., 2015; Greer & Han, 2015; Pereira-Delgado, Greer, Speckman, & Goswami, 2009). It also sets the occasion for more advanced repertoires such as textually responding to print stimuli (reading), writing, and editing.

The “capacity for sameness” across senses is a cusp that leads to the formation of cross-modal relations such that auditory, visual, olfactory, gustatory, or tactile stimulation results in identifying a specific stimulus across multiple senses (Ackerman 2010; Frias, 2017). This provides an ever-expanding set of environmental stimuli with the potential for reinforcement for attending to novel objects or pictures. It also joins the different senses across observing responses to make connections with one’s surroundings regardless of the topography of a response when encountering stimuli. Establishing these preverbal cusps allows for a foundation of conditioned reinforcement for critical responses that serve to solidify the relations between an individual and the environment that he or she is a part of. This leads to an expanding repertoire of potential sources of reinforcement for higher-order verbal operants.
Listener Behavior

Once preverbal foundational cusps are established and observing responses function as conditioned reinforcers, individuals, typically in early childhood, attend to the voices of others. This is then followed by listener behavior in which individuals attend to auditory stimuli in the environment. Once the auditory stimuli take the form of speech, individuals are listening to the combinations of phonemes that have meaning as referents. When this occurs, language takes on meaning. It is also important to consider that the listener repertoires are initially independent of speaker operants such that individuals respond as listeners but do not reliably emit corresponding speaker behavior. Listener cusps include auditory matching and phonemic awareness leading to listener literacy (Greer et al., 2017; Greer & Ross, 2008).

Generalized auditory matching for vocal speech allows individuals to match the same words when spoken and discriminate between similar spoken words and nonexemplars. Research in auditory matching has resulted in the acquisition of unidirectional Naming and improved the articulation of spoken words following an echoic model (Chavez-Brown, 2005; Choi et al., 2015; Du et al., 2017; Speckman-Collins et al., 2007). The auditory matching intervention consists of sets of increasingly less distinctive discriminations between a target auditory stimulus, the matching auditory stimulus, and an auditory non-matching exemplar. For example, the basic phases begin with discriminating between two significantly different auditory stimuli - an environmental sound and white noise, then the phases progress to discriminating between a word and another word without any of the same phonemes, to discriminating between rhyming words and later between sentences with a one-word difference (Choi et al., 2015; Du et al., 2017). Training to differentiate between finer and finer discriminations may also serve to enhance conditioned reinforcement for voices (Greer et al., 2017).
As a listener cusp, phonemic awareness leading to listener literacy enables individuals to follow vocal directions without the need for visual cues. Those who have this cusp in repertoire respond to auditory stimuli and are under the control of phonemes that make up spoken words which is the beginning of verbally governed behavior (Greer et al., 2017). By discriminating between auditory sounds that have no verbal function and auditory sounds that are spoken words, phonemic awareness is necessary in developing word-object relations that extend to high-order verbal operants. These cusps function to generate listener behavior that may still be independent of speaker behavior. For instance, a listener may discriminate a directive to select a spoken stimulus, “bottle” but may not produce a speaker response or say “bottle” when shown the item or picture. However, listener cusps typically function as a prerequisite to speaker cusps, as individuals can discriminate between acoustic phonemes before producing those sounds.

**Speaker Behavior**

Independent speaker cusps arise when individuals vocally label (tact) items and request (mand for) stimuli in their environment from a listener. Initially, speaker behavior is occasioned by echoing sounds that are heard in the environment (parroting) thus reflecting the history of correspondence between listening and saying without verbal meaning or referents. As parroting behavior is the production of echoic responses that are self-reinforcing, true echoic behavior is established when a caregiver provides a history of reinforcement for echoic behavior, praising a child for repeating what he or she said. Following that pairing process, echoic responses function under generalized reinforcement from other as opposed to automatic self-reinforcement.

Eventually, there is a shift in the reinforcement from the correspondence between hearing a word and the production of echoic behavior (e.g., echoic-to-mand-and echoic-to-tact) to emitting independent mands and tacts. Independent mands function to select out an individual’s
reinforcer allowing him or her to mediate his or her own environment (Greer et al., 2017; Skinner, 1957). The tact is another elementary verbal operant that functions under social reinforcement in which an individual emits a spoken response evoked by a nonverbal stimulus to identify such stimuli in the environment (Skinner, 1957). These two basic verbal operants form the basis for more advanced speaker behavior cusps such as intraverbals, transformation of establishing operations across mands and tacts, autoclitics, and textual responding (Greer et al., 2017; Greer & Ross, 2008). The establishment of these speaker cusps leads to more access to varied environmental contingencies and a significant increase in learning opportunities for acquiring more vocabulary, emitting longer sentences, and contacting different sources of reinforcement.

**Joining of Speaker and Listener Behavior**

Prior to becoming truly verbal, listener and speaker behavior may operate independently of each other such that there is no joining or integration between them. As a result, individuals emit speaker or listener behavior separately and require instruction across both topographies (Greer & Du, 2015; Hawkins, Gautreaux, & Chiesa, 2018). This limits what can be thought of as thinking behavior in which a person acts as speaker and listener in his or her own skin (Greer & Ross, 2008). Once speaker and listener are joined, individuals can engage in conversation with others, in rule-governed and verbally mediated behavior which encompasses higher-order thinking. Additionally, individuals can function as readers and writers as they are extensions of listener and speaker behavior. When an individual is truly verbal, he or she engages in say-do correspondence, self-talk, and may acquire bidirectional Naming which results in logarithmic growth in language and learning (Greer et al., 2017; Greer & Ross, 2008; Greer & Speckman, 2009).
Say-do correspondence. It is indicative of a joining between listener and speaker behavior when an individual says what he or she is going to do and then completes a corresponding action. This behavior sequence reflects a relation between the vocal verbal behavior and the corresponding non-vocal verbal behavior (Greer & Ross, 2008). For example, if an individual states, “first, I will turn on the water, then I will use soap,” and completes the actions, then he or she is demonstrating say-do correspondence. The acquisition of this cusp leads to more advanced self-management repertoires, self-talk, and self-awareness such that vocal verbal behavior connects with physical actions. Furthermore, say-do correspondence serves as the start of a rotation of speaker and listener operants that signals the emergence of thinking behavior in which individuals function as their own audience within their skin (Greer et al., 2017).

Speaker-as-own-listener behavior. Skinner (1957) hypothesized that a speaker functions as his or her own listener, demonstrated through the behavior of talking to oneself. He suggests that individuals mediate contingencies and access automatic reinforcement which then serves to condition these self-talk episodes. Individuals who act as speaker-as-own-listener do not need to edit their verbal behavior because of the “optimal correspondence” within the dual roles that serve to automatically reinforce this method of verbal exchange (Skinner, 1957, p. 442). Additional examples are provided of speaker-as-own-listener behavior when an individual who emits an echoic response to his or her own verbal stimulus or respond to a self-initiated intraverbal (Skinner, 1957). The behavior of speaker-as-own-listener can also be extended so that a verbal exchange occurs in the form of a later-defined conversational unit. This verbal episode is comprised of interlocking verbal operants where there is an exchange of listener and speaker responses that function to reinforce the other operant (Greer & Keohane, 2005).
While the examples that Skinner writes are hypothesized, Lodhi and Greer (1989) tested his theory through an experiment measuring speaker-as-own listener behavior of children under two conditions. Children were selected for this experiment since overt self-talk in adults is typically punished. The four participants were observed playing under either under an anthropomorphic toy condition or a non-anthropomorphic toy condition. Vocal verbal behavior units were measured as mands, tacts, intraverbals, autoclitics, and conversational units. These conversational units were defined as verbal exchanges between listener and speaker in which both roles were reciprocated, and in this case, one participant responded in both roles (Lodhi & Greer, 1989). The results showed that all participants emitted a significantly higher number of conversational units during the anthropomorphic toy condition (Lodhi & Greer, 1989). These results supported Skinner’s hypothesis that an individual can respond as both listener and speaker within a verbal episode.

As listener behavior joins speaker behavior, an individual functions as speaker-as-own-listener, from which thinking or the exchange of speaker and listener responses within one’s own skin emerges. Skinner (1957) states that thinking in itself is behavior, so much so that “when we study human thought, we study behavior” (p. 451). When thinking occurs, much of the behavior is covert – this may have originated as a function of convenience or because talking out loud is punished as individuals mature into adults and must integrate into appropriate social norms (Skinner, 1957, p. 436). When individuals think, they act to provide automatic reinforcement for speaking and listening. “Thinking is more productive when verbal responses lead to specific consequences and are reinforced because they do so” (Skinner, 1957, p. 439). It is important to consider that thinking is verbal behavior in that there is not a “mysterious process responsible for
[thinking] but the very behavior itself…with respect to both man, the behaver, and the environment in which he lives” (Skinner, 1957, p. 449).

**Research on Bidirectional Naming**

When an individual functions as a listener and as a speaker within his or her own skin, it provides the foundation for the acquisition of higher-order verbal operants. In particular, higher-order operants are behavior that is occasioned by “multiple-exemplar experiences that join two or more operant relations into a single overarching operant” (Greer & Ross, 2008, p. 239). The bidirectional Naming (BiN) capability provides an example of a higher-order operant (Greer & Ross, 2008). BiN is comprised of the joining of listener and speaker responses so that individuals who have this capability in repertoire learn incidentally through exposure in one response topography and then subsequently can emit a response in an untaught topography. As previously discussed in Chapter I, the onset of BiN has significant linguistic ramifications in the acquisition of incidental language development, how novel operants are taught, and students’ rate of learning (Greer et al., 2005; Greer et al., 2011; Hranchuck et al., 2018).

**Naming Loop**

In their seminal work, Horne and Lowe (1996) presented an account of the developmental sequence to the acquisition of BiN beginning with the acquisition of listener behavior in children. They consider “the learning of listener behavior to be a crucial precursor to the development of linguistic behavior” (Horne & Lowe, 1996, p. 192). When a caregiver interacts with a young child by saying the name of an object in the presence of that child, the caregiver may reinforce the child’s observing responses (i.e., seeing and hearing). This then acts to condition a relation between the spoken (auditory) stimulus and the listener response (hearing the name of the object), and seeing the physical referent (Horne & Lowe, 1996). This vocal
operant may also act as a discriminative stimulus for the behavior that is conditioned with the object. As the caregiver continues to speak to the child, he or she enhances the child’s auditory discrimination of various environmental stimuli. These subsequent adult and child interactions occasion listener behavior in typically developing children by selecting out and reinforcing the listener response (Horne & Lowe, 1996; Longano & Greer, 2014). Subsequently, when the child begins to emit speaker behavior, he or she may name objects that they learned as a listener without having been explicitly taught to say the names of the stimuli. This exchange of listener and speaker responses acts as a “naming loop” and functions to establish relations beyond simply saying the name of something that is seen in the environment or echoing a word that is heard (Horne & Lowe, 1996, p. 201). Rather, when Naming is present, an individual accrues the name of a stimulus after it is learned (through a Naming experience) and can refer to the stimulus without additional exposure as a listener or speaker.

