

The Effect of Bidirectional and Unidirectional Naming on Learning in New Ways and the
Relation Between Bidirectional Naming and Basic Relational Concepts for Preschool Students

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ABSTRACT

The Effect of Bidirectional and Unidirectional Naming on Learning in New Ways and the Relation Between Bidirectional Naming and Basic Relational Concepts for Preschool Students

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Bidirectional Naming (BiN) is the reliable demonstration of incidentally learned word-object relations as both a listener and speaker. In Experiment I, a pilot study, I tested the effects of the establishment of BiN on the rate of learning new math and reading operants under baseline Standard Learn Unit (SLU) and Instructional Demonstration Learn Unit (IDLU) conditions. I conducted a combined multiple probe and counterbalanced ABAB/BABA reversal design across participant dyads, for which each participant's rate of acquisition was compared under the IDLU and SLU conditions before and after the acquisition of BiN. Four participants diagnosed with developmental delays were selected for the study due to the assessed absence of both the listener and speaker components of the BiN capability. Intensive Tact Instruction (ITI) and Multiple Exemplar Instruction (MEI) were used to establish BiN. After the acquisition of BiN, all four participants demonstrated accelerated rates of learning reading and math objectives when provided the opportunity to observe a model (via IDLU instruction) prior to an instructional session, indicating a functional relation between the acquisition of BiN and the acceleration of learning via teacher-modeled instruction. In Experiment II, a demonstration study, 5 preschool students with a disability were selected following BiN probe trials and were grouped according to their BiN repertoires. A combined ABAB/BABA reversal design across learning objectives and BiN level was used to compare the rate of learning new speaker (i.e., tact) and listener (i.e.,

point-to) tasks across SLU and IDLU conditions. Results replicated previous findings wherein students with BiN in repertoire learned at an accelerated rate when provided IDLU instruction as compared to SLU instruction; further, participants with only the listener component of Naming (Unidirectional Naming; UniN) displayed accelerated learning under IDLU conditions for listener tasks, but not for speaker tasks. Results across both Experiments I and II indicate that students' acquisition of the BiN capability (joint stimulus control across speaking and listening) is an essential verbal developmental capability for learning through the observation of a model in a standard classroom instructional setting. In Experiment III, a group correlational design was used to analyze the relation between students' BiN scores and performance during the *Boehm Test of Basic Concepts 3rd Edition – Preschool Version* (BTBC3-P) (Boehm, 2001). Results demonstrated that a significant positive correlation exists between BiN and BTBC3-P assessment scores ($p(42) = .341, p = .027$). These data indicate that a student's degree of BiN is a potential predictor of success on measures of basic concept knowledge, adding to findings from Experiments I and II that BiN is functionally related to learning at an accelerated rate and via observation.

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DEDICATION

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Chapter I

INTRODUCTION AND REVIEW OF THE LITERATURE

Introduction

The fields of education and psychology are particularly intertwined in the realm of special education. Applied Behavior Analysis calls upon teachers to act as strategic scientists by using best-fit methods from the most recent empirical research to address students' social and academic deficits. The interaction between special education and psychology allows for numerous theories to permeate curricular development, and while it is evident that teachers should aim to teach new skills, instruction can- and should- also focus upon the induction of capabilities that allow for students to learn in new ways. What is apparent in the research is that the acquisition and emission of new words is critical to a student's social and academic development (Greer & Longano, 2010; Greer & Ross, 2008; Hart & Risley, 1995; Keohane, Luke, & Greer, 2008). For many children, learning new words appears to be a seamless process; however, the reality of how children learn words is something that many researchers continue to attempt to understand. Word-learning involves both listener and speaker behavior; that is, children must learn both word-object relations (i.e., word meaning) and to emit new words effectively as a speaker (Cao, 2016).

In order for fluent language acquisition to occur, children must be capable of learning verbal operants incidentally; that is, word-learning must occur in the absence of repeated, direct instruction. Verbal operants, defined as "learned relationships between antecedents and consequences that speakers emit to affect a listener" (Greer & Ross, 2008, p. 27), allow an

individual to develop fluent speaker skills to express his or her wants and needs and to have meaningful interactions with others. Developmentally typical children from economically stable families often acquire these from the natural environment, without direct instruction, from the age of 3 years (Hart & Risley, 1995). However, for children with intellectual disabilities, many verbal capabilities do not exist or are not developed naturally, and therefore require direct instruction to be acquired (Hart & Risley, 1995). This deficiency is theorized as being due to the lack of a Bidirectional Naming (BiN) capability in repertoire (Horne & Lowe, 1996; Miguel, 2016).

The purpose of the current study is to contribute to the understanding of incidental language acquisition and basic relational concepts. The aim of Experiment 1 is to assess whether a functional relation exists between the presence of BiN and the reliable demonstration of learning in the absence of direct instruction (i.e., via a model), and the aim of Experiment 2 is to assess whether students with Unidirectional Naming (UniN; the demonstration of learning new words incidentally as a listener but not as a speaker) benefit from modeled instruction for listener tasks. Specifically, Experiment 2 will address whether the degree of BiN present (i.e., BiN or UniN) affects incidental language learning via modeled instruction. To test for broader implications, Experiment 3 aimed to determine whether a BiN “continuum” exists that is correlated with students’ performance on a standardized measure of basic relational concept knowledge, the *Boehm Test of Basic Concepts 3rd Edition – Preschool* (BTBC3-P) (Boehm, 2001).

In this chapter, I will first review literature on cognitive theories of language development related to BiN (i.e., fast mapping) and behavior-analytic theories of language development including Stimulus Equivalence, Relational Frame Theory, and Verbal Behavior

Developmental Theory. Next, I will focus on Bidirectional Naming (BiN), including proposed sources of BiN, interventions to establish BiN, and the educational significance of BiN. Finally, I will review literature on basic relational concepts, including both the educational and social implications of basic concept development for young children.

Theories of Word Learning

Cognitive and verbal behavior analytic psychologists alike have long been interested in studying how children acquire new words. While some psychologists provide an account of word learning as a developmental phenomenon called fast mapping (Carey & Bartlett, 1978; Wilkinson, Dube, & McIlvane, 1998), verbal behavior analysts have identified developmental sources for language development based on the establishment of conditioned reinforcement (Greer & Longano, 2010; Horne & Lowe, 1996; Skinner, 1957). Several studies from both perspectives aim to explain the process of new word acquisition in order to better facilitate word learning for children who present with difficulty in regards to efficiency of learning.

Fast Mapping

For cognitive psychologists, *fast mapping* is the term used for a hypothesized mental process in which a new word is learned using “referent selection” and “referent retention” (Carey & Bartlett, 1978); that is, for this theorized learning process, new language is acquired based on word-object relations. The initial fast mapping research by Carey and Bartlett (1978) suggested that with contextual information, children can acquire novel words as a listener. In their pilot study, children learned a novel color word (“chromium”) when it was provided in contrast to a known color word (i.e., “get me the chromium tray; not the red one, the chromium one”) (Carey & Bartlett, 1978). It has been demonstrated that children as young as 24 months old can infer target meanings of novel words via fast mapping (Brady & Goodman, 2014). By comparing a

novel word and novel object to known words and known objects, cognitive psychologists hypothesize that mapping occurs between the novel word and object by exclusion (i.e., by process of elimination).

Research has also investigated fast mapping responses of typically developing children as compared to children with specific language impairments. Dollaghan (1987) used a similar procedure whereby contextual information was supplied to children in order to teach new words via selection. Children with normal language development were compared to those with expressive (i.e., speaker) syntactic deficits, a specific language impairment characterized by simplified speech (Dollaghan, 1987). Results indicated that the two groups of children did not differ in their relation of novel words to referents or to comprehension of novel words (i.e., number of correct listener responses) after a single exposure; however, language-impaired children were significantly less successful in their speaker behavior related to the novel word. These findings imply that listening and speaking capabilities are initially independent of each other and must be joined in order for a child's rate of language acquisition to improve. Carey (1978) notes that while fast mapping allows a child to "rapidly gather information about a new word," oftentimes multiple exposures to a novel word are required in order for word acquisition to occur. *Slow mapping* is the term used by Carey (1978) to describe the sometimes "long, slow process" of word learning, noting that multiple exposures are often required in order for children to emit both listener and speaker responses for novel word-object relations.

Many researchers have investigated fast mapping with different populations of children; however, some have attempted to identify the specific variables that may be responsible for fast mapping (Brady & Goodman, 2014; Gray & Brinkleya, 2011; Kan & Kohnert, 2008; McKean, Letts, & Howard, 2013). Gray and Brinkleya (2011) tested the effects of providing phonological

cues (such as beginning sounds of words or words that rhyme with a target response) and semantic encoding cues (such as a physical characteristic or use of a target response) on fast mapping performance tasks across typically developing children and children with specific language impairments. Results indicated that both groups of students performed better when provided either no cue or a phonological cue as compared to a semantic encoding cue. Brady and Goodman (2014) reported that fast-mapping abilities and demonstration of benefiting from bias and linguistic cues of typically developing toddlers ($M_{\text{age}} = 18.3$ months) increased between 18 and 30 months of age. They also found that for these children, providing a single social, linguistic, or bias cue was sufficient for fast mapping, but that providing an additional cue did not result in the improvement of fast mapping performance.

The utilization of bias cues, social cues, and linguistic context are common characteristics of research on variables that influence fast mapping ability. During many fast mapping tasks, children are asked to identify or select a target stimulus following the presentation of such a cue. Response criteria are not often clearly defined, and probes for fast mapping abilities are often conducted immediately after mapping tasks. Because of this, some researchers are concerned that many experiments that test for fast mapping are in fact only testing for word reproduction (i.e., echoics) as opposed to word comprehension. Rather than simply identifying a new word, critics of fast mapping argue that research should be conducted to test whether certain events occasion the use of a new word as a speaker and/or listener in the context of a novel setting (Braisby, Sockrell, & Best, 2001). Fast mapping studies typically utilize group statistical designs to assess the phenomena of word learning, calling upon researchers to conduct more fine-grained analyses of word learning variables via single subject design.

Stimulus Equivalence

Stimulus equivalence is a theory that proposes that words are learned via relationships between two or more stimuli. Sidman (1971) conducted the seminal research on stimulus equivalence that indicated operants could be learned without any direct training based on indirect relationships between one stimulus and another. In his study, probes were conducted to test for (1) matching printed words to pictures and (2) reading printed words aloud without any direct training. Results indicated that the participant could emit correct reading comprehension responses (matching words to pictures) without direct training for the given topography. Following these initial findings, Sidman established the theory of SE to identify three types of equivalence in varying levels of complexity: (1) reflexivity, (2) symmetry, and (3) transitivity.

Sidman and Tailby (1982) established the three aforementioned characteristics of stimulus equivalence through an experiment used to test the emergence of untaught relations. For all three components of SE (reflexivity, symmetry, and transitivity), the emergence of untrained responses occurs without any direct instruction or reinforcement. “Reflexivity” is apparent when a stimulus is matched to an identical (or nearly identical) target stimulus ($A=A$). For example, when presented with a card that has a teddy bear on it, a student may express reflexivity if he matches the card to a teddy bear in a field of three without any training or reinforcement. “Symmetry” is the reversibility of two stimuli; that is, if Stimulus A is associated in a certain manner with Stimulus B, then Stimulus B is related in a complementary manner to Stimulus A. For example, if a child is taught to point to a picture of a teddy bear when the teacher says “teddy bear,” and the child similarly says “teddy bear” when the teacher presents the child with a picture of a teddy bear, symmetry is evident ($A=B$, $B=A$). Finally, “transitivity” is evident when two separate stimulus-stimulus relations are taught and a third, untrained relation emerges between

stimuli included in the separate relations. For example, if a child is taught to point to a teddy bear when the teacher says “teddy bear,” and the child is taught to say “teddy bear” when presented with a three-dimensional teddy bear, then transitivity is evident if the child points to the three-dimensional teddy bear when presented with a picture of a teddy bear (or vice versa) (If $A=B$, and $B=C$, then $A=C$). For children who are developing new language repertoires, these complex relations aid in the acquisition of new operants as relations are made between novel operants and those that are already in repertoire.

Relational Frame Theory (RFT)

Relational Frame Theory (RFT) can be viewed as an extension of stimulus equivalence and Skinner’s verbal behavior in that it aims to provide an explanation of complex human language and cognition beyond verbal operants and basic speaker/listener exchanges. RFT was initially proposed by Hayes (1991) to extend beyond the principles of behavior and explain complex language/cognition as “derived arbitrary stimulus relations” (Barnes-Holmes, Barnes-Holmes, & Murphy, 2004). RFT describes relational “frames” as being controlled by context in addition to function, and is therefore a more narrow and concentrated approach to understanding verbal behavior. A relational “frame” can be briefly defined as any response involving a stimulus event, where one looks at a framework comprised of at least two components. For example, if a child is asked: “what is the name for a long orange vegetable?” and the response “a carrot” is given, it is evident that the child can extract equivalence between the tact “carrot” and the words “long orange vegetable.” Both parts of the frame do not need to be directly taught; however, due to bi-directionality, the second part of the frame can be learned through derived relational responding (Moore, 2009).

Three types of relational frames make up the foundation of RFT: (1) mutual entailment, (2) combinatorial entailment, and (3) transformation of stimulus function. Mutual entailment is defined as a bidirectional relation for which a frame is derived based on the occurrence of two stimulus events (i.e., if $A=B$ then $B=A$; if $A<B$ then $B>A$). For example, if a child knows that fewer tokens are required to trade-in for a fruit snack than are needed for an iPad, he or she can derive that an iPad costs a greater number of tokens than a fruit snack. Combinatorial entailment involves the development of a relational frame based on at least three verbal stimuli (i.e., if $A=B$ and $B=C$, then $A=C$; if $A<B$ and $B<C$, then $A<C$). For example, if it is common knowledge that a feather weighs less than a book and a book weighs less than a table, it can be derived that a feather weighs less than a table. Lastly, transformation of stimulus function is evident when the effect of one verbal stimulus is modified based on its association with other relations within a given frame without direct contact. For example, if a child who loves Skittles is offered fruit snacks at lunchtime, the child may be inclined to prefer fruit snacks over other options if a teacher tells her that they are “just like Skittles.” Even without any knowledge of what the fruit snacks taste like, the child may derive a relation between the fruit snacks and Skittles to establish a preference for a snack that he or she had never previously tried.

Families of Relational Frames. Beyond mutual entailment, combinatorial entailment, and transformation of stimulus function, RFT highlights contextual control as playing an integral role in the effect of a stimulus within a given frame. Since derived stimulus relations are defined in RFT as being learned operants, they take on similar characteristics as the operants from which they were derived. Thus, the context in which operants (derived stimulus relations) are acquired should be taken into consideration when assessing their function.

Relational frames can be categorized in terms of the type of relation between stimuli that is involved. “Families” of relational frames include (among others) frames of coordination, frames of opposition, frames of distinction, frames of comparison, spatial frames, and temporal frames (Barnes-Holmes et al., 2004). Perhaps the two most basic types of frames are frames of coordination (incorporates the relation of sameness or similarity) and frames of opposition (distinguishing stimuli as different from the others). Frames of opposition imply that one stimulus is distinctively different from the others, while frames of comparison involve the quantitative or qualitative relation between stimuli along a specified dimension (e.g., better/worse, bigger/smaller) (Barnes-Holmes et al., 2004). Frames of distinction are more complex, as they involve responding to one stimulus in terms of the lack of a frame of coordination with another; however, unlike frames of opposition, they often do not occur with the context in which stimuli are related along a certain dimension (Barnes-Holmes et al., 2004). For example, if a student is asked to “point to the glass that is *full* of water” in a field of four options (for which each glass is filled with a different amount of water), unless the student already has an instructional history with the term “full” and its relation to other measures along a quantitative dimension, it is not likely that he or she can deduce the correct answer except by chance responding.

RFT explains language as emerging based upon such families of relations; that is, for RFT, all behavior that emerges as a result of derived relational frames is verbal and carries functionality. Proponents of RFT acknowledge the importance of stimulus- stimulus relations and utilize them to implement multiple exemplar training and differential reinforcement for responding to teach for generalization of operants across topographies (Barnes-Holmes et al., 2004). RFT theorists also acknowledge a hierarchy of frame families (in terms of difficulty; i.e.,

frames of coordination and opposition are more simple than frames of distinction, which require higher level verbal behavior); however, there is a limited amount of applied research on the matter (Hughes & Barnes-Holmes, 2016).

Verbal Behavior Developmental Theory

B.F. Skinner's (1957) theory of verbal behavior defines six verbal operants (echoic, mand, tact, intraverbal, autoclitic, and textual response) while proposing that the reinforcer for emitting a verbal operant is provided by either a speaker or a listener. This theory focuses on the function of language rather than the topographical nature of language, which is in opposition to many cognitive theories. Theories that emphasize "meaning" assume that learned operants (e.g., vocal words, sign language) transfer meaning when new operants are acquired once the meaning of a given word is directly taught; Skinner specified a distinction between speaker and listener functions of verbal behavior, emphasizing the need to focus on each with careful consideration until the two repertoires are joined (Skinner, 1957).

Verbal Behavior Development Theory (VBDT) (Greer, 2008; Greer & Ross, 2008; Greer & Speckman, 2009), based on Skinner's (1957) Verbal Behavior, describes cusps and capabilities that are necessary for language development. These cusps and capabilities have been identified through experimental research and involve both basic listener and speaker capabilities and higher-order capabilities (e.g., Bidirectional Naming). In the case that cusps and capabilities do not emerge naturally, VBDT research provides methods with which to establish these cusps and capabilities for children such that their verbal repertoires expand at an accelerated rate. VBDT takes into account how the environment selects out verbal behavior, as well as how the conditioning of new reinforcers leads to functional language acquisition (Greer, 2008).

There are developmental stages within VBDT that identify specific verbal cusps and capabilities, which are directly related to a child's level of independent functioning (Greer & Keohane, 2005). Cusps allow a child to “learn things that could not be learned before, learn faster, or learn in new ways” (Greer, Pohl, Du, & Moschella, 2017, p. 680). These stages consist of pre-verbal foundational cusps, listener cusps, speaker cusps, and the joining of listener/speaker cusps (Greer & Ross, 2008). For VBDT theorists, a repertoire complete with verbal developmental cusps is critical for a child's acquisition of social, academic, and linguistic skills across settings. Recently, Greer et al. (2017) proposed the term “behavioral metamorphosis” as an analogy for the verbal behavior development of an individual with the end result of becoming truly verbal. The reliable sequential demonstration of the following cusps is ultimately necessary for the establishment of BiN and acquisition of higher-order operants associated with language and basic relational concept acquisition.

Pre-Verbal Foundational Cusps. Pre-verbal foundational cusps are the building blocks upon which social and linguistic development occur. Typically, these cusps are acquired in utero and infancy; however, they are found to be missing in some children with developmental delays (Greer et al., 2017). Such cusps include conditioned reinforcement for orienting to others' voices (Greer, Pistoljevic, Cahill, & Du, 2011), conditioned reinforcement for orienting to others' faces/the presence of others (Maffei, Singer-Dudek, & Keohane, 2014), generalized matching (Du, Broto, & Greer, 2015; Greer & Han, 2015), and the “capacity for sameness” across the senses (Frias, 2017). Each cusp enables one to attend to stimuli in an ever-growing environment, providing occasions to encounter reinforcement for attending to a variety of new things. For example, conditioned reinforcement for orienting toward others' voices is a prerequisite for responding when one's name is called and for attending to novel words; conditioned

reinforcement for orienting toward the visual presence of others is essential for looking at peers and teachers in the classroom and non-instructional environment; and generalized matching is an essential prerequisite for learning via visual discrimination.

Listener Cusps. Following the establishment of pre-verbal foundational cusps, most children can encounter reinforcement for attending to auditory stimuli in the environment as a listener. Listener cusp development is critical for fluent direction-following, target vocal echoics, and discrimination between auditory stimuli. Two key listener cusps are auditory match-to-sample, which is the reliable demonstration of discriminating between positive and negative auditory exemplars (Choi, Greer, & Keohane, 2015; Du, Speckman, Medina, & Cole-Hatchard, 2017; Speckman-Collins, Lee Park & Greer, 2007); and listener literacy, a cusp that enables a child to learn from spoken instructions via listener responding (Greer, Chavez-Brown, Nirgudkar, Stolfi, & Rivera-Valdes, 2005). Once listener cusps are established, one can expect a given child to perform mastered listener skills fluently (such as simple one- and two-step vocal commands). Students who are fluent listeners can also reliably discriminate between auditory words and non-words, which is a prerequisite for the emission of target echoics and which is critical for becoming a fluent speaker. Initially, listener skills are acquired independent of speaker skills; that is, students who can reliably emit a listener response to a given stimulus (i.e., point-to or otherwise select a target stimulus from a field of exemplars and non-exemplars) may or may not also reliably produce a target speaker response when asked to say the name of the same stimulus.

Speaker Cusps. Children with extensive speaker repertoires can request items or events from a listener (e.g., by saying “open please” or “I want juice”) and can communicate vocally for the purpose of social reinforcement (i.e., by greeting a listener in order to socialize). In general,

speaker cusps allow for children to navigate their environment with greater independence and to encounter a greater number of learning opportunities. Speaker cusps sequentially build upon both pre-verbal and listener cusps, and include parroting, echoic-to-mand, and echoic-to-tact, each of which requires a student to listen to spoken words and produce them vocally (Greer et al., 2017; Greer & Ross, 2008). Parroting involves repeating exactly what is said (i.e., the reliable production of the same sounds/words that are produced in one's environment); echoic-to-mand involves repeating what is said in order to encounter a specified reinforcer (e.g., requiring a child to echo the word "juice" when they want juice); and echoic-to-tact involves repeating what is said in order to encounter social reinforcement for saying the name of a stimulus. Once fluent echoic-to-mand and echoic-to-tact repertoires are established, curricula should aim to occasion opportunities for students to independently emit mands and tacts in order to encounter generalized reinforcement. While the topography of these responses remains the same, what is important to note is that VBDT distinguishes each cusp depending on its function.

Joining of Listener and Speaker Cusps. Once fluent listener and speaker repertoires are established, children are capable of a considerable amount of independence. Initially, listener and speaker responses to environmental stimuli are independent of each other; however, the joining of the two responses allows for an individual to simultaneously act as both a listener and speaker within his or her own skin (Greer & Ross, 2008). Cusps in this category include say-do correspondence, which is the reliable demonstration of acting as a listener to one's own verbal behavior (i.e., accurately following through after saying "first I will put away my coat, then I will go to the carpet and read a book"); self-talk, which is the act of listening and speaking within one's self (i.e., engaging in both listener and speaker roles during solitary imaginative play); and

BiN, which is a circular relation that allows for incidental language acquisition to occur (Horne & Lowe, 1996; Lodhi & Greer, 1989).

BiN is a higher-order operant that is considered to be necessary for an individual to be truly verbal, allowing one to simultaneously act as both a speaker and listener (Horne & Lowe, 1996). As defined by Greer and Keohane (2005), BiN is “when an individual hears something as a listener and can use it as a speaker without direct instruction or can learn something as a speaker and use it as a listener without direct instruction” (p. 33). It has been suggested that an individual can have component parts of BiN; in cases such as this, individuals might only have the listener half of BiN, for which they can reliably emit listener responses to words learned incidentally but not speaker responses (Greer, Stolfi, & Pistoljevic, 2007). This may be referred to as Unidirectional Naming (UniN).

For many children with developmental and language delays, BiN is not established through normal contingencies in the environment; however, VBDT researchers have identified numerous interventions that can effectively condition language learning as a reinforcer. Verbal behavior research has shown that among other interventions, multiple exemplar instruction across listening and speaking (MEI) and intensive tact instruction (ITI) can be effective for the emergence of this capability (Fiorile & Greer, 2007; Greer & Du, 2010; Greer et al., 2007; Greer, Stolfi, Chavez-Brown, & Rivera-Valdes, 2005). MEI is a tactic that brings responses that were initially independent of each other (in this case, the speaker and listener components of BiN) under joint stimulus control (Greer & Ross, 2008). ITI significantly increases a student’s opportunity to recruit social reinforcement for talking, effectively conditioning both listening and speaking and increasing independent speech across both instructional and non-instructional settings (Greer & Du, 2010).

Bidirectional Naming (BiN) and Incidental Word Learning

BiN is a key verbal developmental stage which results in an “exponential expansion” of language, consisting of joined listener and speaker functions of observed stimuli which result through incidental observation (Greer & Longano, 2010, p. 75). Although this capability occurs naturally for developmentally typical children, children with disabilities often must participate in interventions to establish BiN before a fluent speaker repertoire can develop (Greer & Ross, 2008). It is a circular relation; when an individual acquires BiN, he or she can hear someone tact an object in the environment (e.g. “tree”), incidentally learn to say the word “tree” (upon seeing a tree), and respond to it as a listener (e.g., in a novel setting, point-to or select a “tree” when asked to do so). With this capability, when someone says the word “tree” the child will identify a tree if one is present. If an individual has BiN in repertoire, he or she will also learn the names of different types of trees without direct instruction simply through naturally occurring interactions in the environment (Greer & Longano, 2010; Horne & Lowe, 1996).

It is of note that BiN is comprised of two parts: (1) Unidirectional Naming (UniN; the listener half of BiN), and (2) the speaker half of BiN. Children with the listener but not the speaker component may be identified as students with UniN in repertoire; that is, they can learn the names of novel stimuli incidentally as a listener, but not yet produce target responses as a speaker independent of direct training. Verbal behavior developmental theorists have reported that BiN is correlated with faster acquisition of new operants by analyzing the efficiency of classroom instruction (Greer & Longano, 2010). In addition, Corwin (2011) and Greer, Corwin, and Buttigieg (2011) found that prior to the establishment of BiN, students did not benefit from modeled instruction from a teacher; that is, until BiN was established, direct instruction was required for learning to occur. In a general classroom setting, direct instruction in a one-to-one

setting is rare; as such, BiN can be viewed as a necessary prerequisite for a child to benefit from group instruction in a general education classroom setting.

Skinner (1957) described listening and speaking as two separate repertoires independent of each other that become fused during language development, such that the speaker and listener components are joined. Since Skinner's original work, Horne and Lowe (1996) have defined this as BiN and described it as the “basic unit of verbal behavior” and the beginning of what makes an individual truly verbal (Greer & Longano, 2010, p.185). Individuals without the BiN capability lack the speaker component, listener component, or both components of the repertoire. Without both the speaker and listener components, individuals are not yet capable of learning incidentally as a result of “indirect” or naturally occurring exposure to information. When BiN is acquired, the prognosis of an individual in terms of verbal capability is enhanced as he or she can learn new operants via observation (Greer & Longano, 2010). For success in general education, students must learn simply by watching the antecedents delivered by their teacher and by observing their peers’ responses. Therefore, entering education in a general classroom setting without BiN in repertoire can pose learning challenges during the educational process.

Interventions for Establishing BiN

Multiple Exemplar Instruction (MEI). One procedure that has been utilized to establish the listener and speaker components of BiN is Multiple Exemplar Instruction (MEI) across speaker and listener responses to novel stimuli. MEI involves the concurrent presentation of both listener (match/point-to) and speaker (tact/intraverbal tact) learn units to teach target responses for novel operants (Greer, et al., 2005; Nuzzolo-Gomez & Greer, 2004). Greer et al. (2005) demonstrated that untaught novel responses across both vocal and written spelling occurred as a

function of MEI for an intervention set of spelling words, while Nuzzolo-Gomez and Greer (2004) demonstrated a functional relation between MEI and the emergence of joint stimulus control across mand and tact functions. These findings have been applied to joint listener and speaker repertoires in order to establish BiN repertoires for students who did not have listener and/or speaker components of the BiN capability. To assess for the presence of BiN, Greer et al. (2005) utilized match-to-sample instruction to teach children the names of unfamiliar pictures, then occasioned opportunities for students to emit listener (point-to) and speaker (tact/intraverbal) responses to the aforementioned pictures. Participants who did not have BiN in repertoire underwent an MEI intervention; upon mastery of each phase, BiN probes were re-conducted. Their findings indicated a functional relation between MEI (i.e., rapidly rotated instruction for novel operants across both listener and speaker responses) and an increase in point-to, pure tact, and intraverbal tact (listener and speaker) responses to a separate set of untaught unfamiliar pictures. Results of MEI interventions for inducing the listener-to-speaker component of BiN for students suggest that BiN is a higher order operant which requires several prerequisite components, and when stimuli are not under joint listening and speaking control, students are not yet equipped to easily and independently build upon said prerequisite skills at the same rate as many of their similarly-aged peers.

Intensive Tact Instruction (ITI). Intensive Tact Instruction (ITI) is another protocol utilized to establish BiN by expanding the speaker and listener repertoires of individuals via social reinforcement for learning the names of new things (Greer & Du, 2010). During the ITI protocol, students receive 100 learn units (Albers & Greer, 1991) of tact instruction in addition to their typical daily classroom instruction. According to Greer and Ross (2008), "...the intensive tact procedure increases the student's ability to recruit reinforcement by talking" (p. 159). This

reinforcement takes the form of attention from others, thereby reinforcing the social aspect of spoken language (Greer & Du, 2010). Through ITI, students contact reinforcement by emitting target tacts for a variety of categories of operants such as novel images of vegetables, musical instruments, flowers, and cars. In an example of this, Pistoljevic (2008) utilized a multiple probe design across three students to assess the emergence of BiN and vocal verbal operants emitted in non-instructional settings following mastery of the ITI procedure. Before the implementation of ITI, all students lacked both the speaker and listener components of the BiN repertoire. Following the implementation of ITI, full BiN repertoires emerged for all seven participants. In addition, the ITI intervention resulted in a significant increase in the numbers of independent vocal verbal operants emitted in non-instructional settings. The results of this study show a functional relationship between ITI and the acquisition of the speaker and listener components of the verbal capability of BiN.

The Educational Significance of BiN

In a general education classroom, the need to have BiN in repertoire cannot be overstated. According to Greer et al. (2011) and Corwin (2011), if individuals with BiN repertoires attend to teacher verbal instruction and a demonstration of the correct response, the student should learn faster than by standard learn unit presentations. The BiN capability allows individuals to learn more efficiently by decreasing the number of learn units required to master program objectives (Corwin, 2011; Greer et al., 2011; Pistoljevic, 2008). Further, students with BiN in repertoire learn at an accelerated rate because they benefit from teacher-modeled examples in the absence of a three-term contingency. For example, students with BiN in repertoire may learn and benefit from instructional demonstration learn unit (IDLU) conditions. In her doctoral dissertation, Corwin (2011) calculated the mean number of IDLUs required for eight students to meet

criterion across academic objectives prior to and following the establishment of BiN. Results indicated that after acquiring BiN, all participants demonstrated faster rates of learning via teacher modeling than they did prior to the establishment of BiN.

Greer et al. (2011) tested the effect of the presence of BiN on the rates of learning under standard learn unit conditions (SLU) and model demonstration learn unit conditions (MLU) across matched pairs of participants. In Experiment 1, the presence/absence of BiN was tested using a counterbalanced reversal design across matched pairs; in Experiment 2, experimenters established BiN and tested its effects on participants' rates of learning under SLU and MLU conditions. The dependent variable for both experiments was the rate of learning measured as the rate of mastery of learning objectives (the number of instructional trials required to master curricular objectives). Results of Experiment 1 indicated that all participants with BiN learned new skills faster via MLU instruction than they did without a model; however, for students who lacked BiN in repertoire, MLU instruction did not result in learning without extensive instruction. These results suggested a correlation between the presence of BiN and accelerated learning via modeled instruction. The results of Experiment 2 demonstrated a functional relationship between the induction of BiN and learning at an accelerated rate during MLU conditions as compared to SLU conditions. In the time since the aforementioned article was published (Greer et al., 2011), Hbranchuk (2016) proposed "Instructional Demonstration Learn Unit" (IDLU) as a more accurate tact for MLU instruction, as the term "model demonstration" is redundant. For the purpose of the present study, learn units that utilize a model prior to the three-term contingency will be referred to as IDLUs.

Hbranchuk, Greer, and Longano (in press) conducted an ABAB reversal design to compare SLU and IDLU presentations across dyads. Results indicated that students with BiN

learned both math and reading tasks at a faster rate with IDLU presentations, which was indicated in their low number of learn units to meet criterion across academic objectives. Their findings further added to the body of BiN research by graphically displaying students' cumulative numbers of correct responses for each phase of instruction across participants. These cumulative correct records displayed steeper slopes under IDLU conditions for all participants, indicating a significantly faster rate of operant acquisition when provided a model prior to learn unit instruction; further, in many instances, participants with full BiN responded correctly during the first learn unit of instruction during several IDLU reversal phases.

Basic Relational Concepts

Basic relational concepts constitute a specific faction of receptive language (i.e., listener behavior). Basic concepts include abstract words that indicate spatial, dimensional, temporal, quantitative, and class relationships between items or people (Boehm, 2001). Basic concepts are essential for making comparisons, sequencing, and classifying, all of which are essential prerequisites for countless critical skills in both the educational setting and society as a whole. Relational concept development significantly predicts academic achievement in the early elementary years across both literature and math (Steinbauer & Heller, 1978). For teachers and educators of young students it is critical to assess for basic concept awareness and to intervene when necessary, as children are often expected to know and respond appropriately to such words as *alike*, *before*, and *after* by the time they reach a mainstream kindergarten classroom (Boehm, 2009).