**Conditioned Seeing**

Skinner (1953; 1957) described the term “conditioned seeing” as behavior of seeing a stimulus within one’s skin or visualizing a stimulus in the absence of the actual physical stimulus in the present moment. This behavior may be evoked by previous reinforcement contingencies which paired the visual stimulus with an auditory stimulus (i.e., its name) such that hearing the name then results in seeing the object even if it is not physically present. Horne and Lowe (1996) included this seeing response in the Naming loop as occurring when an individual sees an object, the name is evoked due to previous exposure, he or she hears the name of the object and says it. It is also possible that an individual hears the name of a stimulus which then evokes a conditioned seeing response and thus he or she visualizes the object within his or her own skin. However, since conditioned seeing is a covert response, it has been difficult to measure.
Shanman (2013) devised a test for the conditioned seeing response and its relation to BiN by including a drawing component to a BiN probe. First participants were shown pictures of five symbols and were simultaneously told the names for the symbols. Two hours later, the participants were asked to (1) select the picture of the target stimuli after hearing their names, (2) say the names of stimuli when shown a picture, and (3) draw the stimuli that were previously shown during the Naming experience. Results also showed that there was a potential relation between the conditioned seeing response and the speaker component of Naming. Participants who did not accurately respond to conditioned seeing probes (draw the stimuli) also did not demonstrate the speaker component of Naming. However, results showed that some participants who did not have the conditioned seeing response had the listener half of Naming. These results suggest that there is a joining of not only listener and speaker responses but also one of seeing. Moreover, there is a potential for the seeing response to maintain the object-name relation in the absence of the auditory or visual stimulus so that hearing the name of the object evokes a conditioned seeing response. More recently, Syed (2018) expanded on the Shanman’s study and tested the effects of multiple exemplar instruction (MEI) on the emergence of BiN including a conditioned seeing response. Results following the MEI intervention showed that increases in the accuracy of the conditioned seeing responses correlated with the emergence of BiN indicating that there is a relation between those variables.

**Unidirectional and Bidirectional Naming**

When individuals give a name to an object or event, they are in essence, *naming* it (Miguel, 2016). Miguel (2016) suggested that the term “Naming” (as originally named by Horne & Lowe, 1996) be referred to instead as bidirectional naming (BiN) in order to emphasize a more technical definition of the term. This provides a more scientifically precise definition which
emphasizes the higher-order verbal repertoire in which individuals, when taught the name of a stimulus in one topographical response, emit the equivalent relation in another topography without direct instruction in that subsequent topography. An additional term, unidirectional naming (UniN) was also established to identify when individuals have the listener half of Naming but do not demonstrate the speaker half. This results in individuals who, when taught the name of a stimulus, can select the stimulus when asked (as a function of their listener repertoire) but cannot say (as a function of their speaker repertoire) the name of the stimulus after hearing it. Thus, BiN is comprised of two components, unidirectional Naming (UniN) or the listener half of BiN, and the speaker half of BiN. For the purposes of the current study, the overall degree of BiN was measured by calculating the mean number of correct responses across UniN and the speaker component of BiN.

**Classifications in Naming**

More recently, Hawkins et al. (2018) proposed to further clarify the technical definition of Naming by introducing six subtypes of Naming that extend Miguel’s (2016) definition of Common bidirectional Naming, including three subtypes that fall under bidirectional Naming and three subtypes under the category of incidental bidirectional Naming. Under bidirectional Naming, there is (1) listener unidirectional Naming, (2) speaker unidirectional Naming, and also (3) joint bidirectional Naming. The first two subtypes refer to the emergence of untaught listener or speaker behavior following the direct teaching of corresponding speaker or listener behavior, respectively. Joint bidirectional naming occurs when both untaught listener and untaught speaker responses emerge after stimuli are taught in the opposite topography (Hawkins et al., 2018). The listener, speaker, and joint bidirectional Naming subtypes also occur under incidental bidirectional Naming but under the context of emergent behavior. The authors argue
that establishing a new framework for the definitions of the types of Naming has implications for better understanding and application across empirical research.

**Significance of Naming**

The implications for the acquisition of the Naming repertoire are significant across social and academic settings. Individuals learn much of their vocabulary incidentally through contact with environmental contingencies without the need to be taught operants across both speaker and listener topographies (Horne & Lowe, 1996; Greer & Longano, 2010; Greer & Speckman, 2009). In order to function within a verbal community, incidental language acquisition has significant implications in the life and livelihood of individuals. In the school setting, students who lack BiN are restricted in progressing beyond their existing repertoires in terms of incidental language acquisition (Greer & Longano, 2010). They may not learn through experiential contact with a stimulus or teaching moment and can require frequent prompts or repeated instruction to acquire educational objectives. Thus, the acquisition of BiN can vastly improve the quality of life of an individual as he or she will have exponentially more learning opportunities which may lead to greater life prospects and independence (Greer & Longano, 2010).

Students who have BiN in repertoire can learn from their environment in new and different ways. Geer et al. (2011) found that students with BiN acquired instructional objectives at a higher rate when objectives were taught through instructional demonstration learn units (i.e., from a teacher model). Students without BiN did not learn as quickly after observing an instructional demonstration. Given a typical classroom model with a number of students and one teacher, those with BiN will learn after observing the teacher demonstrate a task whereas students without BiN may require additional teacher remediation. Direct, one-on-one teacher
instruction in typical classrooms can be limited and thus students without BiN may have fewer learning opportunities.

Hranchuk et al. (2018) found similar educational benefits for students with BiN in repertoire after comparing students’ rate of learning under instructional demonstration learn units and standard learn unit instruction (i.e., direct teacher instruction). She determined that it was more efficient for students with BiN to be taught with instructional demonstration learn units as opposed to standard learn units (Hranchuk et al., 2018). Students under the instructional demonstration condition learned at an accelerated rate and acquired a greater number of academic objectives than learning through standard learn unit instruction. These results reflect how the presence of BiN in students affects the way that they learn. It also demonstrates that the identification of BiN in students can serve to directly impact educational strategies that are used the classroom.

**Interventions for Establishing BiN**

While many individuals acquire BiN through naturally occurring contingencies, others may require interventions to induce it. Multiple exemplar instruction (MEI), intensive tact training (ITT), establishing conditioned reinforcement for observing responses, and conditioned reinforcement for auditory stimuli are among the varied interventions that have been effective to induce the BiN capability missing in individuals prior to intervention (Du et al., 2017; Fiorile & Greer, 2007; Gilic & Greer, 2011; Greer, Stolfi, Chavez-Brown, & Rivera-Valdez, 2005; Greer, Stolfi, & Pistoljevic, 2007; Longano & Greer, 2014; Speckman-Collins, Park, & Greer, 2007).

**Multiple exemplar instruction (MEI).** A number of studies have demonstrated the effectiveness of MEI on the acquisition of BiN across students with and without developmental disabilities (Fiorile & Greer, 2007; Gilic & Greer, 2011; Greer at al., 2005; Greer et al., 2007;
Longano & Greer, 2014). This procedure incorporates instruction of a single stimulus across multiple responses topographies (e.g., listener and speaker) which are rotated in a rapid manner (Greer & Ross, 2008). It seeks to bring the rotated responses under joint stimulus control so that contact with the stimulus evokes multiple response topographies. This allows for the abstraction of the targeted stimulus across multiple and novel exemplars. For example, listener (point-to) and speaker (tact and intraverbal) responses are rotated until joint stimulus control is established across the multiple topographies of behavior. Procedurally, initial BiN probes are conducted to test for the presence of BiN prior to the MEI intervention. Following MEI, postintervention BiN probes are conducted to determine its acquisition across participants. Typically, following the establishment of BiN, participants also demonstrate a higher rate of learning as reflected by increases in acquisition of targeted objectives with a lower number of instructional opportunities (Gilic & Greer, 2011; Greer et al., 2007; Greer et al., 2011).

**Intensive tact instruction (ITT).** This procedure provides an increase in opportunities for participants to contact and name environmental stimuli in addition to typical instruction that occurs during the school day. They receive an extra 100 opportunities to tact stimuli and potentially be reinforced for emitting accurate speaker behavior. This then creates an opportunity to condition vocal praise as a reinforcer and increase the number of vocal verbal operants (Pistoljevic & Greer, 2006; Schmelzkopf, Greer, Singer-Dudek, & Du, 2017). When vocal praise is conditioned as a reinforcer, it functions to condition the tact or speaker response. The increase in tact opportunities then acts to potentially pair vocal reinforcement with the emission of vocal verbal operants. Thus, not only can ITT lead to the acquisition of BiN but also results in the increase of independent speaker operants (Greer & Du, 2010; Pereira-Delgado & Oblak, 2007; Pistoljevic, 2008).
**Auditory matching.** Listener behavior has a significant effect on the BiN capability and is theorized to be a prerequisite to its development. Research has shown that in order to acquire the full BiN capability, the listener half of Naming or unidirectional Naming (UniN) must be present (Greer, 2002; Greer & Keohane, 2006; Greer et al, 2005; Horne & Lowe, 1996; Kleinert, 2017; Lo, 2016). As previously described in Chapter I, efforts to induce UniN and to establish basic echoic repertoires have resulted in an auditory matching intervention in which participants listen to a target auditory stimuli and select a corresponding match (Chavez-Brown, 2005; Choi et al., 2015; Du et al., 2017; Speckman-Collins et al., 2007). Following the auditory matching intervention, participants emitted a higher number of correct words echoed and also demonstrated the acquisition of UniN (Chavez-Brown, 2005; Choi et al., 2015; Du et al., 2017; Speckman-Collins et al., 2007). This intervention was effective in inducing incidental learning of listener responses by bringing listener behavior under the control of auditory stimuli and thus resulting in a change in speaker behavior.

Matching the auditory stimuli that are spoken might be easier as it is a selection response rather than a speaker response. For example, after hearing a word, selecting the matching auditory stimulus might be easier than saying or producing the same word, especially for individuals who are missing the joining of the listener and speaker components of BiN (Chavez-Brown & Greer, 2009). Furthermore, it is important to note the subsequent increase in the clarity of speech production. This has important implications for bridging the connections between listener and speaker behavior.

**Source of Reinforcement?**
Previous research has identified a multitude of experiential sources of reinforcement that may serve to occasion the joining of listener and speaker repertoires leading to the emergence of the BiN capability (Longano & Greer, 2014).

**Conditioned reinforcement for observing responses.** When a word is spoken, the individual listens and sees the corresponding stimulus either in the environment or potentially by drawing upon on his or her prior experiential history with the stimulus. The learning of the name or word for the targeted stimulus occurs when there is a shift in reinforcement from a nonverbal correspondence between the stimulus and its name to a verbal function wherein there is a correspondence between the hearing (listener) of the spoken name (speaker) and seeing of stimulus (Eby & Greer, 2017). Thus, the potential stimulus control for incidental language acquisition lies in the sequence of conditioned reinforcement for observing responses.

Results from previous research indicate that there is a commonality across interventions that have been successful in inducing BiN. MEI, ITT, and auditory matching procedures include opportunities for conditioned reinforcement for listening to auditory stimuli (Longano & Greer, 2014). These procedures may function to establish vocal praise as conditioned reinforcement which then results in selecting out the listener response across all participants. Once the listener behavior (i.e., hearing auditory stimuli) functions as conditioned reinforcement, the resulting expansion of their verbal community may occasion the onset of UniN and when speaker responses join, BiN emerges. Additionally, MEI and ITT also provide a history of reinforcement for observing visual stimuli which may bring about a conditioned seeing response. When these basic behavioral repertoires, seeing, hearing, and saying, are conditioned, it provides the foundation for the acquisition of higher-order verbal operants. Longano and Greer (2014)
confirmed the significance of these relations by inducing BiN following an intervention where visual or auditory stimuli were conditioned as reinforcers for observing stimuli.

The history of reinforcement selects out specific verbal operants through the shift in transformation of stimulus function following repeated pairings. Recently, Lo (2016) tested the effectiveness of a repeated probe experience, in which experimenters exposed participants to visual stimuli while simultaneously saying the names of the stimuli on the acquisition of BiN. Results following the paired conditioning of the visual and the auditory stimuli resulted in the acquisition of full BiN across participants who, prior to the pairing procedure, only had UniN. The data suggest that the repeated probe procedure induced the joint stimulus control of the targeted stimuli through conditioning of participants’ observing responses. It was posited that the acquisition of these observing responses as conditioned reinforcement serve as potential sources of reinforcement in the BiN relation.

Kleinert (2018) extended the research conducted by Lo (2016) and found similar results following the repeated probe procedure. Participants in Kleinert’s (2018) study demonstrated BiN with both familiar and unfamiliar stimuli following the repeated exposures of corresponding visual and auditory stimuli. The results of her experiments support the significance in establishing conditioned reinforcement for observing responses to occasion the transfer of stimulus control from the previously conditioned observing responses to novel, unfamiliar stimuli. Once novel auditory and visual stimuli function as conditioned reinforcement for observing responses, it sets the stage for establishing incidental language acquisition. Another notable finding from her study indicated that when visual stimuli which functioned as conditioned reinforcers, were paired with neutral auditory stimuli, the pairing procedure functioned to condition the previously neutral stimulus. This suggests that the conditioned
reinforcement for observing responses serves as stimulus control for the acquisition of BiN and other higher-order operants.

**Echoic behavior.** Longano and Greer (2014) theorized that a possible source of reinforcement for Naming might be the production of echoics that occur throughout the multiple interventions used for the induction of the Naming capability. In 2008, Longano tested the effects of a MEI intervention with an echoic component on the acquisition of Naming in three preschool students. The echoic component was implemented only with one student during which he was required to emit an echoic response following rotated instruction across listener and speaker responses. The results indicated significant increases in the number of correct listener and speaker responses during post-intervention probes for the acquisition of Naming.

Horne and Lowe (1996) also expounded on the significance of echoic behavior on the acquisition of Naming and thus the joining of listener and speaker behavior. When a typically developing child learns to echo and emits an echoic response, he or she establishes a relational link between the listener and speaker responses in conjunction with the visual stimuli. For example, when an adult or caregiver sees a cup, points to it, and says, “cup,” it serves as a stimulus for a child to emit the echoic response, “cup.” In this scenario, the stimulus that occasions the echoic response is that of the caregiver’s tact response which results in a listener response in the child. When the child functions as a listener, he or she is then will emit an echoic response. This rotation of listener and speaker responses has significant implications for the acquisition of language in typically developing students (Horne & Lowe, 1996).

Referring back to the auditory matching studies, the results of those experiments have found connections between increasing the accuracy of echoic responses and the training of the listener response that occurs during the experimental interventions. Since the production of the
echoic necessitates a matched hearing and saying response, it stands to reason that there may be a connection between echoic training and conditioned speaker and listener responses that occasion the onset of BiN. Results from Cao and Greer (2019) extend the listener matching response trained in auditory matching to a listener production response that trained echoic responding which then conditioned both listener and speaker responses, occasioning the emergence of BiN. However, additional questions still remain about the relations between accurate echoic behavior, articulation (which serves to measure the correspondence between hearing and saying), and the degrees of BiN. Research has not yet been conducted to test the effectiveness of sentence-length echoic responding as opposed to phonemic sounds or words. There is potential for further analysis in how more advanced echoic repertoires relate to BiN which is a measure of language development.

**Rationale for Study**

Research supports the identification of BiN to be a building block for language development but there are still potential gaps in research as to source of reinforcement for BiN and potential origins of behavior. Across the research on BiN, there are still some questions as to the possible prerequisites necessary for the acquisition of this verbal capability. Looking toward the interventions that have resulted in inducing BiN for individuals who do not acquire it through typical means, it is evident that there is a relationship between the echoic repertoire and acquisition of BiN, however there is limited research on the degree of that relationship. For example, do individuals demonstrate BiN when they can reliably produce accurate echoics for words that they hear? And to what degree does the number of words contained in their echoic repertoire reflect their acquisition of BiN? Previous research using auditory matching has resulted in the acquisition of UniN but since that includes matching listener responses, how does
the introduction of the speaker response in echoic responding affect the acquisition of full BiN? What is the significance in the degrees of correspondence between hear-say or echoic behavior and BiN? Additionally, research conducted by Cao and Greer (2019) demonstrated that once individuals can produce accurate articulation of phonemes that they previously did not, BiN was acquired using words that contained those phonemes. However, how does that affect individuals with faulty articulation or speaker behavior? Is there a relationship between the number of accurate phonemes produced by individuals and their BiN repertoire? It is with these questions in mind that I propose my research questions for Study I.

**Research Questions for Study I**

1. Is there a relation between the degrees of UniN, the speaker component of BiN, full BiN and accurate articulation of sounds commonly used in the English language?

2. Is there a relation between the degrees of UniN, the speaker component of BiN, full BiN and the accurate production of echoics at the sentence level?
CHAPTER III

STUDY I

Method

Participants

A total of 46 elementary school students with and without disabilities were selected for this study. They ranged in age from 5 to 8 years at the onset of the study ($M=6.9$, $SD=.84$). Of these participants, 28 were male, 10 were categorized as English as a Second Language (ESL) students, and 20 had educational classifications and Individualized Educational Plans (IEP) or 504 Plans that stated their eligibility for special education services or educational accommodations. Additionally, 17 students received Free or Reduced Lunch. Twenty-one participants identified as White, 17 were Hispanic, 5 were Mixed, 2 were Black, and 1 was Asian. See Tables 1, 2, and 3 for detailed description of participant data.

Table 1

Description of Participants in Study 1

<table>
<thead>
<tr>
<th>Variable</th>
<th>$N$</th>
<th>Percent</th>
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</thead>
<tbody>
<tr>
<td>Sex</td>
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<tr>
<td>M</td>
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<tr>
<td>F</td>
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<tr>
<td>Grade Level</td>
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</tr>
<tr>
<td>K</td>
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</tr>
<tr>
<td>1</td>
<td>15</td>
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</tr>
<tr>
<td>2</td>
<td>23</td>
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</tr>
<tr>
<td>Individualized Educational Plan</td>
<td>20</td>
<td>43%</td>
</tr>
<tr>
<td>Free/Reduced Lunch</td>
<td>17</td>
<td>37%</td>
</tr>
<tr>
<td>English as a Second Language</td>
<td>10</td>
<td>22%</td>
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</table>

Note. M = male; F = female; K = kindergarten; 1 = first grade, 2 = second grade
Table 2

Description of Educational Classifications of Students with IEPs in Study 1

<table>
<thead>
<tr>
<th>Educational Classification</th>
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<tr>
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<tr>
<td>Autistic</td>
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<td>15%</td>
</tr>
<tr>
<td>Communication Impaired</td>
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<td>11%</td>
</tr>
<tr>
<td>Specific Learning Disability</td>
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<tr>
<td>Other Health Impaired</td>
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<td>4%</td>
</tr>
<tr>
<td>Eligible for Speech Services</td>
<td>1</td>
<td>2%</td>
</tr>
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</table>

Note. IEP = Individualized Education Plan

Table 3

Ethnicities of Participants in Study 1

<table>
<thead>
<tr>
<th>Ethnicity</th>
<th>N</th>
<th>Percent</th>
</tr>
</thead>
<tbody>
<tr>
<td>White</td>
<td>21</td>
<td>45%</td>
</tr>
<tr>
<td>Hispanic</td>
<td>17</td>
<td>37%</td>
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<tr>
<td>Mixed</td>
<td>5</td>
<td>11%</td>
</tr>
<tr>
<td>Black</td>
<td>2</td>
<td>5%</td>
</tr>
<tr>
<td>Asian</td>
<td>1</td>
<td>2%</td>
</tr>
</tbody>
</table>

Participants selected for this study included kindergarten, first grade, and second grade students from a publicly funded, Title 1 school for grades K-2 in a suburb in the Northeast region of the United States. They were recruited from one kindergarten, one first grade, and one second grade inclusion classroom which were comprised of students with and without IEPs.

Additionally, participants were selected from one self-contained kindergarten through second
grade classroom for students with IEPs. Each classroom implemented the Comprehensive Application of Behavior Analysis to Schooling (CABAS®) educational model (www.cabasschools.org). This model is comprised of a behavior analytic approach to instruction using research-based tactics to meet educational objectives derived from state standards.

**Inclusion criteria.** In order to gain a sample size indicative of a diverse range of students, participants were recruited from across grade levels and included students with and without IEPs. Additionally, participants were required to have the following behavioral cusps in repertoire in order to complete the experimental assessments and probes: (1) teacher presence results in instructional control: students follow directions when in the presence of a teacher (2) conditioned reinforcement for voices: students attend to voices of others in their environment, and (3) conditioned reinforcement for observation; students attend to and observe two-dimensional (2D) and three-dimensional (3D) stimuli in their environment. All of these behavioral cusps ensure that the participants followed teacher directions and attend to the stimuli that were presented during experimental procedures.