Basic relational concepts are used across all cultures at different levels of abstraction to compare, categorize, and solve complex problems (Siegler, 1998). Children must have a proficient understanding of many basic relational concepts in order to reliably describe

relationships between and among objects; understand the locations of people, places, and things; understand the order of events; follow standardized test instructions; and engage in many problem-solving activities (Boehm, 2001). During preschool years, many children gradually master responding to a variety of basic concepts (i.e., *both*, *another*, and *before*). As children age, knowledge of these basic concepts becomes increasingly critical for responding appropriately to what is communicated in the classroom (Boehm, 2001).

Research in child development indicates that many basic concepts are learned during preschool years; however, many of these concepts are not necessarily part of a child's repertoire when he or she enters kindergarten (Clark, 1983; de Villiers & de Villiers, 1978; French & Nelson, 1985). Data from the standardization of the BTBC3-P suggest that as many as 50% of kindergarten students do not understand the meaning of *some*, *but not many* when used in the context of "Point to the jar that has some, but not many bugs" (Boehm, 2001 pg. 3). Further, children with learning disabilities and developmental delays tend to have more difficulty with basic concepts (Bracken, 1998; Chin, 1975; Kavale, 1982; Nelson & Cummings, 1981; Spector, 1979). Wiig and Semel (1976) suggest that the preschool child who is at risk for learning difficulty often has a language delay, particularly in using adjectives to describe aspects of space, time, and quantity. The BTBC3-P was created for use as a tool for planning interventions for students who express difficulty in the realm of basic concept development.

Educational Implications of Basic Concept Development

The benefits of early childhood education underscore the importance of high quality instruction in preschool, including the instruction of basic relational concepts. Basic relational concept instruction for preschool and young elementary-age students is linked not only to gains in performance related directly to basic relational concepts, but also to improvement on

standardized achievement tests (Armour-Thomas, 1984). Basic concepts are part of the directions included in major intelligence tests used at the preschool and in early childhood levels (Bracken, 1987; Cummings & Nelson, 1980; Flanagan, Alfonso, Kaminer, & Rader, 1995; Kaufman, 1978). Boehm (2001) posits that a lack of familiarity with these basic concepts may affect test performance.

Basic relational concepts are necessary for completion of daily life tasks and self-help skills (Nelson, 2006). Students are expected to perform tasks and follow oral and written antecedents from their teachers (Bancroft, 2017; Herschkorn, 2014; Zhou and Boehm, 2004). All of these directions include the task that is to be performed and use basic relational concepts to describe how the task should be completed. Herschkorn (2014) has stated that students are expected to attend to relational terms, think about them, remember them, and complete the task. Directions can be arduous if not impossible to execute with better than chance responding if students do not have a satisfactory repertoire of basic relational concepts.

Social Implications of Basic Concept Development

Speakers use basic relational concepts to help a listener with “understanding and interacting with their environment” (Nelson, 2006, p. 126). Many researchers have investigated the importance of basic relational concepts for language, thinking, problem solving, making judgments, comparisons, and sequencing (Bancroft, 2017; Boehm 2013; Nelson, 2006). Basic relational concepts are difficult for any child to learn because they are based off less tangible and more abstract relations. They require the “understanding of unfixed relationships” (Bancroft, 2017, p. 19). For example, concepts can be situational (*most* and *fewer* require comparisons between groups), can require understanding of multiple relational concepts (i.e. *some but not*

all), can be used across sensory modalities (i.e. *high* or *low* when referring to space or sound), or may change depending on the subject (Bancroft, 2017).

The BTBC3-P has prompted researchers to investigate the acquisition of basic relational concepts for *at risk* children. Findings have shown that such children have significantly lower numbers of relational concepts in their repertoire compared with their typically developing peers (Herschkorn, 2015; Lopez and Lord, 2009; Nelson, 2006; Parish-Morris et al., 2009).

Herschkorn (2014) was the first study to examine the relationship between basic relational concepts and children diagnosed with ASD. The findings are consistent in that students with ASD have fewer basic relational concepts in their repertoire compared to their typically developing peers.

Extending upon Herschkorn's (2014) research, Bancroft (2017) was the first to investigate basic relational concepts through a verbal behavior lens as measured by the *CABAS® Verbal Behavior Development Assessment-Revised* (VBDA-R®, 2010). The findings were consistent with previous research indicating that children diagnosed with ASD had fewer basic concepts in their repertoire and had larger variability in scores than their typically developing peers; however, the study was also the first to suggest a relation between the proportion of verbal behavior developmental cusps/capabilities and numbers of basic relational concepts acquired by children. The results indicated that BiN was correlated with higher scores on measures of basic relational concepts (from the BTBC3-P assessment) regardless of ASD status or educational classification.

Basic Concepts, RFT, and VBDT

Several similarities exist between types of basic relational concepts and families of relational frames. For example, abstract words that are categorized as describing spatial

relationships between stimuli (such as farthest, lowest, or smallest) in the realm of basic relational concepts are often categorized as spatial relations in RFT as well. However, with the addition of visual stimuli during a selection-response assessment (such as the BTBC3-P), it is possible that the four categories of basic relational concepts outlined by Boehm (2001) may not be as accurately assessed as was originally thought. For example, the relational concept of “down” is categorized in the BTBC3-P as a spatial relation, but a correct student response is emitted if the student simply selects the only child in a field of four options who is pointing down. From the perspective of RFT, this trial is simply assessing the student’s correct selection of the only stimulus that is different from the others (a frame of opposition) and may not indicate any awareness of the spatial nature of the term “down.” Similarly, “finished” (which is categorized in the BTBC3-P as a temporal relation) is assessed via asking a student to “point to the child who is *finished* eating.” A correct response is recorded if the student selects the only child who does not have food in a field of four options, which can be an example of a frame of opposition. Refer to Appendix C (Tables C1 and C2) for a list of basic relational concept categories and their proposed relational frame that is assessed from an RFT perspective.

It is important to note that while the BTBC3-P is a thoroughly researched and valid assessment, it only assesses one component of a student’s relational concept repertoire. VBDT theorists insist that for a student to be considered “truly verbal,” both listener and speaker repertoires must be joined (i.e., BiN must be in repertoire) such that he or she can hear someone tact a stimulus in the environment, incidentally learn to say the name of the stimulus upon observing it, and respond to it as a listener (e.g., in a novel setting, point-to or select the target stimulus when asked to do so) (Greer & Longano, 2010; Horne & Lowe, 1996). The BTBC3-P assessed listener responses to basic relational concept stimuli; as such, through the lens of

VBDT, students' true repertoire of basic relational concept language cannot be assessed through this test alone. Perhaps UniN (i.e., the listener component of BiN) is more strongly correlated with BTBC3-P scores; however, I propose that it is critical to assess whether the BTBC3-P scores of preschool-age students are correlated with degrees of BiN in order to add to literature on language acquisition and basic relational concepts.

Outline and Rationale for the Current Study

During Experiment 1, I conducted a combined multiple probe and counterbalanced ABAB/BABA reversal design across participant dyads, in which each participant's rate of acquisition was compared under the Standard Learn Unit (SLU) and Instructional Demonstration Learn Unit (IDLU) instructional conditions before and after the acquisition of BiN. By assessing rate of learning (i.e., the mean number of instructional trials required for students to master curricular objectives), past research (Corwin, 2011; Greer et al., 2011) has found that children who do not have BiN cannot learn through modeled instruction, but can learn through modeled instruction following the establishment of BiN. While Corwin (2011) assessed the mean number of IDLUs required for her participants to meet criterion across curricular objectives prior to and following the establishment of BiN, she did not include standard learn units as a control measure during pre- and post-intervention assessments. More recently, Hrachuk et al. (in press) identified that children who have BiN in repertoire learned more efficiently via IDLU instruction by comparing students' mean number of learn units required to master each objective. Hrachuk et al. (in press) also utilized a cumulative record to visually depict that her participants learned at an accelerated rate when instructional demonstrations were presented prior to the opportunity to respond through learn units.

Since BiN is defined as the joining of listener and speaker repertoires such that one may encounter a novel stimulus indirectly as a listener and produce a tact as a speaker without direct training, I propose that it is possible that students who only have UniN (the listener component of BiN) in repertoire may benefit from modeled instruction for listener tasks to some degree. If this is the case, teachers should provide instruction for listener tasks using modeled instruction for students with UniN in repertoire to accelerate student learning. In Experiment 2, I identified (1) students with BiN, and (2) students with UniN; then, I utilized a combined ABAB/BABA reversal design across learning objectives and levels of BiN to compare the rate of learning new speaker (i.e., tact) and listener (i.e., point-to) responses across both conditions via IDLU and SLU instruction.

Lastly, in Experiment 3, I employed a group correlational design to assess whether a student's "level" of Naming (i.e., BiN, UniN, or limited Naming repertoire) is a reliable predictor of performance on measures other than rate of learning and/or accelerated learning via modeled instruction. Participants were preschool-aged students with and without disabilities who attended a school that employs Applied Behavior Analysis as a method of teaching. First, all participants were assessed for performance on standard match-to-sample BiN probes using novel familiar and unfamiliar stimuli. Next, participants were assessed using the *Boehm Test of Basic Concepts 3rd Edition – Preschool Version* (BTBC3-P) (Boehm, 2001). This study replicated components of Bancroft's (2017) dissertation, for which participants were assessed for either the presence or non-presence of BiN and/or UniN prior to the completion of the BTBC3-P. While Bancroft (2017) used nominal data to assess the significance of the presence/non-presence of BiN as it related to performance on the BTBC3-P, the present study utilized continuous data to assess whether a BiN "continuum" exists as a reliable predictor of basic relational concept skills.

Results indicate whether trends exist in regards to level of BiN and performance on a standardized assessment of “the basic relational concepts important for language and cognitive development, as well as for later success in school” (Boehm, 2001, p.1).

The purpose of the present collection of experiments is to identify ways in which the acquisition of BiN can make learning more efficient, assess whether students with UniN (but not BiN) in repertoire can benefit from modeled instruction for listener tasks, and to generalize findings to a broader audience by assessing whether a proficient BiN repertoire is related to higher scores on a standardized assessment of basic preschool language skills and concepts (Boehm, 2001). Ideally, these data will build upon prior research by further testing whether BiN is related to the acceleration of learning, the demonstration of learning in new ways, improved performance on standardized language assessments, and greater academic success in a general education setting. Results will be discussed in terms of students’ rates of learning, efficiency of classroom instruction, social implications and expansions of students’ verbal behavior repertoires, and relevance to learning in the typical classroom environment.

Rationale for Experiment I: Pilot

The aim of Experiment I is to identify whether an adequate BiN repertoire of preschool students plays a role in their efficiency of learning in the absence of direct learn unit contingencies. While Corwin (2011) and Greer et al. (2011) identified that students learn faster via IDLU instruction following the establishment of BiN, and while Hbranchuk et al. (in press) identified that students with BiN in repertoire learn faster via IDLU instruction (as compared to SLU instruction), a gap in the literature remains to identify whether students without BiN in repertoire learn faster via IDLU instruction (as compared to SLU instruction) following the establishment of BiN.

Research Question for Experiment I: Pilot

1. Does a functional relation exist between the establishment of BiN and the acceleration of learning via IDLU instruction (as compared to SLU instruction)?

Chapter II

EXPERIMENT I: PILOT

Method

Participants and Setting

Four participants were selected for Experiment I due to the absence of the BiN capability in their verbal repertoire. The *CABAS® Verbal Behavior Development Assessment-Revised* (VBDA-R®, 2010), a curriculum and curriculum-based assessment of “the development of listening, speaking, writing, editing, algorithmic, and social functions of language from infancy to independence” (Greer, 2010, p. 2), was used to assess all participants for developmental cusps and capabilities present. All participants had listener literacy (described as reliably following directions across academic, social, and behavioral areas), had conditioned reinforcement for 2D print stimuli, and their data demonstrated that the teacher's presence resulted in instructional control. As such, these participants were described as emergent speakers and listeners ready to acquire more advanced verbal cusps and capabilities.

Table 1 provides a description of participants. Participant K was a 4.9-year-old male identified in his Individualized Education Plan (IEP) as a preschooler with a disability who had several pre-BiN cusps in repertoire. Participant K came from a household where English was not the primary language, and had documented language delays in both his native language (Japanese) and English. Participant P was a 5.2-year-old female identified by her IEP as a preschooler with a disability with some pre-BiN cusps in repertoire. Participant S was a 4.8-year-old female identified by her IEP as a preschooler with a disability with several pre-BiN cusps in

repertoire. Participant H was a 5.3-year-old male identified in his IEP as a preschooler with a disability with some pure tacts and pre-BiN cusps in repertoire. All participants in the present experiment came from different school districts; as such, diagnostic criteria within IEPs differed across participants. Diagnoses reported in the present study are parent-reported disabilities in order to control for variances in terms of the type of diagnostic assessment(s) used.

Table 1

Description of Participants

Participant	Dyad 1		Dyad 2	
	K	P	S	H
Age (Years. Months)	4.9	5.2	4.8	5.3
Gender	Male	Female	Female	Male
Native Language	Japanese/English	English	English	English
Diagnosis	Specific Language Impairment	Autism	Autism, ADHD	Autism
Educational Classification	Preschooler with a Disability	Preschooler with a Disability	Preschooler with a Disability	Preschooler with a Disability

Note. Diagnoses were reported by the parents of each participant on their individualized education plans (IEPs). An educational classification of Preschooler with a Disability means that the child has been evaluated by their school district as having an educational limitation “and who, by reason thereof, needs special education and related services” (Individuals with Disabilities Education Improvement Act, 2004).

All participants were selected from the same self-contained classroom in a CABAS® accredited program (Selinske, Greer, & Lodhi, 1991) with nine students, one teacher, and two teaching assistants. All participants were assessed using the *CABAS® International Curriculum*

and Inventory of Repertoires for Children from Pre-School to Kindergarten (C-PIRK®, 2014) and VBDA-R® (Greer, 2010). School-wide instruction was based on short and long-term objectives from the C-PIRK®, and students' results were continuously measured, analyzed, and displayed publicly.

All SLU and IDLU alternating treatment sessions were conducted in the participants' classroom during regularly scheduled instruction periods in a quiet area of the room. During SLU/IDLU sessions with interobserver agreement (IOA), a second observer was present and independently recorded data on his/her own data sheet. BiN probes were always conducted in the presence of a second independent observer during regularly scheduled instruction periods in a quiet area of the classroom. The intervention sessions were conducted in one-to-one instruction settings as ITI or MEI learn units in the participants' classroom during regularly scheduled instruction periods.

Dependent Variable

The dependent variable in this experiment was the rate of acquisition of math and sight-word reading tasks under SLU and IDLU presentations as measured by the mean number of learn units (instructional trials) required for participants to master objectives. Table 2 lists the objectives selected for each participant during pre- and post-intervention IDLU/SLU reversal conditions. Objectives were selected based on each participant's current curricular programs for math and reading objectives, and therefore were not uniform across participants or dyads. We collected data on the number of cumulative correct responses while teaching new reading and math objectives using IDLU and SLU instruction in order to compare the rate at which participants learned new operants under IDLU and SLU conditions. The rate of acquisition was measured by calculating the numbers of learn units delivered in order for the participants to meet

criteria for each objective. Criterion for mastery was set at 90% accuracy for two consecutive sessions (20 SLU/ IDLU presentations) or 100% accuracy for any one session (20 SLU/ IDLU presentations).

Table 2

Objectives taught during pre- and post-intervention IDLU/SLU reversal sessions for each participant.