**Setting and Materials**

All probes and assessments were conducted within the school setting, either in a classroom or hallway outside of the classroom. The experimenter accounted for visual and auditory distractions by seating the student away from high volume areas. The participant sat near or across from the experimenter during probes and assessments. The Goldman-Fristoe Test of Articulation 3 (GFTA-3) Stimulus book and print record forms were used to assess for the student’s articulation. Additional materials include Record Form 1 of the Recalling Sentences subtest and the Examiner’s Manual of the Clinical Evaluation of Language Fundamentals® – Fifth Edition (CELF®-5). During bidirectional Naming (BiN) probes, the experimenter used a
computer laptop to display pictures of unfamiliar visual stimuli, preconstructed data sheets, and pens to record participant responses. The symbols chosen as the unfamiliar stimuli were selected from a list of symbols available through the Microsoft PowerPoint software. These symbols were selected as unfamiliar stimuli due to the low likelihood that participants had previously contacted them or had an opportunity to learn their names. See Table 4 for a detailed list of stimuli used during unfamiliar BiN probes.

Table 4

Unfamiliar Novel Stimuli Used During Bidirectional Naming Probes for Study 1

<table>
<thead>
<tr>
<th>Stimulus</th>
<th>Stimulus Name</th>
</tr>
</thead>
<tbody>
<tr>
<td><img src="image1" alt="Symbol" /></td>
<td>dharma</td>
</tr>
<tr>
<td><img src="image2" alt="Symbol" /></td>
<td>mahjong</td>
</tr>
<tr>
<td><img src="image3" alt="Symbol" /></td>
<td>joteer</td>
</tr>
<tr>
<td><img src="image4" alt="Symbol" /></td>
<td>pulpa</td>
</tr>
<tr>
<td><img src="image5" alt="Symbol" /></td>
<td>gitbon</td>
</tr>
</tbody>
</table>

Experimental Sequence

The experimenter conducted three probe measures for each participant including: (1) a bidirectional Naming probe, (2) a phonemic articulation assessment using the Goldman-Fristoe Test of Articulation 3 (GFTA-3), and a (3) sentence level echoic probe using the Recalling...

Dependent Measures

Bidirectional Naming (BiN). Dependent measures for the degrees of BiN included (1) the degree of unidirectional Naming (UniN), (2) the degree of speaker component of Naming, and (3) the calculated degree of BiN. UniN was measured by the number of correct untaught listener responses out of 10 response opportunities following a Naming experience. The speaker component of Naming was measured by the number of correct untaught tact and intraverbal responses out of 20 response opportunities (10 tact and 10 intraverbal) following a Naming experience. The degree of BiN was determined by calculating the mean percentage of correct UniN and speaker responses out of a total of 30 response opportunities.

Goldman-Fristoe Test of Articulation 3 (GFTA-3; Goldman & Fristoe, 2015). The GFTA-3 is an individually administered and standardized assessment used to measure the articulation of speech sounds produced by individuals ages 2 years and 0 months through 21 years. There are two tests included in the GFTA-3, the Sounds in Words test and the Sounds in Sentences test. For this experiment, only the Sounds in Words test was provided. This assessment provided multiple opportunities for the participant to produce 23 consonant and 16 consonant cluster sounds used in Standard American English across initial, medial, and final word positions. Standard and norm-referenced scores compared to same-aged and sex peers are produced based on the participant’s raw score. The GFTA-3 also provides age-based percentile ranks for the standard scores which indicate each participant’s standing relative to others in the normative sample. A mean standard of 100 is at the 50th percentile across all ages.
The standardization sample for the GFTA-3 included a normative sample of 1,500 individuals from the ages of 2 to 21. The reliability of the GFTA-3 was measured using internal consistency and test-retest stability. Internal consistency reliability coefficients were examined using coefficient alpha with an overall alpha for females at .94 and for males at .95, demonstrating a high degree of reliability. The Standard Error of Measurement (SEM) was measured at 4.02 for females and 3.75 for males. Test-retest stability was measured at $r (.86)$ and a corrected $r (.92)$ with a standard difference of .09 indicating good assessment stability. For the purposes of this experiment, each participant’s raw score was converted to a scaled score to allow statistical analysis.

Clinical Evaluation of Language Fundamentals® – Fifth Edition (CELF®-5; Wiig, Secord, & Semel, 2013). The CELF®-5 assesses receptive and expressive language function with 16 subtests for semantics, grammar, and working memory for language. For this experiment, only one subtest was assessed: Recalling Sentences, as a measure of echoic responses at a sentence level. It includes 26 sentences of increasing complexity in meaning and structure. The objective of the subtest is to evaluate an individual’s ability to listen to and repeat sentences without changing the word order and meaning, morphology, or syntax. The normative sample of the CELF®-5 included 2,380 students from the ages of 5 to 21. The internal consistency across all tests were measured between .75-.98. Test-retest stability for core and index scores was measured between .83-.9 which suggest a stable measure of reliability. Evidence of validity for the CELF®-5 included differences at <.01 between the normative sample and of individuals with language or learning disorders and Autism. In this experiment, the scaled score of each participant’s Recalling Sentences subtest was used for statistical analysis.
Data Collection

Bidirectional Naming. The experimenter recorded data on participant responses to BiN probes on preconstructed data sheets. Correct responses to the listener and speaker probes were recorded as a plus (+) and incorrect responses were recorded as a minus (-). Effort was made to ensure that participants did not see what was marked on the data sheet so as not to influence their responses.

GFTA-3. Participant responses during the GFTA-3 assessment were marked on the record form as the raw data. No mark was made on the form if the participant made no errors in articulation for the corresponding word. If the participant made any articulation errors, the word or phonemes that he or she said was recorded under the corresponding word on the record form so that the raw data could be tabulated and converted to their corresponding standard score.

CELF®-5. Experimenters recorded data on participant responses by marking the corresponding record form. As prescribed by the recording form, marks corresponded with participant responses so as to reflect potential errors that were emitted. If a participant correctly repeated each word in a sentence, a “3” was circled on the record form. If the participant emitted one error, a “2” was circled. A “1” was circled for two or three errors emitted. If the participant emitted four or more errors, a “0” was recorded. The scores for each item response were totaled to determine the raw score for each participant. Next, the experimenter used the raw score and the participant’s age at the time of the assessment to calculate his or her scaled score. This final scaled score was used for statistical analysis.

Procedure

Bidirectional Naming. In order to conduct bidirectional Naming probes, a Naming experience was first provided for each participant. This experience consisted of exposing
participants to a total of 20 picture stimuli consisting of five different items that were shown four times. During the Naming experience, the experimenter directed the participant’s attention to the visual stimuli and simultaneously said the name of the stimulus while he or she looked at the given picture. Two hours later, probes were conducted to measure the participant’s listener and speaker responses to the pictures that were previously shown. Listener probes consisted of ten trials with two opportunities for each of the five stimuli for the student to select the correct picture of the stimuli (from a field of three pictures) named by the experimenter. If the participant emitted 80% correct responding for the listener responses, he or she demonstrated the presence of UniN. Next, probes were conducted to test for the presence of BiN. They consisted of ten trials of tact responses and ten trials of intraverbal responses to visual stimuli that were previously shown during the Naming experience. If the participant emitted 80% correct responding across both of the speaker topographies, then BiN was demonstrated. The criterion of 80% accuracy was set based on previous research conducted on BiN. Participants did not receive feedback for their responses during the probe sessions. Each participants’ degree of UniN and BiN were determined by calculating his or her percentage of correct untaught listener and speaker responses divided by the total number of correct and incorrect responses, multiplied by 100.

**GFTA-3.** When conducting the GFTA-3, each participant and experimenter sat facing the GFTA-3 Stimulus book that contained pictures which corresponded with the targeted response. The experimenter directed the participant to either vocally label the picture that was shown or complete a sentence referring to the picture in order to prompt the participant to produce the targeted word. The experimenter recorded the participant’s response on the record form to measure their articulation of each targeted word. Feedback was not given for participant
responses; however, participants were given vocal praise for attending to stimuli or other appropriate behaviors to maintain attention and motivation.

**CELF®-5.** The experimenter followed the prescribed instructions of the *Recalling Sentences* subtest by directing the participants to repeat the sentences that were said by the experimenter. There were first two practice trials that were conducted to familiarize the participants with the procedure. Participants were given feedback on the practice trials, either vocal reinforcement for correctly repeating or echoing the given sentence or instructions were repeated to remind the participants of the directions. In order to move on to the assessment, participants were required to correctly echo the two trial sentences. Following the trial sentences, the experimenter informed the participants that the subsequent sentences could only be said one time and directions were repeated to listen and repeat the sentences. Each of the 26 sentences was given one at a time for the participants to echo and feedback on their performance was not provided. However, participants received vocal praise for attending and appropriate in-seat behavior during this assessment.

**Interobserver Agreement**

A second observer served to collect interobserver agreement (IOA) during experimental measures. A second observer was a trained teaching assistant who was calibrated in data collection. Each observer was calibrated to record data with 100% accuracy across two consecutive sessions. During data collection for the *GFTA-3* and *CELF®-5 Sentence Recalling* subtest, a licensed Speech-Language Pathologist was consulted and observed to ensure measurement fidelity. IOA was calculated for each session of the bidirectional Naming probes by dividing the number of agreements by the total number of agreements and disagreements. IOA was conducted for 60% of Naming probes with a mean agreement of 98% and a range
between 87% to 100%. IOA was conducted for 41% of sessions during the GFTA-3 probes with a mean agreement of 96.8% and a range between 83% to 100% accuracy.

**Results**

A Pearson’s correlation was conducted using the SPSS program to determine the relationship between UniN, BiN, and participant scores on the GFTA-3 and CELF®-5 Sentence Recalling subtest. An alpha level of .05 was used for all statistical analyses. Results found no significant correlation between participant’s standard scores on the GFTA-3 and their degree of UniN, $r(44) = .05, p = .741$; the percentage of correct responses on the speaker component of BiN, $r(44) = .015, p = .921$; nor the participants’ degree of BiN, $r(44) = .037, p = .808$.