Objective	Participant K	Participant P	Participant H	Participant S
1	SLU – Sight Words <i>Mother, Purple, Small, Driver</i>	IDLU – Sight Words <i>Had, But, They, On</i>	SLU – Sight Words <i>Had, But, They, On</i>	IDLU – Sight Words <i>Pineapple, Quickly, Temperature, Chore</i>
2	IDLU – Sight Words <i>Tractor, Outside, Notebook, Pillow</i>	SLU – Sight Words <i>Mom, Boy, It, Dog</i>	IDLU – Sight Words <i>Mom, Boy, It, Dog</i>	SLU – Sight Words <i>Photograph, Medium, Surprise, Jewelry</i>
3	SLU – Math <i>Circle ____ Items (3, 4, 5, 6)</i>	IDLU – Math <i>Count Items & Circle Arabic Number (1, 2, 3, 4)</i>	SLU – Math <i>Circle ____ Items (3, 4, 5, 6)</i>	IDLU – Math <i>Circle ____ Items (3, 4, 5, 6)</i>
4	IDLU – Math <i>Fill In Numbers in Sequence by 2s (2, 4, 6, 8, 10)</i>	SLU – Math <i>Fill In Numbers in Sequence by 1s (1, 2, 3, 4, 5)</i>	IDLU – Math <i>Count Items & Circle Arabic Number (1, 2, 3, 4)</i>	SLU – Math <i>Fill In Numbers in Sequence by 2s (2, 4, 6, 8, 10)</i>
5	SLU – Sight Words <i>Mold, Prince, Sail, Ghost</i>	IDLU – Sight Words <i>Say, Own, Girl, Blue</i>	SLU – Sight Words <i>Play, Look, Here, Ride</i>	IDLU – Sight Words <i>Energy, Suddenly, Mountain, Believe</i>
6	IDLU – Sight Words <i>Mango, Pearl, Storm, Goose</i>	SLU – Sight Words <i>Friend, Back, Last, Not</i>	IDLU – Sight Words <i>Please, White, Run, Many</i>	SLU – Sight Words <i>Special, Without, Remember, Distance</i>
7	SLU – Math <i>Addition (+1), Numbers 1-5</i>	IDLU – Math <i>Responding with Number of 3D Objects (1-5)</i>	SLU – Math <i>Responding with Number of 3D Objects (1-5)</i>	IDLU – Math <i>Fill In Numbers in Sequence by 5s (5, 10, 15, 20, 25)</i>
8	IDLU – Math <i>Group 2D Items by 2, 3, 4, 5</i>	SLU – Math <i>Point to “Next” Number in a Sequence (1-5)</i>	IDLU – Math <i>Fill In Numbers in Sequence by 1s (1, 2, 3, 4, 5)</i>	SLU – Math <i>Addition (+1), Numbers 1-5</i>
9			SLU – Sight Words <i>First, Should, Away, Morning</i>	IDLU – Sight Words <i>Penguin, Strange, Terrible, Everything</i>
10			IDLU – Sight Words <i>Friend, Thing, Leave, Never</i>	SLU – Sight Words <i>Another, Caught, Flamingo, Myself</i>
11			SLU – Math <i>Addition (+1), Numbers 1-5</i>	IDLU – Math <i>Subtraction (-1), Numbers 1-5</i>
12			IDLU – Math <i>Group 2D Items by 2, 3, 4, 5</i>	SLU – Math <i>Group 2D Items by 2, 3, 4, 5</i>

Standard Learn Unit Presentations. In SLU conditions, the experimenter delivered a vocal antecedent instruction based on the objective to which the student responded, and a consequence was delivered based on whether the response was correct or incorrect (Albers & Greer, 1991). We recorded a plus and delivered reinforcement for each correct student response. For an incorrect student response, we recorded a minus and gave a correction. The correction procedure varied based on the curricular objective; however, an SLU correction procedure consisted of (1) the teacher's model of the correct response, (2) the student's emulation/imitation of the correct response, and (3) the student's independent emission of the correct response. The correction for an incorrect math response consisted of the experimenter saying, "Watch me" and completing the math problem while the participant observed. The correction for an incorrect sight word response consisted of the experimenter reading the word aloud, and then the participant was required to read and correctly repeat the word. No reinforcement was delivered for incorrect responses or for the correction responses.

Instructional Demonstration Learn Unit Presentations. In the IDLU condition, an experimenter demonstrated the operations for doing the math problems or correctly reading the sight words two times while the participant attended and observed. With these demonstrations, the students observed an exemplar of the correct response two times for each math problem or sight word at the beginning of each session before beginning independent responses. During instructional demonstrations, students were not required to mimic the teacher; however, if they did mimic or attempt to mimic the teacher's model, no reinforcement or correction was provided. After the instructional demonstrations, the experimenter presented 20 learn unit presentations without a model or demonstration included. The learn unit presentations were conducted in the same manner as they were in the SLU condition.

Independent Variable

The independent variable in the present study was the establishment of BiN. Our four participants were selected because they did not demonstrate criterion for BiN in repertoire across speaker and listener probe responses. All participants initially presented with varying “degrees” of BiN and varying instructional histories; therefore, the intervention was complete for a given participant once he or she met criterion during BiN probes for the same set of stimuli used during pre-intervention BiN probes. Prior to the intervention, naming experience sessions were conducted via match-to-sample instruction for five novel foods (gourd, lime, yam, quince, and prune). The naming experiences provided participants with the opportunity to observe novel 2D stimuli while the experimenter said the names of the stimuli, mimicking the manner in which incidental word learning occurs. Appendix A provides a sample of a naming experience (See Figure A1). After two hours, probe sessions were conducted and consisted of two opportunities to respond to each stimulus by pointing to target operants in a field of three, responding to an intraverbal antecedent (“what is this?” while displaying the card), and responding under pure tact conditions (simply displaying the card to the participant). Appendix A provides samples of listener and speaker BiN probe trials (See Figures A2 and A3). After completion of each set of either ITI or MEI, BiN was re-assessed using the same stimuli and probe procedure as was completed prior to the intervention. Criterion for the acquisition of BiN was set at 80% correct responding across each of the three response topographies (point, tact, and intraverbal responses to probe stimuli) as per the intensive tact instruction protocol (Greer & Ross, 2008). Re-assessment of dependent measures (responding under IDLU and SLU conditions) was conducted after both participants within a given dyad demonstrated BiN in repertoire for the initial set of probe stimuli.

The ITI protocol was used for Participants K, H, and S, while MEI across listening and speaking was used for Participant P. For the ITI procedure, an additional 100 learn units of tact instruction to novel stimuli were added to the participants' daily instruction. Five sets of two-dimensional stimuli presented on PowerPoint were used. Each set contained five categories such as flowers, insects, foods, or instruments with multiple exemplars of four novel stimuli.

Instruction was presented using an echoic-to-tact procedure, with an echoic provided as the antecedent for the first two presentations of each operant. Then, participants were provided with five tact learn unit opportunities for each operant. Correct tact responses were reinforced using praise, playful physical contact, and non-vocal approvals (each of which was a known reinforcer for academic and communication tasks across other classroom programs) while incorrect responses were followed by the SLU correction procedure. Refer to Table 3 for the list of tact sets used for ITI with Participants K, H, and S.

Table 3

Sets of stimuli used during intensive tact instruction for Participants K, H, and S

Set	1	2	3	4	5
Phase 1	Centipede Cicada Cockroach Mantis	Carnation Daffodil Daisy Tulip	Brazilian Cashew Pistachio Walnut	Bread maker Colander Crockpot Grater	Dust pan Lint roller Loofah Plunger
Phase 2	Buick Hyundai Mercedes Volkswagen	Bonnet Fedora Mortarboard Visor	Gecko Iguana Newt Skink	Accordion Kazoo Organ Viola	Artichoke Collard Radish Turnip
Phase 3	Bok choy Coleslaw Kale Quinoa	Cello Flute Harmonica Tuba	Athlete Barber Referee Rower	Alpaca Hedgehog Jaguar Lemur	Crane Ferry Sled Tricycle

Participant P did not demonstrate tact acquisition during ITI; that is, the CABAS® decision protocol (Keohane & Greer, 2005) indicated that a tactic was necessary because she did not emit any correct tact responses to stimuli across all five sets for three consecutive sessions. To establish BiN, MEI was implemented across listener tasks (point-to) and speaker tasks (tact and intraverbal responses) as the intervention for Participant P. MEI consisted of both listener and speaker responses to novel stimuli including pictures of cartoon characters, foods, and animals such that 240 additional learn units were presented daily with 80 learn units per response topography (point, intraverbal, and tact). The MEI procedure implemented for Participant P was modified from the procedure described by Greer et al. (2005) because although she required multiple opportunities to respond to stimuli as both a listener and speaker, she did not require a match topography in order to acquire speaker responses for novel stimuli. For the sake of time and efficiency of instruction, only point-to, intraverbal, and tact learn units were presented.

All stimuli were presented on two-dimensional flashcards. During MEI for a given set of stimuli, the experimenter presented (1) a listener (point-to) learn unit for each operant (i.e., the experimenter set three cards on the tabletop with one target stimulus and two non-exemplars while saying “point to the ___”), (2) an intraverbal (speaker) learn unit for each operant (i.e., the experimenter held up a target stimulus and asked “what is this?”), and (3) a tact (speaker) learn unit for each operant. This was repeated in a randomized order across operants until all 20 learn units for each topography were completed. Four sets of stimuli were presented each day, providing Participant P with 240 learn units of MEI instruction per day until BiN was established. Refer to Table 4 for a list of stimuli sets used for MEI with Participant P.

Table 4

Sets of stimuli used during multiple exemplar instruction for Participant P

Set	1	2	3	4
Phase 1	Daphne Flounder Popeye Taz	Hedgehog Jaguar Lemur Llama	Bundt cake Cobbler Dilly bar Sundae	Nike Pepsi Starbucks Yankees
Phase 2	Daisy Dumbo Iago Rex	Jimmy Lucy Pinky Velma	Cumin Ginger Nutmeg Wasabi	Centipede Cicada Cockroach Mantis
Phase 3	Cannoli Crepe Fortune cookie Toffee	Bok choy Coleslaw Kale Quinoa	Accordion Kazoo Organ Viola	Gecko Iguana Newt Skink
Phase 4	Bonnet Fedora Mortarboard Visor	Artichoke Collard Radish Turnip	Cello Flute Harmonica Tuba	Crane Ferry Sled Tricycle

Design

A combined pre- and post-intervention and multiple probe design with counterbalanced ABAB/BABA alternating treatments across participant dyads was conducted in which each participant's rate of acquisition was compared under the IDLU and SLU conditions before and after the acquisition of BiN. All participants were matched as dyads based on their levels of verbal behavior and academic repertoires. Within each dyad, during IDLU/SLU measures prior to and following the acquisition of BiN, one participant completed instruction under the SLU condition first while the other participant of the dyad simultaneously completed the IDLU condition first. The conditions were alternated such that each participant in a given dyad received

instruction for repeated sessions under different conditions (e.g., Participant K underwent sessions in an ABAB sequence while Participant P underwent sessions in a BABA sequence).

The design for a given participant within the intervention phase was a multiple probe design until BiN was established. During the intervention, participants progressed through objectives at their own pace until BiN was established, thus establishing numbers of curricular objectives across the conditions based on the responses of each participant. For a given dyad, BiN was assessed prior to and following each intervention phase across ITI or MEI conditions depending on the type of intervention selected for each participant. See Figure 1 for a visual display of the delay in the experimental design across dyads, and refer to Figure 2 for a visual display of the ABAB/BABA reversal design across dyads.

Dyad 1	BiN Pre-Experimental Probe	Pre-BiN IDLU/SLU Reversal Conditions across Sight Word and Math Objectives (counterbalanced across Participants K and P)	Establishment of BiN via Intensive Tact and/or Multiple Exemplar Instruction	Post-BiN IDLU/SLU Reversal Conditions across Sight Word and Math Objectives (counterbalanced across Participants K and P)		
Dyad 2	BiN Pre-Experimental Probe	Pre-BiN IDLU/SLU Reversal Conditions across Sight Word and Math Objectives (counterbalanced across Participants H and S)		Pre-BiN IDLU/SLU Reversal Conditions across Sight Word and Math Objectives (counterbalanced across Participants H and S)	Establishment of BiN via Intensive Tact and/or Multiple Exemplar Instruction	Post-BiN IDLU/SLU Reversal Conditions across Sight Word and Math Objectives (counterbalanced across Participants H and S)

Figure 1. Multiple probe design sequence across participant dyads.

Dyad 1	Participant K	SLU – Sight Words	IDLU – Sight Words	SLU – Math Objective	IDLU – Math Objective
	Participant P	IDLU – Sight Words	SLU – Sight Words	IDLU – Math Objective	SLU – Math Objective
Dyad 2	Participant H	SLU – Sight Words	IDLU – Sight Words	SLU – Math Objective	IDLU – Math Objective
	Participant S	IDLU – Sight Words	SLU – Sight Words	IDLU – Math Objective	SLU – Math Objective

Figure 2. A sample of the ABAB/BABA reversal design across participant dyads. Participants in each dyad underwent IDLU and SLU instruction conditions across sight word and math objectives pre- and post-BIN acquisition. The type of instruction presented at a given time (IDLU or SLU) was counterbalanced across participants within each dyad.

Interobserver Agreement

Probe and intervention sessions with interobserver agreement (IOA) were conducted by both the experimenter and a trained observer. Trained observers were provided instruction on how to conduct probe and intervention sessions via modeling, vocal consequences, and Teacher Performance Rate and Accuracy Scales (TPRAs) (Ross, Singer-Dudek, & Greer, 2005). The TPRA is a method of teacher observation used in CABAS® schools to provide teachers with direct, immediate feedback on their accuracy of learn unit presentation (i.e., clear antecedents and correct consequences for correct/incorrect student responses) and accuracy of data collection. Occasionally, ITI and MEI intervention sessions were observed by a CABAS® behavior analyst supervisor for additional teacher feedback and IOA.

Since target student behaviors were clearly identifiable (i.e., 2D matching, pointing to 2D cards on a tabletop, and emitting vocal tacts with point-to-point correspondence to a teacher model), percentage of IOA across all sessions remained high throughout the experiment. IOA was calculated by dividing the number of learn units with agreement between the experimenter and a trained observer by the number of agreed plus disagreed items and multiplying by 100%. Percent of agreement is reported in terms of point-to-point agreement across learn units for both the experimenter and the trained observer.

For Dyad 1 (Participants K and P), IOA was obtained for 34% of pre- and post-intervention SLU/IDLU sessions with 100% agreement. For Dyad 2 (Participants H and S), IOA was obtained for 25% of pre- and post-intervention SLU/IDLU sessions with 100% agreement. For Participant K, IOA was obtained for 20% of ITI sessions with 100% agreement. For Participant P, IOA was obtained for 45% of MEI sessions with 100% agreement. For Participant H, IOA was obtained for 22% of ITI sessions with 100% agreement. For Participant S, IOA was

obtained for 16% of ITI sessions with 100% agreement. All BiN probe sessions across participants were conducted in the presence of a trained observer. Across all participants, point-to-point IOA for all BiN probes was 100%.

Results

Figure 3 displays the mean number of learn units to meet criterion for both SLU and IDLU conditions prior to and following the establishment of BiN across participants. After the establishment of BiN, all participants required fewer learn units to meet criterion in IDLU conditions than in SLU conditions for both math and sight word objectives. Prior to the intervention, all participants were assessed for BiN as a prerequisite for participation in the study.

Dyad 1 consisted of Participants K and P. Prior to the induction of BiN, Participant K learned at a mean rate of 110 learn units to master objectives in the SLU condition and a mean rate of 100 learn units in the IDLU condition (See Figure 3). Following the acquisition of BiN, Participant K learned at a mean rate of 90 learn units to master objectives in the SLU condition and a mean rate of 60 learn units to master objectives in the IDLU condition (See Figure 3). Prior to the induction of BiN, Participant P learned at a mean rate of 180 learn units to master objectives in the SLU condition and a mean rate of 160 in the IDLU condition (See Figure 3). Following the acquisition of BiN, Participant P learned at a mean rate of 180 learn units to master objectives in the SLU condition and a mean rate of 100 learn units to master objectives in the IDLU condition (See Figure 3).

Dyad 2 consisted of Participants H and S. In the first pre-intervention phase, Participant H learned at a mean rate of 180 learn units to master objectives in the SLU condition and a mean rate of 140 learn units to master objectives in the IDLU condition. In the second pre-intervention

phase, Participant H learned at a mean rate of 290 learn units to master objectives in the SLU condition and a mean rate of 210 learn units to master objectives in the IDLU condition (See Figure 3). Following the acquisition of BiN, Participant H learned at a mean rate of 110 learn units to master objectives in the SLU condition and a mean rate of 60 learn units to master objectives in the IDLU condition (See Figure 3). In the first pre-intervention phase, Participant S learned at a mean rate of 70 learn units to master objectives in the SLU condition and a mean rate of 90 learn units in the IDLU condition. In the second pre-intervention phase, Participant S learned at a mean rate of 70 learn units to master objectives in the SLU condition and a mean rate of 80 learn units in the IDLU condition (See Figure 3). Following the acquisition of BiN, Participant S learned at a mean rate of 90 learn units to master objectives in the SLU condition and a mean rate of 50 learn units to master objectives in the IDLU condition (See Figure 3).

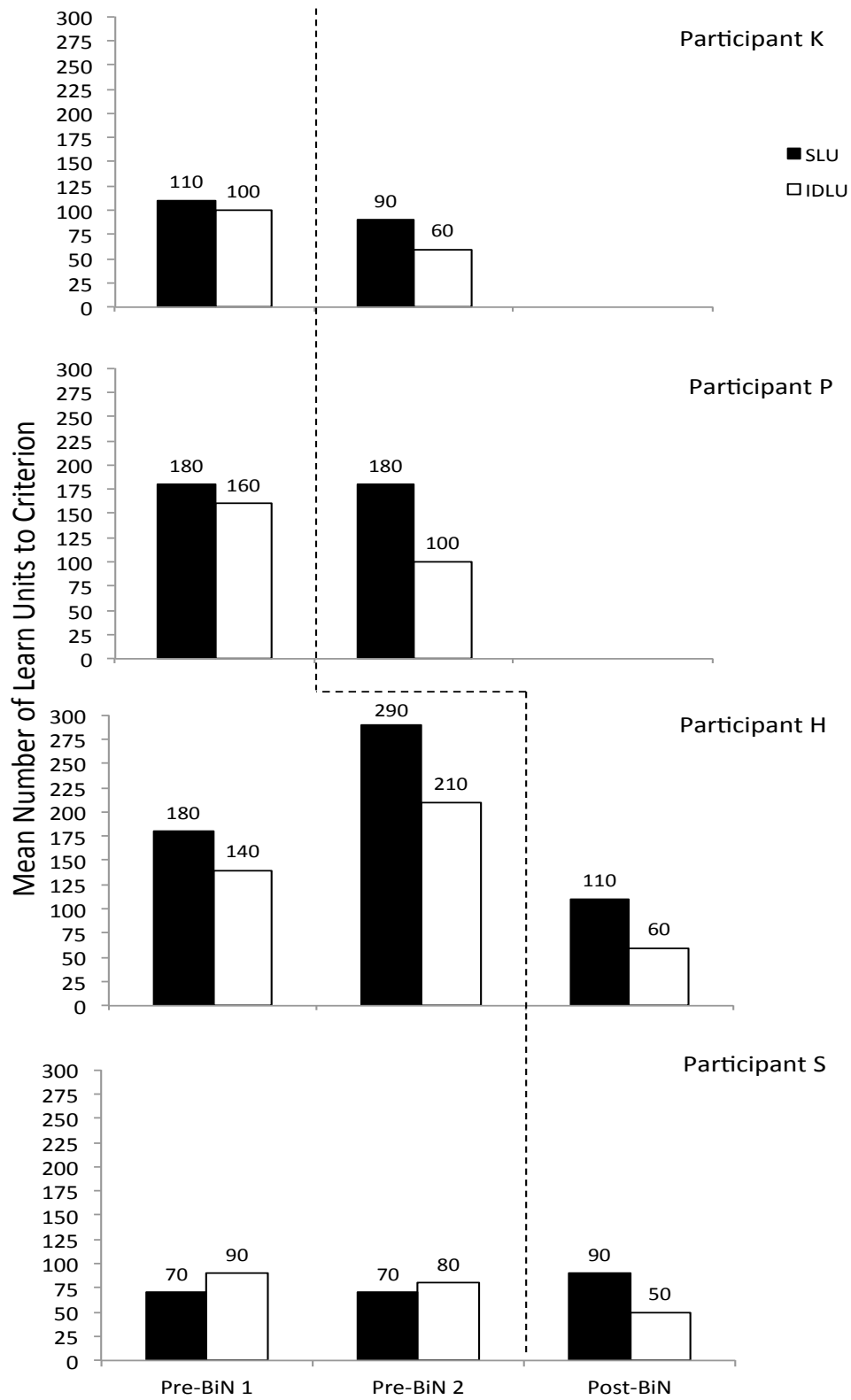


Figure 3. Participants' mean number of learn units required to meet criterion for both SLU and IDLU objectives before and after the establishment of BiN.

Figure 4 displays each participant's cumulative number of correct responses during SLU/IDLU alternating treatment conditions to analyze trends in responding (See Figure 4). All participants emitted correct responses during pre-intervention reversal phases at a steady rate; that is, the slope across all pre-intervention conditions for all participants demonstrates that the participants did not learn at an accelerated rate with an instructional demonstration by the teacher prior to the induction of BiN. After the establishment of BiN, all participants indicated an accelerated of learning across IDLU conditions as compared to SLU conditions. These data indicate that after the establishment of BiN, all participants learned at an accelerated rate given instructional demonstrations (models) prior to instructional learn unit sessions for both sight words and math objectives.

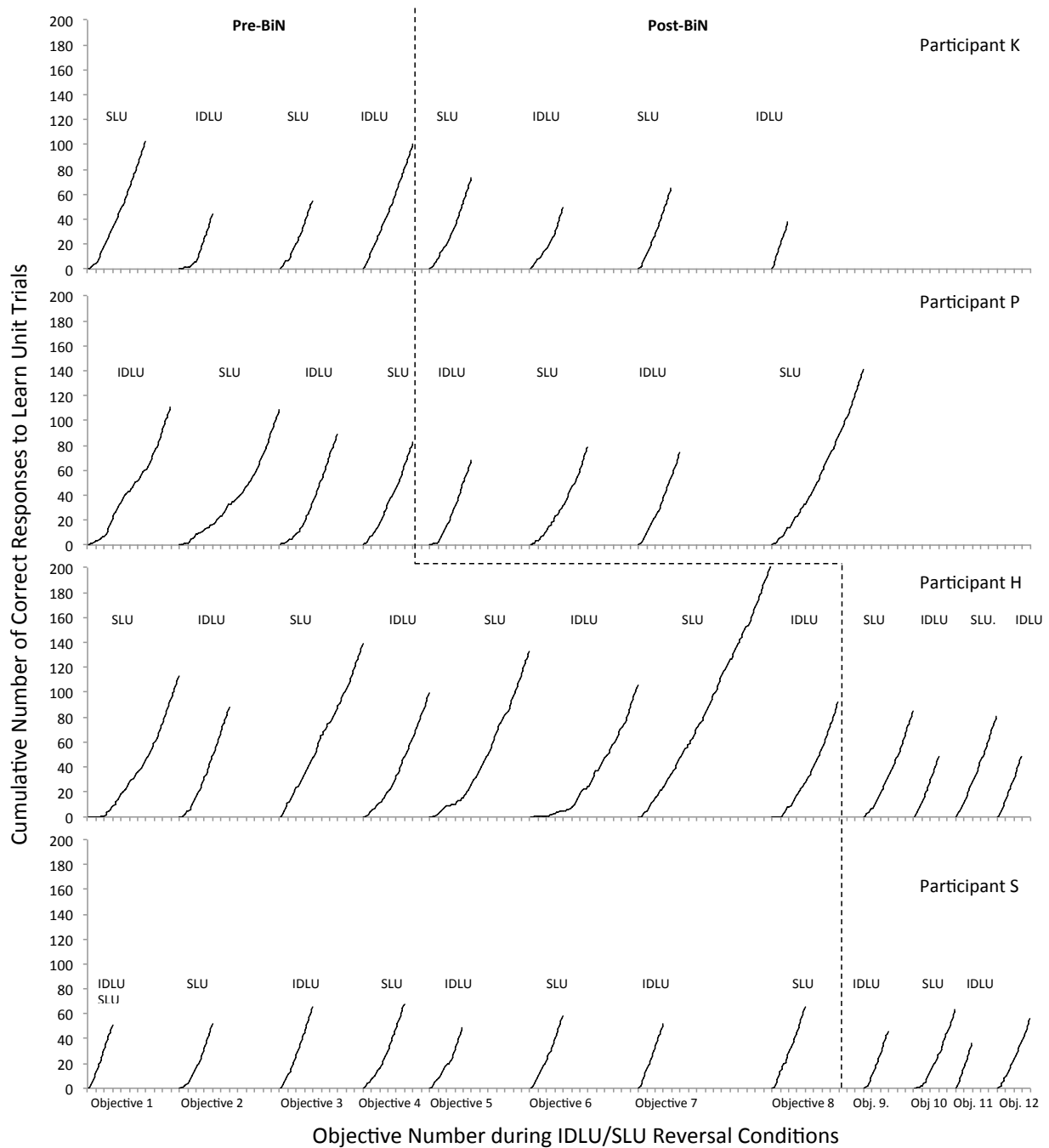


Figure 4. Cumulative correct responses for all participants in Dyads 1 and 2 across IDLU and SLU conditions before and after the establishment of BiN.

Figure 5 displays combined cumulative correct responses across all SLU/IDLU reversal conditions. For this display of data, both IDLU conditions and SLU conditions in each phase of the dependent measure have been combined in order to calculate an overall slope (trend) for each

pre- and post-BiN IDLU and SLU condition. For example, in the first pre-intervention reversal, SLU data for Participant K have been combined and graphed together while IDLU data for Participant K have been combined and graphed together (See Figure 5).

The slope (m) of each cumulative correct record was calculated and reported as well in order to identify a more accurate measure of trends in learning across all instructional conditions (See Figure 5). A steeper slope indicates accelerated learning for each given condition, whereas the mean learn units to criterion measure (See Figure 3) indicates the efficiency of learning for each given condition. For all participants except Participant K, the rate at which learning occurred under IDLU instructional conditions was faster following the induction of BiN as compared to SLU instruction. Following the induction of BiN, trends in Participant K's data indicate that the slope of his cumulative correct responses to IDLU instruction was not significantly better than SLU instruction ($m=0.78$ for SLU instruction, $m=0.75$ for IDLU instruction); nevertheless, the mean number of learn units required for Participant K to meet criterion under IDLU instructional conditions indicate more efficient instruction as compared to SLU instructional conditions (90 learn units to criterion for SLU instruction vs. 60 learn units to criterion for IDLU instruction).

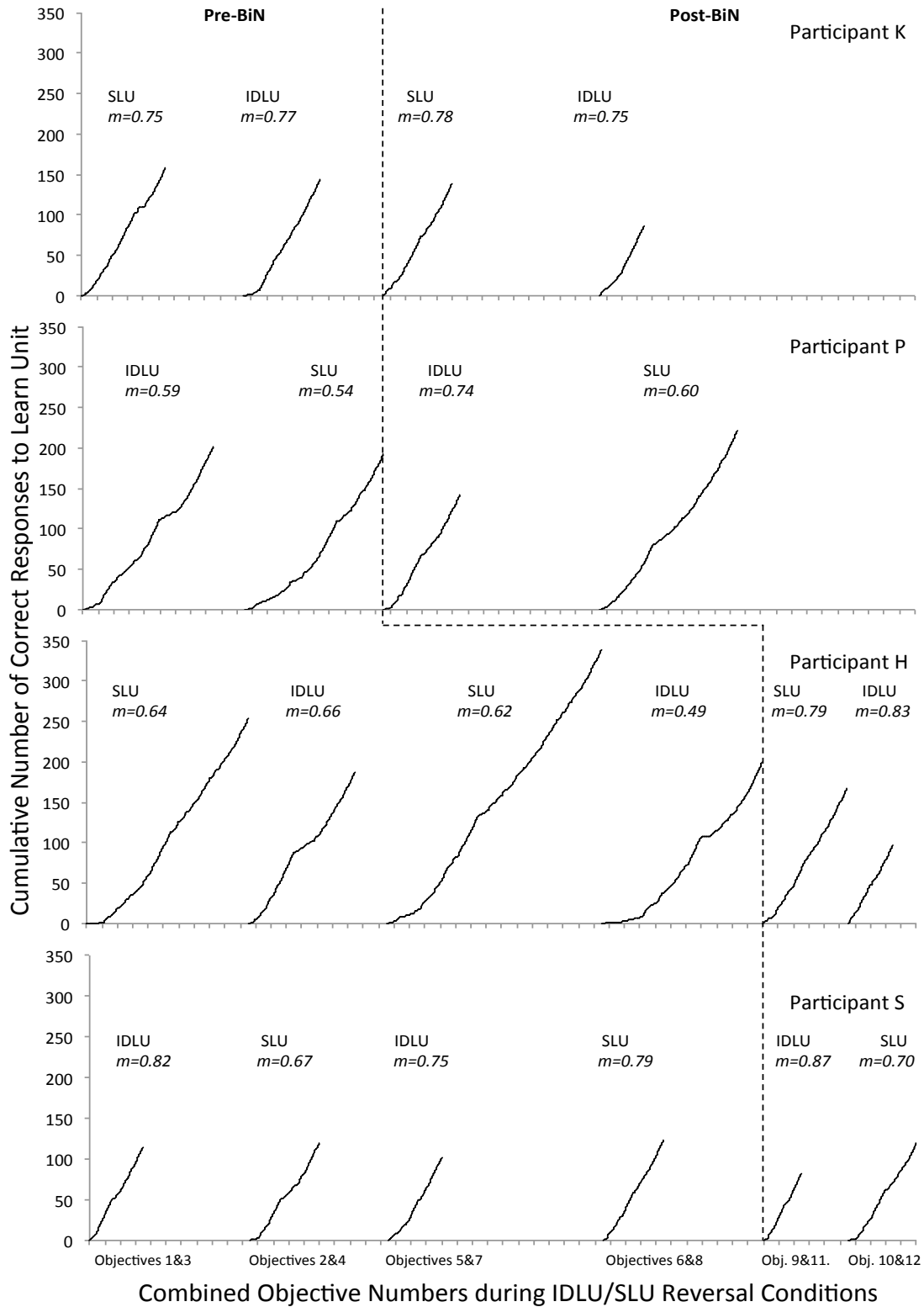


Figure 5. Combined cumulative correct responses across all pre-BiN IDLU conditions, pre-BiN SLU conditions, post-BiN IDLU conditions, and post-BiN SLU conditions for Dyads 1 and 2. The slope (m) of each trend is reported as well.

Figure 6 displays participants' correct responses during BiN probes. Probes were conducted for each participant following completion of a phase of the intervention (ITI or MEI) until criterion was met (80% correct responding across point-to/listener, intraverbal/speaker, and tact/speaker measures). During the ITI intervention for BiN, Participants K and H completed 3 phases for 5 sets of tact stimuli while Participant S completed 1 phase for 5 sets of tact stimuli. Once participants met criterion (90% x2 or 100% x1) for each set within a phase, post-intervention BiN probes were conducted. Participants K and H required 3 phases of ITI in order to display criterion level responding on BiN probes, while Participant S required 1 phase of ITI (See Figure 6). Refer to Appendix B for ITI intervention data for Participants K, H, and S. After 4 phases for 4 sets of MEI, Participant P displayed criterion level responding on BiN probes for initial probe stimuli (See Figure 6). Refer to Appendix B for MEI intervention data for Participant P.

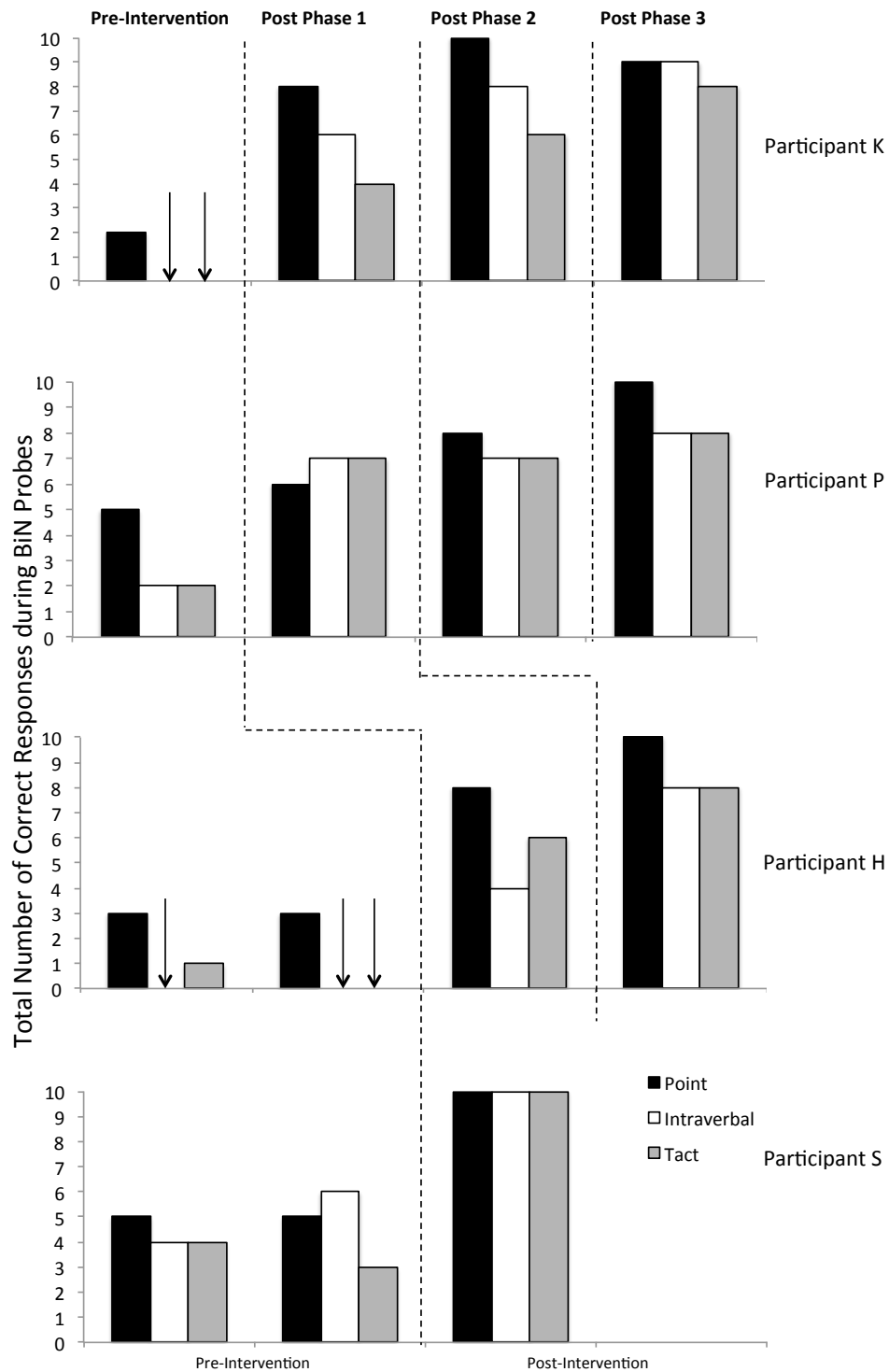


Figure 6. Correct responses during BiN probes for all participants in Experiment I. These data indicate the number of correct point-to, intraverbal, and tact responses to novel food stimuli two hours after match-to-sample naming experiences. Probes were conducted for each participant in Dyad 1 once before the intervention, and once following each phase of the MEI or ITI intervention; probes were conducted for each participant in Dyad 2 twice before the intervention, and once following each phase of the ITI intervention.