With regard to the relationship between the degrees of bidirectional Naming and their scores on the CELF®-5 there was a correlation between participant scores on the CELF®-5 Sentence Recalling subtest, $r(44) = .381, p = .009$. Additionally, there was a stronger, significant correlation between the percentage of correct participant responses on the speaker component of BiN, $r(45) = .633, p < .001$; as well as the degree of overall BiN, $r(45) = .589, p < .001$. The results of the correlations between UniN, the speaker component of Naming, and BiN remained significant after applying a Bonferroni correction for the $p$-value. The results of these analyses demonstrate a significant positive relationship between the participants’ degree of BiN, specifically their speaker responses and their score on the Recalling Sentences subtest of the CELF®-5. The data suggest that participants that score higher on the CELF®-5, demonstrate a higher degree of BiN.
Table 5

*Mean and Standard Deviation across Dependent Measures*

<table>
<thead>
<tr>
<th></th>
<th>M</th>
<th>SD</th>
</tr>
</thead>
<tbody>
<tr>
<td>GFTA-3</td>
<td>98.3</td>
<td>15.1</td>
</tr>
<tr>
<td>CELF®-5</td>
<td>10.09</td>
<td>3.88</td>
</tr>
<tr>
<td>UniN</td>
<td>73.69%</td>
<td>23.69%</td>
</tr>
<tr>
<td>Speaker</td>
<td>27.66%</td>
<td>25.33%</td>
</tr>
<tr>
<td>BiN</td>
<td>50.68%</td>
<td>21.27%</td>
</tr>
</tbody>
</table>

*Note.* UniN = unidirectional Naming; Speaker = speaker component of Naming; BiN = bidirectional Naming.

Table 6

*Summary of Correlations*

<table>
<thead>
<tr>
<th>Degree of UniN</th>
<th>GFTA-3</th>
<th>CELF®-5</th>
</tr>
</thead>
<tbody>
<tr>
<td>.050</td>
<td>.381*</td>
<td></td>
</tr>
<tr>
<td>Degree of Speaker</td>
<td>.015</td>
<td>.633**</td>
</tr>
<tr>
<td>Degree of BiN</td>
<td>.037</td>
<td>.589**</td>
</tr>
</tbody>
</table>

*Note.* Significance levels: *p<.01; **p < .001; UniN = unidirectional Naming; Speaker = speaker component of Naming; BiN = bidirectional Naming.
**Figure 1.** The participants’ degree of bidirectional Naming in relation to their scaled score on the *CELF®-5*.

**Figure 2.** The participants’ degree of the speaker component of bidirectional Naming in relation to their scaled score on the *CELF®-5*. 

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Figure 3. The participants’ degree of unidirectional Naming in relation to their scaled score on the CELF®-5.

Figure 4. The participants’ degree of bidirectional Naming in relation to their standard score on the GFTA-3.
Figure 5. The participants’ degree of unidirectional Naming in relation to their standard score on the GFTA-3.

Figure 6. The participants’ degree of the speaker component of bidirectional Naming in relation to their standard score on the GFTA-3.
Discussion

The results of this study found that there is a significant positive correlation between the participants’ degree of UniN, degree of speaker component of BiN, and also degree of overall BiN and their score on the Recalling Sentences subtest of the CELF®-5. This suggests that participants who emit more accurate echoic responses at the sentence level also demonstrate a higher degree of BiN. More specifically, the highest correlation was between the speaker component of Naming and the scaled scores on the CELF®-5. This suggests that there is a strong relationship between speaker behavior and echoic behavior. However, there were no significant correlations between the aforementioned variables and their scores on the GFTA-3. These results suggest that the accuracy in participant articulation of phonemes may not be related to their Naming repertoires.

These results support previous research on the relationship between echoic training and the acquisition of bidirectional Naming (Longano & Greer, 2014). However, the form of echoics measured during the Recalling Sentences subtest differs from previous research in that they are much longer in length. Additionally, by emitting sentence-length echoics, there is a question of whether or not participants have a conditioned seeing response when listening to a sentences that refer to multiple stimuli. If we consider that bidirectional Naming is the joining of speaker and listener operants, there is also a connection to a conditioned seeing response in that when someone says a word, it evokes a seeing response that refers to the stimulus that is said. Therefore, did students who scored higher on the Recalling Sentences subtest do so because the words have a verbal function, thereby evoking correspondences between hear-see behavior in which they “understand” the sentence? Or were they under the auditory control of the spoken words in the sentence and emitted accurate point-to-point responses due to a hear-say behavior?
Rationale for Experiment I

Study I established a correlation between accuracy in echoic responding at a sentence level and UniN, the speaker component of BiN, and full BiN. These results provide support for previous research that incorporated the importance of echoic behavior with the presence of BiN. However, previous echoic interventions have trained echoic responding at the phoneme and word level; there has been little research on the effects of training longer echoic responses (Cao & Greer, 2019; Longano & Greer, 2014). Therefore, I proposed to test the effects of sentence-length echoic training on the acquisition of BiN. However, it is important to note the difference in echoic training with sentences and echoic training with words and phonemes.

When saying a sentence, the speaker may accrue meaning through hearing and then repeating the sentence if there have been previous contingencies of reinforcement that have been established with the words in the sentence. This may not be the case for echoic training with single words and phonemes that do not possess referential qualities to objects (Cao & Greer, 2019; Longano & Greer, 2014). It is with this in mind that I considered comparing the effects of two different echoic training conditions on the establishment of BiN. The first condition includes echoic training with grammatically coherent sentences that have verbal function or are meaningful. The other echoic training condition uses sentences that do not have meaning or verbal function because the words in the sentence are scrambled and are syntactically incoherent, thus these echoics are dependent on the acoustic properties of the words.
Research Questions for Experiment I

1. Does echoic training using sentences with verbal function result in the acquisition of bidirectional Naming in students who have unidirectional Naming?

2. Does echoic training using sentences with purely acoustic correspondence, lacking in the verbal function, result in the acquisition of bidirectional Naming in students who have unidirectional Naming?
CHAPTER IV

EXPERIMENT I

Method

Participants

The participants were eight kindergarten and first grade students selected from Study 1 who did not demonstrate bidirectional Naming with unfamiliar stimuli. The inclusion criteria for participants entering Experiment I included the presence of unidirectional Naming in at least one preintervention probe with the addition of some number of accuracy in (i.e., >2) speaker responses during preintervention probes. Table 7 includes detailed demographics of all participants.

Table 7

Description of Participants in Experiment I

<table>
<thead>
<tr>
<th>Participant</th>
<th>Acoustic Condition</th>
<th>Verbal Condition</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>1A</td>
<td>2A</td>
</tr>
<tr>
<td>Grade</td>
<td>K</td>
<td>K</td>
</tr>
<tr>
<td>Age</td>
<td>6</td>
<td>5</td>
</tr>
<tr>
<td>Sex</td>
<td>F</td>
<td>M</td>
</tr>
<tr>
<td>IEP</td>
<td>N</td>
<td>N</td>
</tr>
<tr>
<td>CELF®-5</td>
<td>53</td>
<td>35</td>
</tr>
<tr>
<td>Initial BiN</td>
<td>60%</td>
<td>53%</td>
</tr>
</tbody>
</table>

Note. K = Kindergarten; 1 = first grade; M = male; F = female; IEP = Individualized Education Plan; Y = yes; N = no; CELF®-5 = scaled score on the Recalling Sentences subtest of the Clinical Evaluation of Language Fundamentals® – Fifth Edition; Initial BiN = degree of BiN during preintervention probes.
**Participant grouping.** Participants were paired into dyads based on their scaled score on the *Recalling Sentences* subtest of the *CELF®-5*. Dyad 1 were comprised of participants with the highest *CELF®-5* score and Dyad 4 were comprised of participants with the lowest *CELF®-5* score. Additionally, I calculated the mean percentage of correct listener and speaker responses for each participant’s preintervention bidirectional Naming probes to determine his or her treatment conditions. One participant from each dyad with the highest number of correct responses were placed in either condition in an alternating manner so that there was an equal number of participants for each treatment condition and the conditions were counterbalanced. For example, in Dyad 1, Participant 1A had a higher overall degree of bidirectional Naming so this participant was placed in the acoustic intervention. In the next dyad, Dyad 2, Participant 2V had a higher degree of bidirectional Naming so this participant was placed into the verbal condition to counterbalance the participant from Dyad 1. The same sequence was followed by participants from Dyads 3 and 4 so that the participant from either dyad with the higher degree of bidirectional Naming was placed in the acoustic condition (Participant 3A) and verbal condition (Participant 4V).

**Setting and Materials**

The setting of this experiment was consistent with that of Study 1. All experimental probes and intervention sessions occurred in a classroom or hallway outside of the classroom to minimize auditory distractions. Participants were seated next to or across from the experimenter during all probe or intervention sessions. A second observer was also present at times to collect interobserver agreement (IOA).

During bidirectional Naming probes, visual stimuli were presented on a laptop computer or iPad using slides on Microsoft PowerPoint. Table 8 includes the names and symbols used to
represent the unfamiliar stimuli used during probe sessions. The names of the stimuli included uncommon or nonsense words containing phonemes that occurred in the English language. The symbols were selected from those available through Microsoft PowerPoint. Unfamiliar stimuli were considered visual and auditory stimuli that were not commonly found in the participants’ environment and thus had a low likelihood of previous exposure. A novel set of unfamiliar Naming stimuli were used for each probe across all participants; thus, a different set of stimuli was given each time that a participant received a bidirectional Naming probe. Additional materials included preconstructed data sheets to record data on participant responses during probe and intervention sessions. Appendix B includes an example of a data sheet used to record participant responses during bidirectional Naming probes.

The sentences used during the echoic intervention were created based on the *Recalling Sentences* subtest of the *CELF®-5*. Each sentence contained from seven to nine words and included vocabulary that was familiar to school-aged children (i.e., common items, school related words). First, the verbal echoic sentences were created, then the words from each sentence were put through a sentence scrambler (http://www.altastic.com/scramblinator/) so that the words were out of order and the subsequent sentence contained the same words as the verbal condition but did not have any verbal function. The experimenter ensured that the generated acoustic sentences followed a word order did not have verbal function. Appendix C includes an example of data sheets used to record data during the verbal echoic interventions. Appendix D includes an example of data sheets used to record data during the acoustic echoic interventions.
### Table 8