Discussion

The results of this study support the assertions of Corwin (2011), Greer et al. (2011), and Hranchuk et al. (in press) that BiN impacts an individual's learning outcomes from specific types of instruction. Further, this research supports the existing evidence that BiN is a critical learning capability and adds to BiN literature by displaying a functional relation between the induction of BiN and accelerated learning via teacher-modeled instruction. These findings indicate that BiN allows for students to contact stimuli in ways they could not before. Before a student demonstrates BiN, he or she may not learn through teacher instructional demonstrations; as such, the teacher will need to devote a significant amount of time to teaching skills directly and repeatedly to mastery. The previously described results from Corwin (2011) and Greer et al. (2011) indicate that students without full BiN repertoires do not benefit from IDLU instruction, or that higher numbers of learn units are required to learn new operants, while Hranchuk et al. (in press) found that those with BiN in repertoire learn faster via IDLU instruction, thereby indicating that modeled instruction accelerates learning for students with BiN. By comparing mean number of learn units to criterion across both SLU and IDLU instruction prior to and following the establishment of BiN, the present study suggests that BiN is functionally related to faster learning via IDLU instruction as compared to SLU instruction. For this reason, BiN may be the most critical verbal developmental capability because it allows individuals to learn incidentally. Additionally, students who have BiN may require fewer resources in the classroom, saving teacher time and increasing the number of curricular objectives presented in a given day.

It is critical to consider limitations and confounding variables in the study relative to the results. One limitation is the size of the study (two dyads). In the future, more dyads could be added in order to test the reliability of the results. It is important to note that Participant P's poor

articulation resulted in faulty echoic responses during the echoic-to-tact procedure; these faulty echoic responses led Participant P to emit approximation tact responses. Approximations were accepted as appropriate responses because of Participant P's lack of point-to-point correspondence. In the future, Participant P will continue Auditory Match-to-Sample instruction to increase her point-to-point correspondence for echoic responses. Another limitation is the lack of a second pre-intervention BiN probe for Dyad 1. If multiple pre-intervention probes had been conducted, it would have been possible to assess whether improvements made by Participant K and P on BiN assessments were already occurring as a result of maturation. Lastly, participants were not assessed for BiN using a novel set of stimuli following the intervention. Testing for the presence of BiN using a novel set of stimuli (i.e., different from initial probe stimuli) would have further enhanced findings.

Rationale for Experiment II

Based on previous research conducted by Corwin (2011), Greer et al. (2011), and Hbranchuk et al. (in press), it was hypothesized that the acquisition of BiN would allow for participants to benefit from instructional demonstrations prior to learn unit instruction in terms of rate of learning. The results of Experiment I indicate that accelerated learning via IDLUs occurs as a function of the establishment of BiN, adding to the body of BiN research pointing toward its critical nature as an essential verbal developmental capability. With the addition of cumulative correct response visual displays, it was possible not only to analyze the efficiency of IDLU instruction via mean numbers of learn units to achieve criterion, but also to visually depict the slope of student learning across teaching modalities (SLU/IDLU) with and without BiN. However, additional research questions arose upon completion of Experiment I; namely, whether a student's "degree" of BiN (e.g., no Naming repertoire, full BiN repertoire, or only UniN in

repertoire) is indicative of his or her rate of language acquisition when provided with IDLU instruction for a variety of listener and speaker responses to novel operants. While participants in Experiment I displayed overall improvements in their rate of learning via IDLUs after the establishment of BiN, three of the four participants still did learn via IDLUs at a similar rate compared to SLU instruction prior to the establishment of BiN. If we had taken into account degree of UniN across participants and whether IDLU/SLU academic tasks required listener or speaker responses to given antecedents, we could have potentially isolated the listener component of BiN as a contributing factor in participants' capacity to learn certain operants via modeled instruction.

In Experiment II, participants were first assessed for BiN across both familiar and unfamiliar stimuli. Participants were separated into two groups: participants with BiN in repertoire who responded with $\geq 80\%$ correct responses to listener and speaker BiN probe trials, and participants with UniN in repertoire who responded with $\geq 80\%$ correct responses to point-to (listener) probe trials but $\leq 40\%$ correct responses to intraverbal and tact (speaker) probe trials. Then, ABAB alternating treatments across SLU and IDLU teaching conditions were implemented for novel unfamiliar 2D symbols to assess research questions.

Research Questions for Experiment II

1. Is there a relation between a student's "degree" of BiN and rate of acquisition of new operants via IDLU instruction?
2. Does accelerated learning via IDLU instruction depend upon the type (listener or speaker) of verbal operant taught; that is, do students with UniN in repertoire (but not BiN) benefit from IDLU instruction for listener tasks?

Chapter III

EXPERIMENT II

Method

Participants and Setting

Five preschool-age participants who attended a publicly funded private preschool based on the CABAS® model were included in this study (Greer et al., 2002). All students were enrolled in a self-contained preschool classroom containing nine students, one head teacher and two teaching assistants; further, each student was educationally classified as a Preschooler with a disability according to their IEPs. All participants were assessed using the C-PIRK® (Greer, 2014) to determine appropriate curricula and programs of instruction. Table 5 lists participants' age, gender, level of verbal behavior, diagnosis, and educational classification. All participants in the present experiment came from different school districts; as such, diagnostic criteria within IEPs differed across participants. Diagnoses reported in the present study are parent-reported disabilities in order to control for variances in terms of the type of diagnostic assessment(s) used. Table 6 lists participants' relevant cusps and capabilities in repertoire.

Table 5

Description of Participants

Participant	BiN in Repertoire		UniN in Repertoire		
	C	L	D	O	V
Age (Years. Months)	5.4	5.2	3.10	4.5	3.10
Gender	Male	Male	Male	Male	Male
Native Language	English	English	English	English	English
Diagnosis	Autism	Autism, ADHD	Specific Language Impairment	Autism	Autism
Educational Classification	Preschooler with a Disability	Preschooler with a Disability	Preschooler with a Disability	Preschooler with a Disability	Preschooler with a Disability

Note. BiN and UniN repertoires were assessed via standard MEI BiN probes (Greer & Ross, 2008). Diagnoses were reported by the parents of each participant on their individualized education plans (IEPs).

Table 6

Participants' relevant pre-reader verbal behavior cusps and capabilities in repertoire

Participant	C	L	D	O	V
Self-talk (student acts as both a listener and speaker within their own skin)	X	X	X	X	
Conversational units with adults and peers	X	X			
Say-do in speaker-as-own listener function					
BiN	X	X			
UniN	X	X	X	X	X
Independent mands	X	X	X	X	
Independent tacts	X	X			
Echoic-to-tact	X	X	X	X	X
Echoic-to-mand	X	X	X	X	
Auditory matching	X	X			
Basic listener literacy	X	X	X	X	X
Teacher presence results in instructional control over child	X	X	X	X	X

Note. Cusps and capabilities in repertoire were assessed via the VBDA-R® (Greer, 2010) in order to determine appropriate curricular programs and goals for each participant's daily classroom instruction.

Participants with BiN in repertoire were Participant C and Participant L, both of whom met criterion during pre-experimental probes for BiN (80% correct responding across point-to, intraverbal, and tact responses) with both familiar stimuli and novel cartoon stimuli. Participant C was a 5.4-year-old male who functioned on a listener/speaker level of verbal behavior. Participant L was a 5.2-year-old male who functioned on a listener/speaker level of verbal behavior.

Participants with UniN in repertoire Participant D, Participant O, and Participant V, all of whom met criterion during pre-experimental probes for UniN (but not BiN) with both familiar and novel cartoon stimuli; that is, participants in the second group responded with $\geq 80\%$ accuracy during point-to tasks, but $\leq 40\%$ accuracy to intraverbal and tact (speaker) tasks during BiN probes. Participants who responded with greater than 40% but less than 80% accuracy to speaker tasks and $\geq 80\%$ accuracy during point-to tasks during BiN probes were omitted from the present study. Participant D was a 3.10-year-old male who functioned on a listener/pre-speaker level of verbal behavior. Participant O was a 4.6-year-old male who functioned on a listener/pre-speaker level of verbal behavior. Participant V was a 3.10-year-old male who functioned on a listener/pre-speaker level of verbal behavior. Participant V infrequently emitted instances of vocal verbal behavior in the classroom (echoic or independent vocal behavior); however, upon the conduction of BiN assessments across familiar and novel cartoon stimuli, it was ascertained that he possessed UniN in repertoire.

All participants were selected for this study to determine whether their respective degrees of BiN (i.e., BiN or UniN in repertoire) affected their rate of learning when instruction was presented in two different ways (i.e., SLU vs. IDLU presentations), and specifically, whether UniN in repertoire was related in any way to students' rate of learning when instruction was presented via SLUs vs. IDLUs. Participants were included in groups for ABAB/BABA alternating SLU/IDLU conditions and were matched according to their level of verbal behavior and prerequisite cusps/capabilities.

All participants possessed the prerequisites required for the BiN assessment, including (1) the performance of visual-visual match-to-sample (MTS) tasks in the form of placing items or pictures on top of identical items or pictures, and (2) pointing to common items upon hearing

their names (Gilic & Greer, 2011, p.158). The same setting was used for both BiN probes and IDLU/SLU instruction as was described in Experiment 1.

Materials

Table 7 lists the stimuli used during pre-experimental BiN probes. Pre-experimental BiN probes were conducted to determine whether participants had UniN or BiN in repertoire. During these sessions, two different sets of 5 stimuli were presented on 3"x5" picture cards. Sets were images of novel animals and novel teacher-generated cartoon stimuli, and there were multiple exemplars of each operant within the set.

Table 7

Stimuli used to assess the presence/absence of BiN

Novel Animal Stimuli	Novel Cartoon Stimuli
Goose	Gaf
Hawk	Hep
Koi	Lat
Newt	Muf
Yak	Nat

Note. Novel cartoon stimuli were unique teacher-generated cartoon stimuli with novel one-syllable names. All stimuli were presented on laminated paper notecards.

Table 8 lists the stimuli used during the study for the measure of the dependent variable. In the comparison of SLU and IDLU instruction across participant dyads, four sets of unfamiliar symbols were used, which were presented as 3"x 5" 2D cards.

Table 8

Stimuli used in the comparison of students' rates of learning during SLU and IDLU conditions

Set	Speaker (Tact) Responses		Listener (Point-to) Responses	
	1	2	3	4
	Command	Aries	Bass	Beta
	Libra	Euro	Pi	Mu
	Om	Lambda	Tilde	Omega
	Pisces	Taurus	Zeta	Phi

Note. All stimuli were unfamiliar (contrived) symbols and were presented on laminated paper notecards.

Dependent Variable

The dependent measure for Experiment II was participants' rates of learning under IDLU and SLU conditions across speaker and listener tasks. The rate of learning or acquisition was measured in the same manner as was done in Experiment I; similarly, the criterion set across both conditions and tasks was 90% accuracy over two consecutive sessions or 100% accuracy in one session. Each session provided 20 IDLU or SLU presentations to teach target listener or speaker responses to novel unfamiliar symbol stimuli.

During speaker task conditions, tacts were defined as verbal operants that are emitted under the control of non-verbal antecedents and are maintained by generalized social reinforcement from a listener (e.g., teacher attention) (Greer, 2002). For these tasks, the antecedent was the presentation of the visual stimulus (i.e., 2D card) without a vocal antecedent from the teacher; the student response was the correct or incorrect vocal emission of the name of the stimulus presented (or no response within 3s); and the consequence was either social reinforcement for correct responses (i.e., no other forms of prosthetic reinforcement such as edibles or toys) or the correction procedure for incorrect responses. The correction procedure

involved the experimenter re-presenting the two-dimensional card and saying the correct response. The student was required to echo that response and was then given an independent opportunity to respond, which was not consequated.

During listener tasks, participants were either required to point to or give the experimenter the stimulus specified in the antecedent from a field of three options. For these tasks, the antecedent was the presentation of stimuli in a field of one target exemplar and two non-exemplars with a vocal antecedent (i.e., “Give me omega” or “Point to pi”). The response was the student’s emission of a listener response (pointing to or giving the experimenter either the correct card or an incorrect two-dimensional card as specified in the antecedent) or no response within 3s, and the consequence was reinforcement for correct responses (i.e. praise and/or other prosthetic reinforcement) or the correction procedure for incorrect responses. The correction procedure involved the experimenter re-presenting the antecedent and modeling the correct response. The student was required to imitate that response and was then given an independent opportunity to respond after stimuli were randomly shuffled on the table, which was unconsequated.

For Experiment II, SLU and IDLU instruction was presented in the same manner as described in Experiment I, with the only difference being the types of target operants taught. While academic (math and reading) objectives were targeted for Experiment I, participants in Experiment II were taught listener and speaker responses to novel unfamiliar two-dimensional stimuli (See Table 7).

Independent Variable

The independent variable in the current study was the level of BiN in repertoire, i.e., BiN or UniN. BiN probes were conducted in the same manner as was described in Experiment 1, for

which participants were presented with match-to-sample naming experience sessions for two sets of stimuli (See Table 7 for a list of stimuli used during BiN probes). The criterion set for BiN was 80% across all three response topographies (point-to, intraverbal, and tact responses) during probe sessions. However, if the participant responded with at least 80% accuracy in the pointing task (i.e., the listener response) but $\leq 40\%$ accuracy to intraverbal and tact (speaker) tasks, it was concluded that the student possessed UniN in repertoire. Each participant's classification as having either BiN or UniN in repertoire was then established based on performance on measures of the BiN capability.

Design

The design employed in this study was a counterbalanced ABAB/BABA reversal design (Baer, Wolf, & Risley, 1968) across participants with BiN in repertoire and participants with UniN in repertoire, wherein the rate of learning in IDLU and SLU conditions across speaker and listener tasks was compared. IDLU and SLU conditions were counterbalanced across participants with BiN and across participants with UniN. Both instructional conditions were alternated until all participants underwent IDLU and SLU conditions twice- one each for speaker and listener tasks. For instance, if the first two phases (IDLU followed by SLU or vice versa) for one participant were speaker tasks, then the next two phases were listener tasks across both conditions. Participants with BiN in repertoire were Participants C and L. Participants with UniN in repertoire were Participants D, O, and V.

Interobserver Agreement

Probe and instructional sessions with IOA were conducted by both the experimenter and a trained observer. Trained observers were provided instruction on how to conduct probe and instructional sessions via modeling, vocal consequences, and TPRAs (Ross et al., 2005).

Occasionally, IDLU and SLU instructional sessions were observed by a CABAS® behavior analyst supervisor for additional teacher feedback and IOA. Since target student behaviors were clearly identifiable (i.e., 2D matching, pointing to 2D cards on a tabletop, and emitting vocal tacts with point-to-point correspondence to a teacher model), percentage of IOA across all sessions remained high throughout the experiment. IOA was calculated by dividing the number of learn units with agreement between the experimenter and a trained observer by the number of agreed plus disagreed items and multiplying by 100%. Percent of agreement is reported in terms of point-to-point agreement across learn units for both the experimenter and the trained observer.

All BiN probes across participants were conducted in the presence of a trained observer. Across all participants, point-to-point IOA for all BiN probes was 100%. During the IDLU/SLU instructional conditions, IOA was calculated for 29% of Participant C's sessions with 100% agreement. For Participant L, IOA was calculated for 27% of sessions with 100% agreement. For Participant D, IOA was calculated for 35% of sessions with 100% agreement. For Participant O, IOA was calculated for 23% of sessions with 100% agreement. For Participant V, IOA was calculated for 30% of sessions with 100% agreement.

Results

Figure 7 displays the number of learn units required for each participant to meet criterion in both SLU and IDLU conditions for speaker and listener tasks. Participants with BiN in repertoire were Participants C and L. In the speaker task, Participant C required 60 learn units to meet criterion in the IDLU condition and 140 learn units to meet criterion in the SLU condition. For the listener task, Participant C required 40 learn units to meet criterion in the IDLU condition and 100 learn units to meet criterion in the SLU condition. Participant L required 40 learn units to meet criterion in the IDLU condition and 80 learn units to meet criterion in the SLU condition.

for the speaker task. For the listener task, Participant L required 20 learn units to meet criterion in the IDLU condition and 80 learn units to meet criterion in the SLU condition.

Participants with UniN in repertoire were Participants D, O, and V. Participant D required 80 learn units to meet criterion during both IDLU and SLU conditions for the speaker task. For the listener task, Participant D required 40 learn units to meet criterion in the IDLU condition and 80 learn units to meet criterion in the SLU condition. Participant O required 80 learn units to meet criterion during both IDLU and SLU conditions for the speaker task. For the listener task, Participant O required 40 learn units to meet criterion in the IDLU condition and 60 learn units to meet criterion in the SLU condition. Participant V required 60 learn units to meet criterion during both IDLU and SLU conditions for the speaker task. For the listener task, Participant V required 20 learn units to meet criterion in the IDLU condition and 60 learn units to meet criterion in the SLU condition.

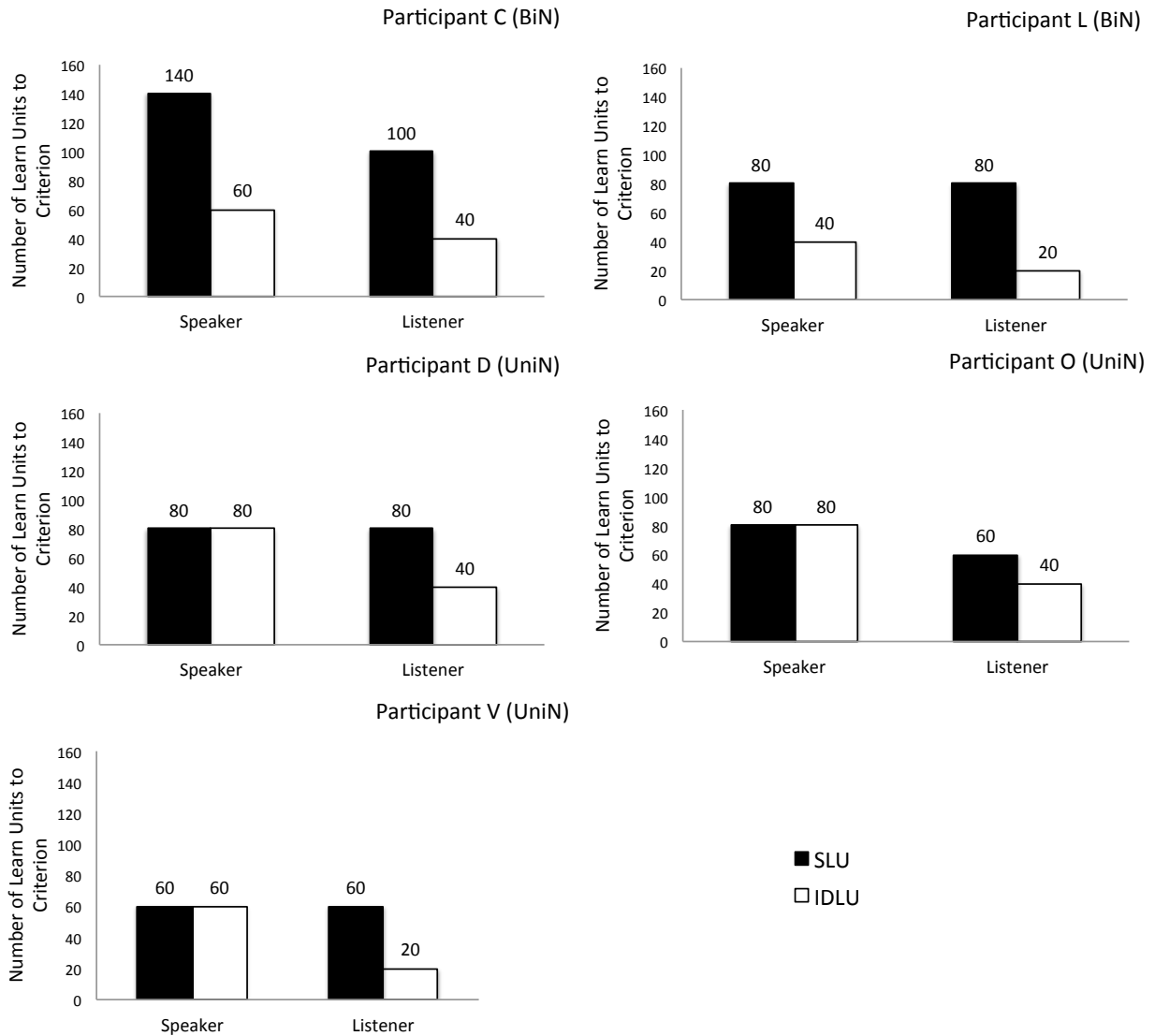


Figure 7. Each participant's number of learn units to meet criterion across SLU and IDLU instruction for listener and speaker objectives. Participants with BiN in repertoire (Participants C and L) required fewer learn units to meet criterion when provided instructional demonstrations across both speaker and listener tasks; participants with UniN in repertoire (Participants D, O, and V) required fewer learn units to meet criterion when provided instructional demonstrations for listener tasks but not for speaker tasks.

The number of learn units to criterion across SLU and IDLU instructional conditions indicates the rate at which speaker and listener objectives were acquired. For example, during a speaker task, Participant C required 60 learn units to meet criterion in the IDLU condition and required 140 within the SLU condition. Participant L indicated a similar trend in a listener task

wherein he achieved criterion-level responding within only one session via IDLU instruction, yet required 80 learn units to meet criterion given SLU instruction. Additionally, a cumulative record of correct responses across sessions for Participants C and L indicates that both participants learned at a significantly accelerated rate when provided an instructional demonstration prior to learn unit instruction for both listener and speaker tasks (See Figure 8).

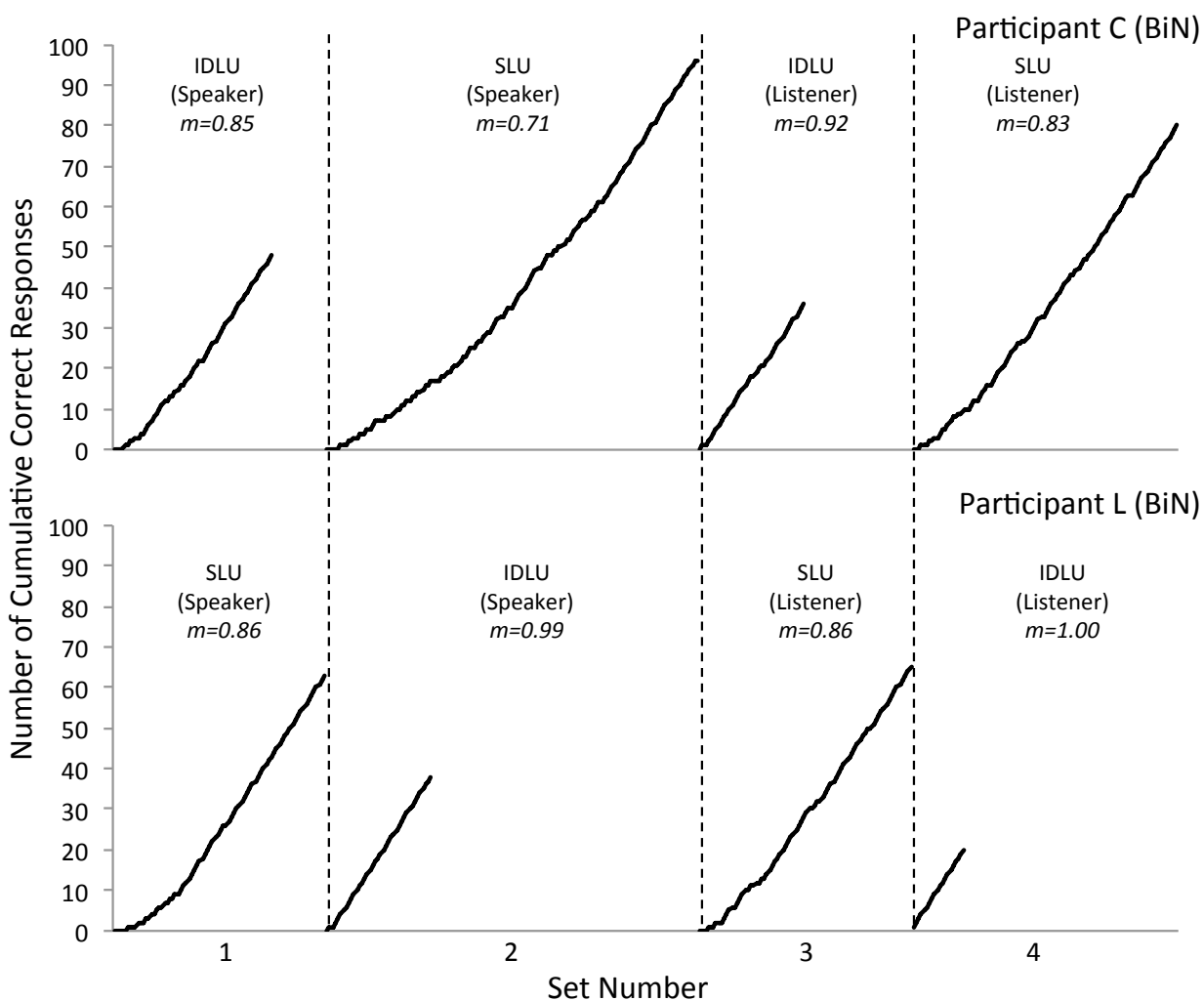


Figure 8. Cumulative correct responses during both SLU and IDLU conditions across speaker and listener tasks for Participants with BiN in Repertoire (Participant C and Participant L). The slope (m) of each trend is reported as well. A steeper slope indicates a faster acquisition of target operants.

Participants D, O, and V, all of whom had UniN in repertoire but did not possess full BiN repertoires, benefitted from IDLU presentations for listener tasks but not for speaker tasks. As is displayed in Figure 9, the cumulative rate of correct responding for these participants in speaker tasks across both IDLU and SLU conditions indicated a similar trend. However, for the listener tasks, the cumulative rate of correct responding was accelerated in the IDLU condition as opposed to the SLU condition (See Figure 9).

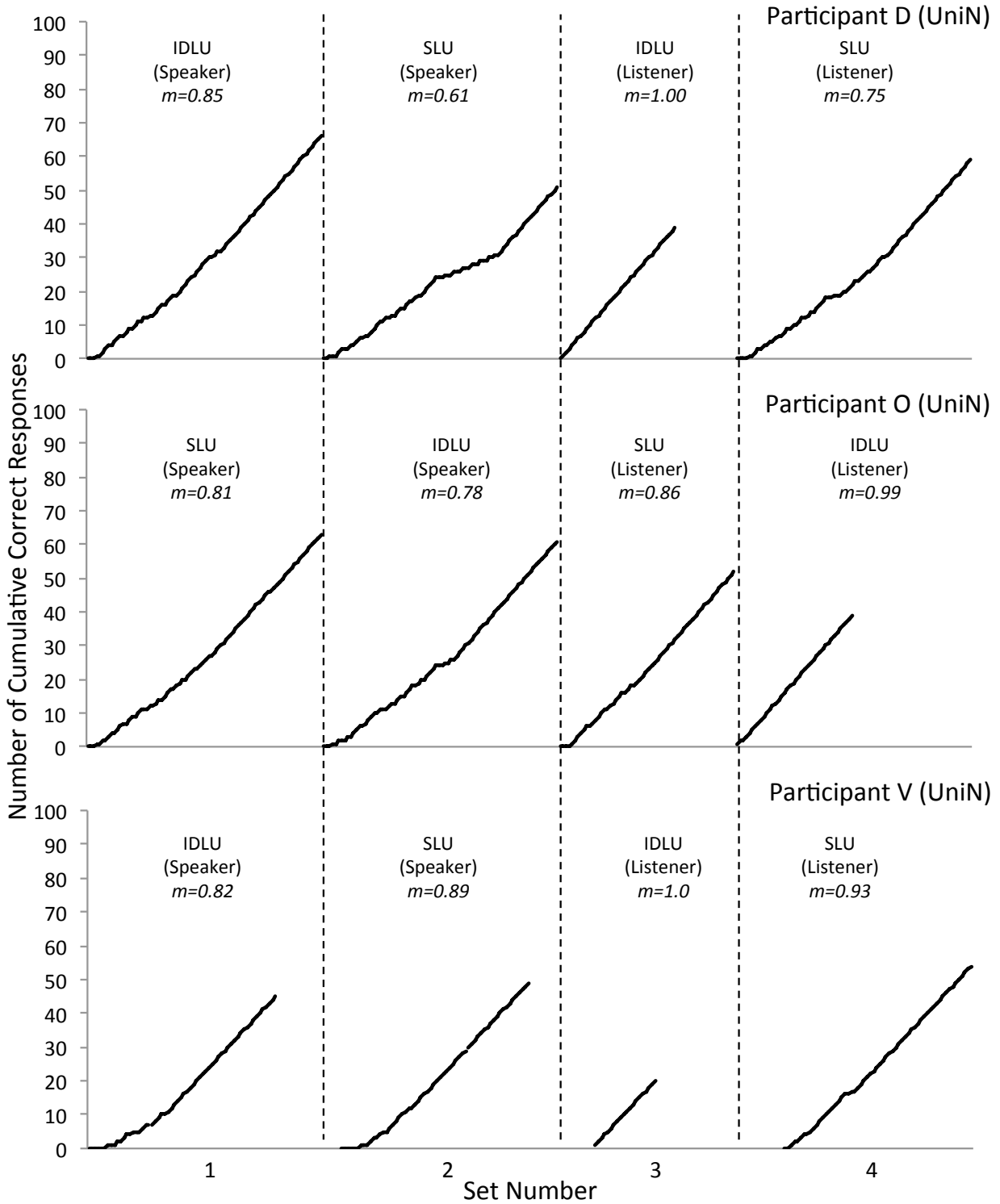


Figure 9. Cumulative correct responses during both SLU and IDLU conditions across speaker and listener tasks for Participants with UniN in repertoire (Participant D, Participant O, and Participant V). The slope (m) of each trend is reported as well. A steeper slope indicates a faster acquisition of target operants.

Figure 10 displays each participant's number of correct responses to first learn unit response opportunities across each operant in a given phase of instruction with and without an instructional demonstration. When participants did not receive instructional demonstrations for the names of new operants (across both speaker and listener objectives), they were not able to correctly respond upon the first presentation of said operants. This indicated that all of the stimuli used in the given experiment were novel to each participant. However, when instructional demonstrations were provided, participants with BiN responded to a certain number of operants correctly the first time they were presented across both speaker and listener responses; similarly, participants with UniN responded to some operants correctly the first time they were presented for listener tasks but not for speaker tasks. Participant C responded to 2 out of 4 operants correctly on the first trial for speaker tasks and 3 out of 4 operants correctly on the first trial for listener tasks after receiving instructional demonstrations with no direct consequences. Participant L responded to 2 out of 4 operants correctly on the first trial for speaker tasks and 4 out of 4 operants correctly on the first trial for listener tasks after receiving instructional demonstrations with no direct consequences. Participants D and O responded to 3 out of 4 operants correctly on the first trial for listener tasks after receiving instructional demonstrations with no direct consequences, while Participant V responded to 4 out of 4 operants correctly on the first trial for listener tasks after receiving instructional demonstrations with no direct consequences. Participants D, O, and V, all of whom had UniN in repertoire but lacked BiN, did not respond correctly to any speaker trials after receiving instructional demonstrations (see Figure 10).