*Unfamiliar Novel Stimuli Used for Bidirectional Naming Probes in Experiment I.*

<table>
<thead>
<tr>
<th>Set</th>
<th>Symbols</th>
<th>Names</th>
</tr>
</thead>
<tbody>
<tr>
<td>Set 1</td>
<td><img src="image1" alt="Symbol" /> <img src="image2" alt="Symbol" /> <img src="image3" alt="Symbol" /> <img src="image4" alt="Symbol" /> <img src="image5" alt="Symbol" /></td>
<td>Gitbon Pulpa Joteer Mahjong Dharma</td>
</tr>
<tr>
<td>Set 2</td>
<td><img src="image6" alt="Symbol" /> <img src="image7" alt="Symbol" /> <img src="image8" alt="Symbol" /> <img src="image9" alt="Symbol" /> <img src="image10" alt="Symbol" /></td>
<td>Foble Notag Dewor Kaser Laxid</td>
</tr>
<tr>
<td>Set 3</td>
<td><img src="image11" alt="Symbol" /> <img src="image12" alt="Symbol" /> <img src="image13" alt="Symbol" /> <img src="image14" alt="Symbol" /> <img src="image15" alt="Symbol" /></td>
<td>Neckmit Hendas Morfan Winzoo Yubat</td>
</tr>
<tr>
<td>Set 4</td>
<td><img src="image16" alt="Symbol" /> <img src="image17" alt="Symbol" /> <img src="image18" alt="Symbol" /> <img src="image19" alt="Symbol" /> <img src="image20" alt="Symbol" /></td>
<td>Clag Santee Chinto Hern Antive</td>
</tr>
<tr>
<td>Set 5</td>
<td><img src="image21" alt="Symbol" /> <img src="image22" alt="Symbol" /> <img src="image23" alt="Symbol" /> <img src="image24" alt="Symbol" /> <img src="image25" alt="Symbol" /></td>
<td>Zurry Weggen Plob Kessel Mantor</td>
</tr>
<tr>
<td>Set 6</td>
<td><img src="image26" alt="Symbol" /> <img src="image27" alt="Symbol" /> <img src="image28" alt="Symbol" /> <img src="image29" alt="Symbol" /> <img src="image30" alt="Symbol" /></td>
<td>Pullic Nori Tramo Yingal Clob</td>
</tr>
<tr>
<td>Set 7</td>
<td><img src="image31" alt="Symbol" /> <img src="image32" alt="Symbol" /> <img src="image33" alt="Symbol" /> <img src="image34" alt="Symbol" /> <img src="image35" alt="Symbol" /></td>
<td>Durma Nixo Broq Vistry Extin</td>
</tr>
<tr>
<td>Set 8</td>
<td><img src="image36" alt="Symbol" /> <img src="image37" alt="Symbol" /> <img src="image38" alt="Symbol" /> <img src="image39" alt="Symbol" /> <img src="image40" alt="Symbol" /></td>
<td>Lutick Prench Ingore Clong Jupe</td>
</tr>
</tbody>
</table>
Experimental Design

The experimental design was a combined multiple probe and simultaneous treatment design counterbalanced across dyads with a crossover to assess the effectiveness of two echoic treatment conditions on the acquisition of bidirectional Naming using unfamiliar stimuli (Greer et al., 2007; Johnston & Pennypacker, 2010). Initial bidirectional Naming probes were conducted across all participant dyads to determine the presence of absence of bidirectional Naming. Next, the first set of dyads entered either echoic treatment condition – verbal or acoustic. The participants in each dyad functioned as matched pairs in that they received the same number of intervention sessions to control for instructional histories. If one participant met criterion during a phase of intervention, the other participant in the matched pair’s intervention was discontinued and a postintervention bidirectional Naming probe was conducted for both participants in the dyad. If only one participant in the dyad met criterion for the acquisition of bidirectional Naming in the postintervention probe, the other participant in the dyad switched treatment conditions and continued intervention sessions in the other condition. If neither participant in a dyad met criterion, they continued in the same treatment conditions for one more intervention phase and postintervention probes were conducted following criterion level responding for either participant in the treatment condition. When postintervention probes were conducted for the first dyad, another preintervention probe was conducted for the next set of dyads before they began the interventions. The sequence of probes continued so that all dyads received a preintervention probe before entering either treatment condition. This was conducted to control for instructional history and to establish a stable trend for responding to bidirectional Naming probe prior to intervention. Furthermore, each probe used a novel set of unfamiliar Naming stimuli. See Figure 7 for a visual example of the experimental design.
Figure 7. A visual example of the combined multiple probe and simultaneous treatment design across dyads. An initial preintervention probe was conducted across dyads. Next, the first dyad entered the simultaneous treatment intervention with one participant in the acoustic intervention and the other in the verbal intervention. When one participant in the dyad met intervention criterion, postintervention probes were conducted for both participants. The next dyad received a second preintervention probe before entering intervention to control for instructional history and followed the same intervention sequence. If a participant did not meet postintervention criterion after three phases of the intervention, he or she switched treatment conditions.
**Dependent Variable**

The dependent variable for Experiment I was the degree of bidirectional Naming as measured by the number of correct untaught listener and speaker responses to unfamiliar stimuli following the presentation of a Naming experience. A total of 10 response opportunities were presented to measure the number of correct listener responses. Speaker responses were comprised of 10 tact responses and 10 intraverbal responses to novel, unfamiliar stimuli. The degree of bidirectional Naming for each participant was calculated by determining the mean percentage of correct responses across listener and speaker topographies.

**Independent Variable**

The independent variables were two echoic treatment conditions – verbal and acoustic. The verbal treatment condition consisted of participants repeating sets of sentences with verbal function in that the sentences followed typical grammatical standards using the English language. Thus, these sentences were meaningful in that they had semantic function. The acoustic treatment condition consisted of participants repeating sets of sentences without verbal function such that the words used in the verbal sentence condition were scrambled and did not follow typical grammatical structure. Thus, acoustic sentences did not have syntax or semantic function. For example, a sentence used in the verbal treatment condition would state, “you can ride your bike in the park” and the corresponding sentence in the acoustic treatment condition would state, “in the your bike you ride can park.” Each intervention phase consisted of three sets of sentences with each set containing 10 sentences. Participants in either treatment condition completed at least one set of sentences per intervention session.

**Data Collection**
Data collection procedures during bidirectional Naming probes were identical to those during Experiment I in which correct and incorrect responses were marked as a plus (+) or minus (-) on premade data sheets (see Appendix B). During intervention sessions, data were also collected on premade data sheets (see Appendix C and D). If participants echoed the given sentence with 100% accuracy, a plus (+) was recorded on the corresponding sentence on the data sheet. If the participant emitted any errors and did not accurately echo the sentence with one-to-one correspondence, a minus (-) was marked on the respective data sheet.

**Procedure**

**Bidirectional Naming.** The bidirectional Naming probes conducted for this experiment was identical to that of Experiment I. Participants were selected based on these initial probes to select individuals who had at least unidirectional Naming and some speaker responses in repertoire. All dyads received at least two bidirectional Naming probes before the first dyad began intervention. Additionally, all subsequent dyads underwent an additional probe before entering intervention to control for maturation. The stimuli used for bidirectional Naming probes consisted of symbols and words that the participants were unfamiliar with at the onset of the experiment. Prior to the Naming experience, the experimenter confirmed with participants that the stimuli used were novel and unknown to them.

**Echoic Intervention.** The echoic training procedure for both verbal and acoustic sentences used learn units to teach the appropriate echoic response (Albers & Greer, 1991). If the participant emitted a correct echoic response with point-to-point correspondence for each word in the sentence, vocal praise was delivered. If the participant did not accurately produce an echoic response, the sentence was repeated up to three times or until the participant independently emitted the correct response. During this error correction procedure, a sentence
was repeated up to three times before moving on to the next sentence. The criterion for the echoic intervention was nine or ten correct responses across three sets of sentences, with each set containing ten sentences. Once the criterion was met for either participant in the matched dyad, postintervention probes were conducted to test for the acquisition of bidirectional Naming in both participants.

**Interobserver Agreement**

A second observer served to collect simultaneous data during probe and intervention sessions. Observers included classroom teaching staff who were trained to record data. Interobserver agreement (IOA) was calculated for each session of the bidirectional Naming probes by dividing the number of agreements by the total number of agreements and disagreements. IOA was collected for 44.9% of bidirectional Naming probes with a mean agreement of 99% and a range between 95% and 100% agreement. During the echoic intervention sessions, IOA was calculated for 43.8% of sessions with 99.5% mean agreement and ranged between 90% and 100% agreement.

**Results**

Figure 7 displays the percentage of correct listener and speaker responses that represent the degree of bidirectional naming during pre and postintervention probes. Results from the postintervention probes show that Participants 1V, 1A, 2V, 2A, and 3A acquired bidirectional Naming following either echoic intervention. Of the 5 participants for whom bidirectional Naming emerged, 4 of the participants met criterion following the verbal echoic condition and 1 participant met criterion after completing the acoustic intervention. Furthermore, 2 of the participants, 1A and 3A started intervention under the acoustic condition. Data showed that these participants did not increase in the number of correct responses during bidirectional
Naming probes following the acoustic intervention. After switching conditions and completing three phases of the verbal intervention, bidirectional Naming emerged in both participants.

Participant 2A was the only student who acquired bidirectional Naming after completing one phase of the acoustic echoic responding intervention. Participant 2V required 3 phases of the verbal echoic intervention before the emergence of BiN. Increases in the percentage of correct responses are also apparent in Participants 1A, 3V, and 3A, specifically in speaker responses. It should also be noted that there was a decrease in the percentage of correct responses following the acoustic intervention for Participant 1A. Therefore, a decision was made to switch conditions to the verbal echoic treatment resulting in an increase in percentage of correct listener and speaker responses.

Bidirectional Naming has not yet emerged in Participants 3V, 4A, and 4V. Postintervention data on the number of correct responses to BiN probes for Participant 3V showed that there were some increases in the number of correct speaker responses following the verbal echoic condition. After three phases in the verbal condition, Participant 3V then switched to the acoustic condition. After one phase of the acoustic intervention, his number of correct speaker responses decreased from the post-verbal intervention phases. Data from postintervention BiN probes for Participants 4A and 4V showed no difference in the number of correct responses in Participant 4A but there were some slight increases in correct responding in Participant 4V.
Figure 8. A combined multiple probe and simultaneous treatment design counterbalanced across dyads with a crossover measuring the degree of bidirectional Naming across listener and speaker responses during preintervention and postintervention probes.
Figure 9. Data collected from intervention sessions for Dyad 1. Participant 1A started under the acoustic echoic intervention and Participant 1V started under the verbal echoic intervention. Postintervention bidirectional Naming (BiN) probes were conducted after every three intervention sets at criterion level responding (nine or ten correct responses in each set). Each dashed line represents that criterion was met for the preceding intervention set.Participant 1V met criterion for postintervention BiN probes after intervention Set 6. Participant 1A switched from the acoustic echoic condition to verbal echoic condition after intervention Set 6.
Figure 10. Data collected from intervention sessions for Dyad 2. Participant 2A started under the acoustic echoic intervention and Participant 2V started under the verbal echoic intervention. Postintervention bidirectional Naming (BiN) probes were conducted after every three intervention sets at criterion level responding (nine or ten correct responses in each set). Each dashed line represents that criterion was met for the preceding intervention set. Participant 2A met criterion for postintervention BiN probes after intervention Set 3. Participant 2V met criterion for postintervention BiN probes after intervention Set 9.
Figure 11. Data collected from intervention sessions for Dyad 3. Participant 3A started under the acoustic echoic intervention and Participant 3V started under the verbal echoic intervention. Postintervention bidirectional Naming (BiN) probes were conducted after every three intervention sets at criterion level responding (nine or ten correct responses in each set). Each dashed line represents that criterion was met for the preceding intervention set. Participant 3A switched from the acoustic intervention to verbal intervention after Set 9 and met criterion for postintervention BiN probes following intervention Set 12. Participant 3V switched from the verbal echoic intervention to acoustic echoic intervention after Set 9 and has not met criterion for postintervention BiN probes.
Figure 12. Data collected from intervention sessions for Dyad 4. Participant 4A started under the acoustic echoic intervention and Participant 4V started under the verbal echoic intervention. Postintervention bidirectional Naming (BiN) probes were conducted after every three intervention sets at criterion level responding (nine or ten correct responses in each set). Each dashed line represents that criterion was met for the preceding intervention set. Neither Participant has met criterion for postintervention BiN probes.
Discussion

The results of Experiment I have shown that participation in either echoic interventions have resulted in the acquisition of BiN. However, more specific analysis showed four participants who completed the verbal echoic condition and one participant from the acoustic condition have acquired BiN. Results also indicate that two participants (1A and 3A) initially started in the acoustic echoic condition but subsequent postintervention BiN scores showed that the number of correct responses for both listener and speaker components remained steady or decreased as compared to preintervention BiN probes. Both participants then switched to the verbal echoic condition. It was only following the verbal echoic condition that their responses on postintervention BiN scores increased. This suggested that when students were trained to emit echoic responses to sentences that are meaningful or are verbal, it may have acted to join the listener and speaker responses from which BiN emerges.

Conversely, the majority of participants who went through the acoustic sentence condition did not acquire BiN as measured by postintervention probes. It is possible that the jumbled arrangement of the words resulting in syntactically and semantically incoherent sentences did not occasion verbal behavior in the joining of listener speaker responses. Both echoic conditions required a rotation of listener and speaker responses as participants had to listen to the model sentence and produce the corresponding echoic speaker response. However, in the acoustic condition, there was no verbal function to the sentences which did not allow for potential connections to be made to prior verbal experiences. Rather, participants were reinforced only for accuracy in echoing each word in the series with point-to-point correspondence. This may be the defining difference between the two intervention conditions and their relation to occasion the emergence of BiN. Sentences that have verbal function or
meaning allow participants to contact potential linguistic contingencies that they have previously encountered to form a context for the words in the sentence. Data from the participants in the acoustic condition show a much lower percentage of correct responses when compared to the responses of the participants in the verbal echoic condition as measured during intervention sessions. This demonstrated the difficulty of emitting accurate hear-say behavior when the acoustic stimuli do not follow typical verbal functions. The lack of point-to-point correspondence with regard to listener and speaker behavior reflects the significance that function has on language.

A2 was the only participant who acquired BiN following the acoustic condition and it is of note that it occurred only after one phase of the intervention. This may suggest that there was a confounding variable or other event that occasioned the joining of the listener and speaker responses. It is possible that since the participant was a Kindergarten student and new to the CABAS® classroom and was unfamiliar with the Naming procedure. BiN may have emerged after the multiple pairings of the Naming experience and procedure which then conditioned the listener and speaker response topographies required during the BiN probe. All other participants required additional phases across the echoic conditions.

It is also important to consider the responses of the participants following postintervention probes after switching conditions. Participant 3V who switched from the verbal phase to the acoustic phase demonstrated a lower number of correct responses to postintervention probes and Participants 1A and 3A who switched from the acoustic condition to the verbal condition increased the number of correct speaker responses. This suggests that there is a significant difference between training echoic responses with verbal function as opposed to training echoic responses purely on a listener-speaker response that did not have verbal function.
Based on the results of the experiment thus far, there are still questions about the relationship between echoics and bidirectional Naming. One of the questions is connected to the conditioned seeing response – especially as related to the two echoic conditions, either as composed of meaningful sentences or sentences without verbal function. There were no visual stimuli present for during any of the echoic interventions as opposed to previous interventions (e.g., MEI, intensive tact instruction) that have resulted the acquisition of bidirectional Naming. This lack of see-say and see-hear correspondence may suggest that there needs to be a visual component for inducing the joining of listener and speaker responses, especially when probe procedures include visual stimuli.
CHAPTER IV
GENERAL DISCUSSION

Overview

The presence of bidirectional Naming for many has significant implications for language acquisition and rate of learning (Fiorile & Greer, 2007; Gilic & Greer, 2011; Greer & Longano, 2010; Greer & Ross, 2008; Greer et al., 2007; Greer et al., 2011; Hranchuk et al, 2018). Several published studies investigated the effects of various interventions which increased the accuracy of listener (auditory matching) (Chavez-Brown, 2005; Choi et al., 2015; Du et al., 2017; Speckman-Collins et al., 2007), speaker (intensive tacts and echoic training) (Cao & Greer, 2019; Longano & Greer, 2014; Pistoljevic, 2006), and listener and speaker (multiple exemplar instruction) (Fiorile & Greer, 2007; Gilic & Greer, 2011; Greer et al., 2005; Greer et al., 2007) responses resulting in the acquisition of BiN for participants who did not previously demonstrate BiN prior to the interventions. Across all studies, results showed that participants increased in their understanding (correspondence in listener behavior) and production (speaker behavior) of speech and language. When the listener and speaker repertoire are joined as in BiN, individuals can form word-object relations such that new contingencies of behavior are established, and they can learn in a new way – incidentally (Greer and Longano, 2010). The significance of this capability cannot be overstated as it opens the door to a new world of experiences and that affects language, academic, and social development. Without BiN, individuals cannot learn from contacting indirect contingencies, such as listening to others in the environment and require direct instruction to acquire new words (Greer & Longano, 2010). Individuals who lack the capability to learn from new experiences and may require frequent prompts and support to learn
new repertoires. This impacts an individual’s independence and increases the reliance on others for daily living.

Although BiN has been identified as a fundamental capability in the development of language, there are still some questions about its origin and the necessary prerequisites for the BiN relation to emerge. Previous research has shown that auditory matching, a protocol devised to increase discriminative listener responding has resulted in improved accuracy for not only listener behavior but also increases in the clarity and articulation of words. I sought to expand these findings to determine if there was a relationship between BiN and not only discriminative listener responding but also discriminative listener/speaker behavior in the form of echoic responding using the *Recalling Sentences* subtest of the *Clinical Evaluation of Language Fundamentals® – Fifth Edition* (*CELF®*-5). Additionally, results from Cao (2017) suggested that monolingual English-speaking students did not have BiN in Chinese because they did not accurately produce the Chinese phonemes. BiN emerged only after echoic training with Chinese phonemes and once they accurately articulated the sounds. Thus, I also included a measure of articulation using the *Goldman-Fristoe Test of Articulation 3* (*GFTA-3*). In order to get a more precise measure of the relationships between the degrees of BiN and echoic responding and articulation, I included the separate measures of BiN – the listener half (UniN) and speaker half, in addition to full BiN.

Study I used statistical analysis to determine the relationships between the multiple variables across echoic responses, articulation, and the degrees of BiN which include UniN and the speaker component of BiN. The findings from Study I, the correlation between echoic responding and BiN, guided the research for Experiment I which tested the effects of two echoic interventions on the acquisition of BiN for participants who only had UniN in repertoire.
Experiment I extended previous research that has resulted in the acquisition of BiN through training listener responses and training echoic responses by comparing the effectiveness of two types of echoic training conditions.

**Summary of Findings**

**Study I.** Results from Study I showed a significant positive correlation between participant scores on the *Recalling Sentences* subtest *CELF®-5*, representing sentence length echoic responses and their overall degree of BiN. More specifically, there was a higher correlation between the speaker component of BiN, followed by overall BiN, and UniN. There were no significant correlations between the degrees of BiN and the measure of articulation. The results of these correlations suggest that participants who emit a higher number of accurate echoic responses also demonstrate a higher degree of BiN. Since echoic behavior incorporates both listener and speaker responses, this suggests that there is a relation between the joining of both repertoires resulting in the emergence of BiN.

**Experiment I.** In Experiment I, I tested the effects of two types of echoic intervention conditions on the acquisition of BiN in participants who had demonstrated UniN and some correct speaker responses during preintervention probes. During the echoic training intervention, participants were paired into matched dyads, one in the verbal echoic condition and one in the acoustic condition. Following intervention sessions, results from postintervention BiN probes showed that four participants who went through the verbal condition acquired BiN and one participant who received the acoustic intervention acquired BiN. Furthermore, two of the participants from the verbal condition originally went through the acoustic condition but did not increase their number of correct responses during postintervention probes. Specifically, Participant A1 completed two phases of the acoustic intervention and following each phase, the
postintervention BiN probe showed greater decreases in the number of correct responses as compared to preintervention probes. Participant A1 then switched sentence conditions to the verbal echoic and increased the numbers of correct responding during postintervention probes following completion of the first verbal echoic phase. Participant A1 demonstrated full BiN in postintervention probes following two additional verbal echoic phases.

Similar results were shown for Participant 3A, who after three phases of the acoustic echoic condition did not meet criterion for demonstrating BiN. His postintervention BiN probes demonstrated similar numbers of correct responses as emitted during preintervention probes and did not increase following the acoustic intervention. However, after switching to the verbal condition, correct responding increased substantially, and he demonstrated full BiN after one phase. Two other participants, 1V and 2V demonstrated BiN after two and three phases of the verbal echoic intervention, respectively. Data from Participant 3V showed that following three phases of the verbal echoic condition, there were slight increases in the correct number of responses to postintervention BiN probes. However, since he did not demonstrate the acquisition of BiN following three phases of an echoic intervention, the conditions were switched so that he was placed under the acoustic condition. After completing one phase of the acoustic condition, postintervention results showed a decrease in the number of correct speaker responses as compared to the number of correct responses following the verbal echoic condition. Similarly, results from Participants 4A and 4V showed a decrease the number of correct listener responses to postintervention BiN probes following acoustic interventions while the number of correct speaker responses increased after verbal echoic interventions.

**Verbal Functions of Language**
The results across participants in Experiment I showed that the verbal echoic condition was more effective in joining listener and speaker responses resulting in the emergence of BiN. Additionally, the data show that participants required multiple echoic pairing opportunities (i.e., completing more than one phase of the intervention) before listener and speaker repertoires are joined. Since the verbal echoic condition was the most successful in establishing BiN, it indicates that producing echoic responses with meaning impacts the function of language for individuals. It is possible that repeating a sentence that has meaning may act to yoke prior experiences that then join listener and speaker responses emitted during the verbal echoic procedure. Tying together these multiple relations between hearing, saying, and understanding (correspondence between word-object relations that have been established through contacted environmental contingencies) has significant implications for language development.

When participants emit an echoic response to a sentence that is made up of incoherent, jumbled words that do not follow typical syntax, it alters the semantic function of the sentence so that there is no meaning. This perhaps disrupts the connections that can be made between words and their function because the sentence does not follow language or word relations that the participants have had prior contact with. This distortion of language may also disrupt the language contingencies that were previously established and interfere with the joining of a listener-speaker response because the acoustic intervention relies solely on the hear-say response, reinforcing the correspondence of phonemic sounds and not the verbal function of the sentence. This may have been demonstrated in Participant 4A’s postintervention responding following the three acoustic intervention phases. He emitted a lower number of correct listener responses as compared to preintervention BiN probes following the acoustic intervention. Additional data are
needed to provide more evidence and a fuller account of how both types of echoic interventions affect the acquisition of BiN.

**Educational Implications**

Previous research has established the importance of BiN on rates of learning and in language acquisition (Fiorile & Greer, 2007; Gilic & Greer, 2011; Greer et al., 2011; Hranchuk et al, 2018). It is clear that the presence of BiN is a pivotal capability that allows students to learn in new ways (Greer & Longano, 2010). It is also important to consider that BiN with unfamiliar and abstract stimuli is crucial to establish relations for symbols that will take on different significances and meaning for students. For example, the symbol for addition (+) and subtraction (-) may not have any meaning for students that have not encountered them before but after contacting the relevant contingencies where the symbols are applied, meaning is established. If students have BiN in repertoire, they may only need to contact the contingencies a few times to establish meaning of previously unknown symbols through the joining of the listener and speaker repertoires. However, for students without BiN in repertoire, those contingencies may never be established, resulting in the need for remedial study or repeated instruction and a stagnant rate of learning.

**Limitations**

A limitation in Study I is the difference in stimuli used to test for the presence of BiN between Grades 1 and 2 and the stimuli used for Grade K. For Grades 1 and 2, stimuli consisted of nonfamiliar symbols while different sets of familiar stimuli (e.g., rare animals, flowers, fruits) were used for Grade K. This occurred due to the repertoire and age of kindergarten students. Since the BiN probes were conducted at the beginning of the year and the students were still new to a classroom setting, familiar stimuli may serve to condition the BiN procedure. This occurs
potentially due to the preestablished conditioned reinforcement for observing familiar stimuli as opposed to stimuli that are unfamiliar resulting in an increase in attending to the familiar stimuli while the Naming experience occurs and during the probe procedure.

In Experiment I, Participant 1A switched conditions after only two phases of the acoustic condition because of the low numbers of correct responding on the postintervention BiN probes in reference to her preintervention responses. Another potential limitation was conducting an additional preintervention probe for Participant 3V because the first two preintervention probes for Participant 3V showed inconsistent speaker responses to establish a steady baseline of responding.

Additionally, three participants did not acquire BiN following either echoic intervention condition. It is possible that since Participant 3A started in the acoustic treatment condition and demonstrated comparable levels of correct responding across post and preintervention probes that he may eventually acquire BiN after switching to the verbal condition. Preliminary results show that following the first verbal treatment condition, his number of correct responses to the BiN postintervention probe have increased. Since other participants who have acquired BiN following the verbal condition required multiple phases, it is possible that conducting more verbal echoic sessions would result in the emergence of BiN.

Participants 4A and 4V have both completed three phases of the acoustic and verbal echoic conditions, respectively. Even though neither have acquired BiN, the results of their postintervention probes provide insight on the effectiveness of both conditions. Participant 4A’s number of correct listener responses decreased during postintervention probes following each acoustic intervention phase. The decrease specifically in listener responses may suggest that emitting echoic responses to sentences that did not have semantic function may serve to punish
listener behavior. Repeating sentences that have no verbal function may have potentially interfered with the correspondence between previously established word relations and may have acted to disrupt the correspondence between word and meaning.

It is also possible that these participants require more echoic training phases to acquire BiN as was true for Participants 1A and 3A. Switching Participant 4A to the verbal condition echoic condition may function to induce BiN. Participant 4V increased in the number of correct speaker responses during the third and last postintervention BiN probe. Depending on his performance during postintervention probes, data following his switch to the acoustic condition will potentially shed more light on the effects of either echoic condition on the acquisition of BiN. Although current data from the results show that the verbal echoic condition is more effective toward the establishment of BiN, more research is needed to understand the interactions between the listener and speaker functions and their relation to echoic behavior.

**Future Research**

Based on the limitation from Experiment I, future analyses to determine the relations between BiN, articulation, and echoic behavior should consider using the same type of stimuli across all participants (i.e. familiar or unfamiliar). Additionally, although the standard and scaled scores of the assessments used in Experiment I were calculated with participant age factored in, it may be prudent in future studies to have a larger sample size with similarly-aged students (i.e., between one year in age) to account for the natural emergence of BiN. The results from Experiment I suggest that further research is needed to

A potential research consideration from the results of Study 1 may be the development of an assessment procedure that incorporates speech standards to serve as a potential indicator of BiN as there was a significant correlation between the scores on the CELF®-5 and BiN. More
specifically, it may serve to identify the presence of the speaker component of BiN as highest correlation was between the scores on the CELF®-5 and the speaker component of BiN.

Results from Experiment I showed that echoic training is effective in joining the listener and speaker responses to occasion the emergence of BiN. However, analysis of intervention data suggest that there are differences in the number of sessions necessary to meet criterion on each phase of the echoic conditions. Future studies should consider creating different scales of the intervention for participants based on their level of echoic repertoire. For example, the length of the sentence and the complexity of its semantic relations could be decreased for students with a more limited echoic repertoire. For students with a more advanced echoic repertoire, sentences should be of sufficient length and contain additional semantic details.

A consideration for future research may also include a potential modification to the echoic intervention to incorporate both types of echoic sentences to test whether or not rotating between sentences with verbal function and acoustic functions will result in the acquisition of BiN. Rotating between both types of sentences during the same intervention phase may act to condition accuracy in listener and speaker responses and also establish links to the environmental contingencies that were previously contacted by the individual. This then can be used to construct meaning in the words that are heard and said. Rotating between echoing sentences with meaning and also focusing on actual production of phonemes that make up words by echoing sentences with incoherent semantics may potentially join separate listener and speaker repertoires.

In order to facilitate the joining of listener and speaker responses, future research should consider adding a conditioned seeing component that may act to establish an additional cross-modal relation. Results from Experiment I demonstrate that the verbal echoic intervention is
more effective in inducing BiN for participants. Considering that the verbal echoic intervention uses sentences that are meaningful and have verbal function, they may incorporate a conditioned seeing response in the participants due to the words in the sentences evoking experiences that have been previously conditioned or that the participants already had contact with. For example, participants will more accurately respond to emitting an echoic response to the sentence, “the cat is sitting on the chair” than, “is chair the on sitting cat the” because the former sentence evokes a conditioned seeing response of a cat sitting on a chair whereas the “is chair the on sitting cat the” may evoke a response of chair and cat but not a relation between the two objects. Including a conditioned seeing component by having participants select a corresponding picture that matches the verbal echoic sentence may serve to join a hear-say-see relation. According to Horne and Lowe (1996), Naming is a circular relation that includes hearing the word that is said which then evokes seeing the object or saying the word, hearing the word, and seeing the stimulus. Designing an intervention that incorporates all the cross-modal relations included in BiN may serve to establish BiN for individuals for whom BiN did not naturally emerge.

Additional research in conditioned seeing and its relation to BiN conducted by Mercorella (2017) found that there were fewer numbers of accurate drawing responses as a representation of their conditioned seeing response in students that were below-level in reading when compared to students that were on or above grade-level. Additionally, there were fewer students who demonstrated the BiN capability among those that were below-level in reading. Since reading is an extension of listener behavior with some speaker components, these results suggest that conditioned seeing plays an important part in comprehension or verbal repertoire for which BiN is a prerequisite. Therefore, I propose that incorporating a conditioned seeing
component to interventions that join listener and speaker repertoires may have a significant effect on the acquisition of BiN.

**Conclusion**

The results of these experiments have contributed to a better understanding of the relationship between echoic behavior and the degrees of bidirectional Naming. Experiment I showed that there was a correlation between echoic behavior and the different components of BiN. Experiment I found that a novel form of echoic training is effective in joining listener speaker repertoires occasioning the emergence of BiN. More specifically, echoic training with sentences that have verbal function was most successful in establishing the BiN relation. Including echoics with a verbal condition may reveal the significance of training echoic responses with verbal function and how it may act to join listener and speaker behavior by evoking previous linguistic contingencies that have been established to occasion BiN. Furthermore, including sentences that do not have verbal function would potentially train listener responses but may not function to bridge listener and speaker relations since there is no meaning in the words that are repeated. These results point to the significance in how the meaning in words may establish verbal qualities that are necessary for the emergence of BiN. Echoic behavior, especially at the sentence level necessitates a listening and saying response. Joining these repertoires with previously established contingencies of reinforcement that were contacted in the environment may function to condition the listener and speaker response. Establishing connections between a word and the previous context in which the word was used potentially leads to join the verbal function or meaning to the word. The results of these studies suggest that an intervention that bridges the verbal function to words may function to induce BiN. Additional
research is required to continue investigating the relationship between echoic behavior, verbal function, and the establishment of bidirectional Naming.
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Choi, J. (2012). *Effects of mastery of auditory match-to-sample instruction on echoics, emergence of advanced listener literacy, and speaker as own listener cusps by elementary school students with ASD and ADHD* (Doctoral dissertation). Available from Dissertations & Theses @ Columbia University. (Order No. 3489932)


82


Siller, M., & Sigman, M. (2002). The behaviors of parents of children with autism predict the


## Appendix A

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Appendix B

Sample of data sheet used record data during bidirectional Naming probes.

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Appendix C

Sample of data sheet used in the verbal echoic intervention condition during Experiment I.

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<td>2. I forgot to take the keys back home.</td>
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<td>3. The waves are making the boat bumpy.</td>
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<td>4. The dog and cat are running together outside.</td>
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<td>5. Can you come over to do the dishes?</td>
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<td>6. Mac and cheese is my favorite dinner food.</td>
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<tr>
<td>7. She can have a turn after me.</td>
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<td>8. My friend likes to watch the birds outside.</td>
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<td>9. Yesterday, I took the bus to school.</td>
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<td>10. They don’t like to jump rope too fast.</td>
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Appendix D

Sample of data sheet used in the acoustic echoic intervention condition during Experiment I.

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<td>6. mac my is favorite cheese dinner and food</td>
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<td>7. me can she turn a have after</td>
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<td>8. birds outside to friend watch the my likes</td>
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<td>9. to yesterday bus the took school I</td>
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