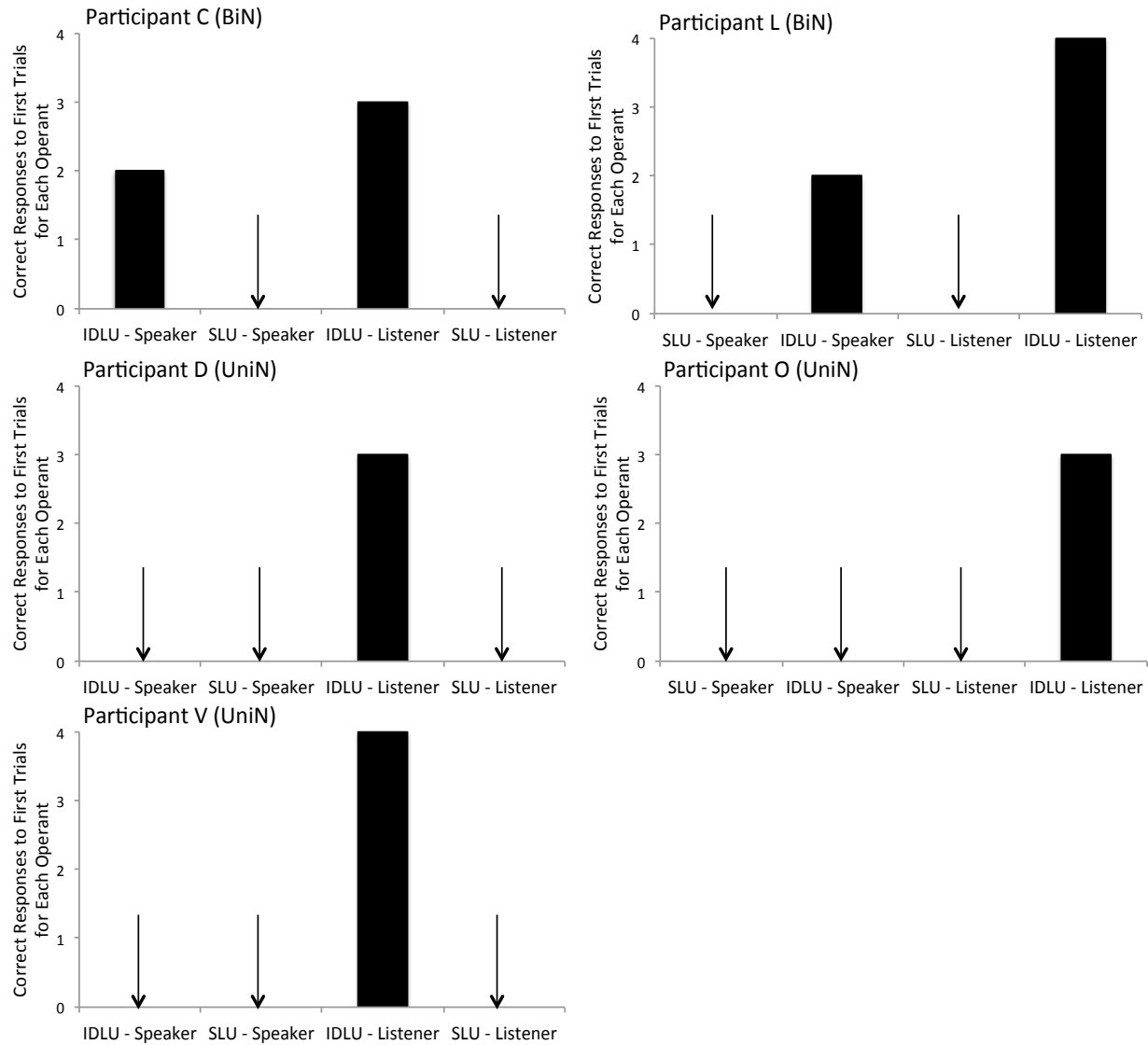


Figure 10. Number of correct responses to first trials when no instructional demonstrations were provided (SLU instruction) as compared to when instructional demonstrations were provided (IDLU instruction) across both listener (point-to) and speaker (tact) instruction.

During BiN probe sessions, experimenters recorded the number of correct point-to (listener), tact (speaker), and intraverbal (speaker) responses to familiar stimuli and unfamiliar stimuli sets (See Figure 11). For the novel set of cartoon stimuli, Participant C emitted 10 correct point-to responses, 9 correct intraverbal responses, and 8 correct tact responses; for the familiar set, he emitted 10 correct point-to responses, 10 correct intraverbal responses, and 9 correct tacts.

Participant L emitted 10 correct point-to responses, intraverbal responses, and tact responses for both the familiar set of stimuli and the novel set of cartoon stimuli. For the novel set of cartoon stimuli, Participant D emitted 8 correct point-to responses, 1 correct intraverbal response, and 0 tact responses; for the familiar set, he emitted 8 correct point-to responses, 2 correct intraverbal responses, and 3 correct tacts. Participant O emitted 8 correct point-to responses, 0 correct intraverbal responses, and 0 correct tact responses for the novel set of cartoon stimuli; for the familiar set, he emitted 8 correct point-to responses, 1 correct intraverbal response, and 0 correct tacts. Participant V emitted 8 correct point-to responses, 4 correct intraverbal responses, and 3 correct tact responses for the novel set of cartoon stimuli; for the familiar set, he emitted 8 correct point-to responses, 3 correct intraverbal responses, and 3 correct tacts.

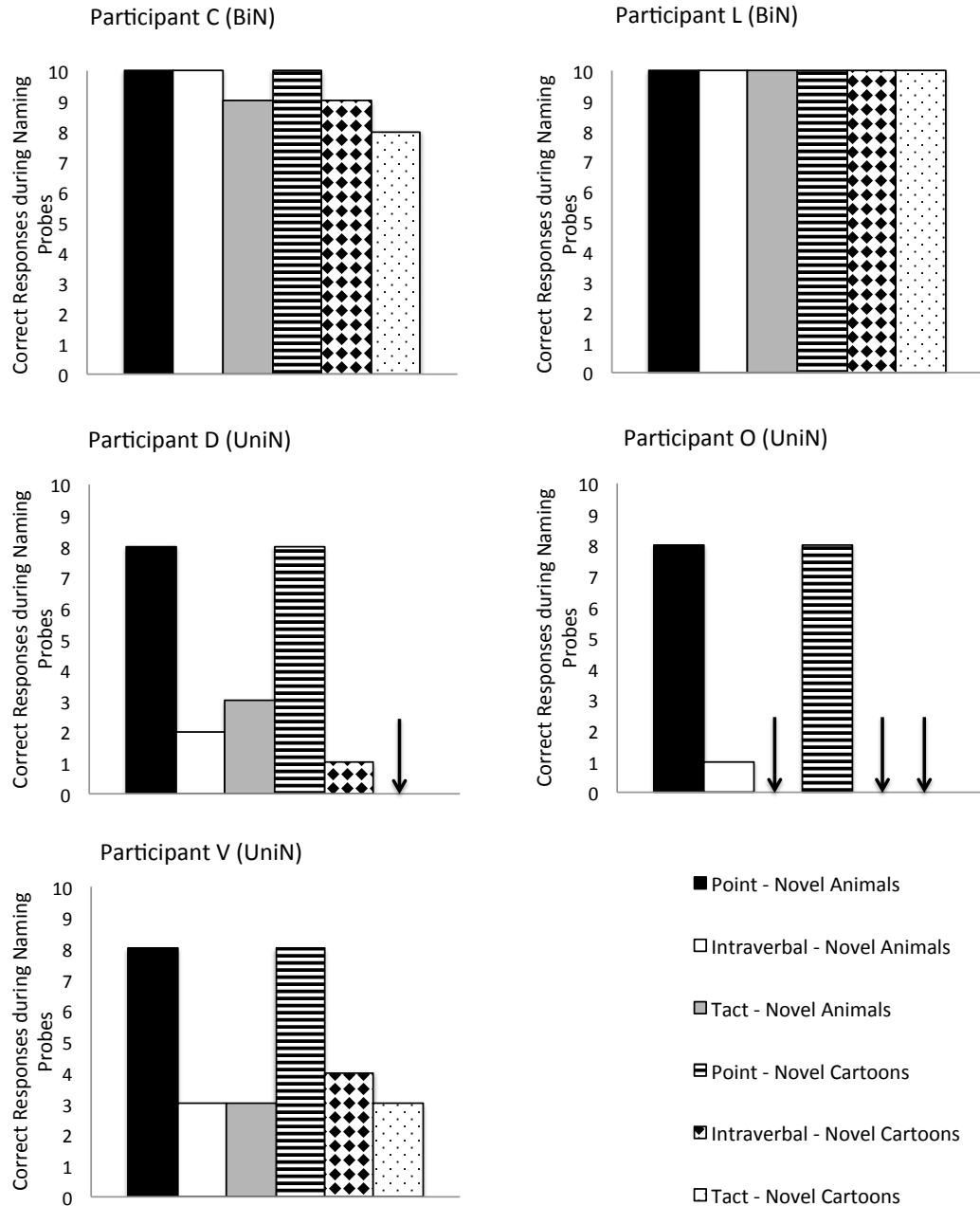


Figure 11. Correct responses during BiN probes for all participants in Experiment II. BiN probes were conducted prior to the measure of the dependent variable in order to categorize participants as having either BiN or UniN in repertoire. These data indicate the number of correct point-to, intraverbal, and tact responses to both novel animal stimuli and novel cartoon stimuli two hours after match-to-sample naming experiences. Criterion for BiN is 80% correct responses across all response topographies (listener and speaker), while criterion for UniN is 80% correct responses for point-to (listener) tasks.

Results for each participant's correct responses to 20 learn unit sessions under both SLU and IDLU conditions for speaker and listener tasks are presented in Figure 12. The sequence of objectives was counterbalanced across groups such that those with BiN in repertoire (Participants C and L) were presented Sets 1, 2, 3, and 4 simultaneously albeit in a counterbalanced manner regarding the type of learn units used (i.e., SLUs or IDLUs). The sequence was counterbalanced across those with UniN in repertoire (Participants D, O, and V) as well (see Figure 12).

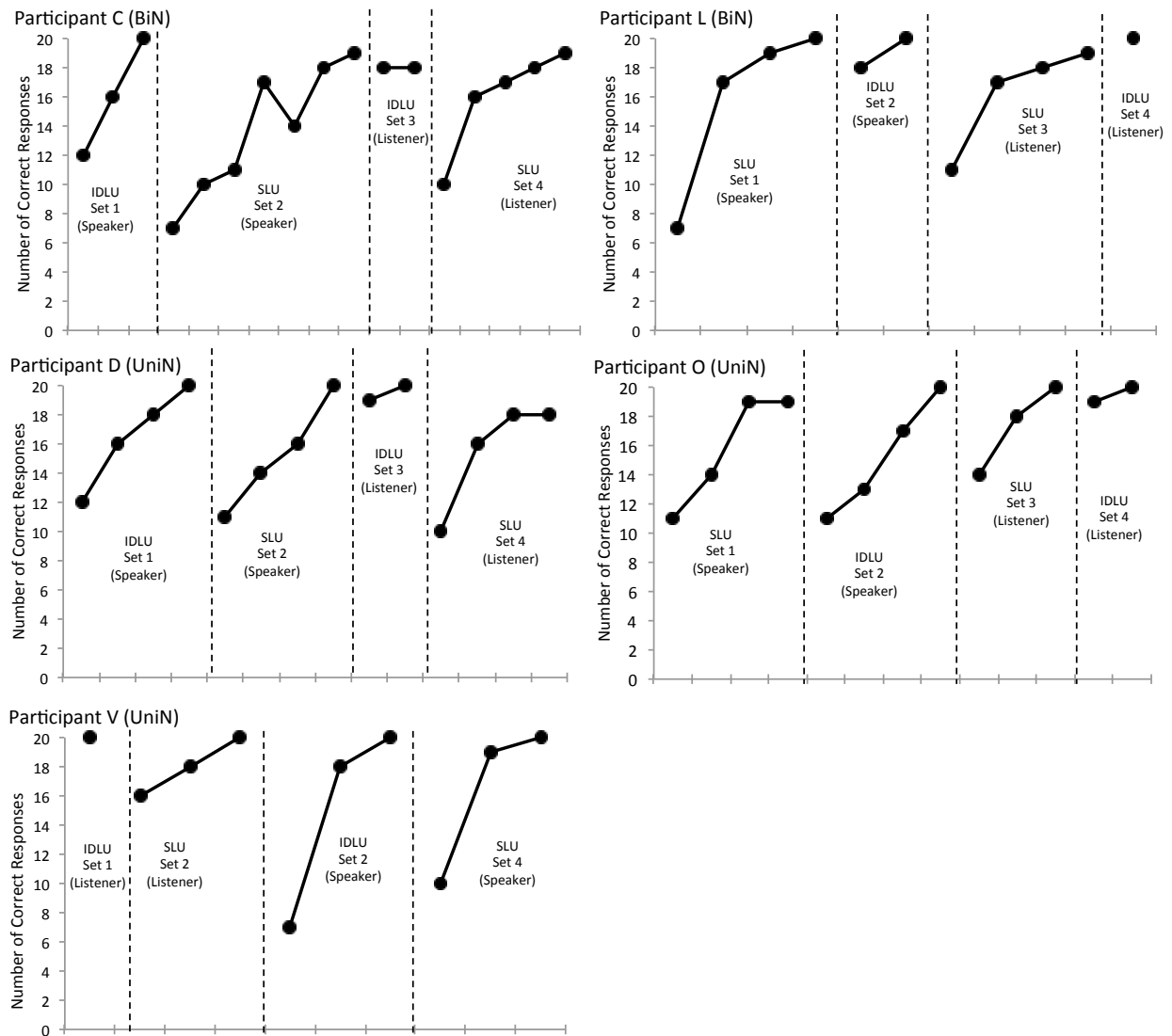


Figure 12. The number of correct responses to point-to (listener) and tact (speaker) learn units across each session of SLU and IDLU instruction.

Discussion

The data in the current study indicate the efficacy of using IDLU presentations across speaker and listener tasks for students with different components of BiN in repertoire. Following the BiN probes, participants were paired according to the presence of the BiN capability. For instance, Group 1 (Participants C and L) possessed full BiN and Group 2 (Participants D, O, and V) possessed the listener component of BiN.

As was indicated in Experiment I and in previous studies (Corwin, 2011; Greer et al., 2011; Hranchuk et al., in press), participants who possessed BiN learned at a significantly faster rate when provided IDLU instruction across both speaker and listener tasks. For instance, in one speaker task, Participant C required 60 learn units to meet criterion in the IDLU condition and required 140 within the SLU condition. Participant L indicated a similar trend in a listener task wherein he met criterion within only one session with IDLU presentations yet required 80 learn units to meet criterion given SLU instruction. Additionally, a cumulative record of correct responses across sessions for participants with BiN in repertoire (Participants C and L) indicates that both participants learned at a significantly accelerated rate when provided an instructional demonstration prior to learn unit instruction for both listener and speaker tasks.

Participants D, O, and V, all of whom had UniN in repertoire but did not possess full BiN repertoires, benefitted from IDLU presentations for listener tasks but not for speaker tasks. As is displayed in Figure 10, the cumulative rate of correct responding for these participants in speaker tasks across both IDLU and SLU conditions indicated a similar trend. However, for the listener tasks, the cumulative rate of correct responding was accelerated in the IDLU condition as opposed to the SLU condition. While the discrepancies in the rate of learning across IDLU and SLU conditions for listener tasks were not as striking for participants with only UniN as they

were for participants with BiN repertoires, this finding has important implications for how we design instruction for students with varying components of BiN. While previous studies indicated the efficacy of IDLU presentations for students with BiN in repertoire, perhaps instructors could utilize IDLU instruction for listener tasks with students who have UniN in repertoire until BiN is established in order to accelerate instruction in the classroom setting.

It was also observed that participants often responded correctly in the first presentation of each operant during IDLU conditions across speaker and listener tasks (for participants with BiN) or listener tasks only (for participants with only UniN in repertoire), thereby indicating that the participants could learn new operants merely by observing a model (See Figure 11). As only novel operants were introduced for learning tasks, this result differs from SLU conditions wherein students emitted a higher number of incorrect responses in the beginning of each lesson and required at least one learn unit of instruction for each operant in a given set in order to reliably emit correct responses in the future. Learn units were necessary since participants did not know the stimuli; since all stimuli were novel, any correct responses to first trials during SLU instruction would have been by chance.

As students progress to kindergarten, and more specifically to general education classrooms (with larger student-to-teacher ratios), it is critical for them to have the capability to learn through observation of teacher models or demonstrations. Going forward, participants' teachers should implement interventions to establish BiN for all students who lack the capability.

There were some limitations in the experiment that should be addressed. First, while the findings shed light on the differences in IDLU and SLU presentations across speaker and listener tasks, only contrived (i.e., unfamiliar) stimuli were used to assess the effect of BiN level on demonstration of learning via a model. As is often the case in basic scientific research, findings

will be applied to a more realistic setting in the future (i.e., regular classroom curricula across speaker and listener tasks) in order to further substantiate the credibility of using IDLUs to improve teaching efficiency. We could have also increased the number of participants across both BiN and UniN groups. Lastly, perhaps including participants without BiN or UniN (i.e., those who did not respond with 80% correct responding during point-to, intraverbal, or tact MEI BiN probes) would have further reiterated the importance of acquiring the capability to learn efficiently; however, if such participants were included, careful consideration would need to be taken in order to match pairs of participants across all other verbal behavior measures other than level of BiN in repertoire to control for confounding variables.

Rationale for Experiment III

Based on findings in both Experiment I and Experiment II, it is evident that the verbal behavior repertoires of preschool-aged students vary greatly; as such, this variability implies that students do not all benefit from the same type of instruction. These findings can- and should- be used to guide teachers' curricular development for students, with the ultimate aim being the acquisition of BiN repertoires for all students. However, it is not known whether BiN is related to measures of basic concept proficiency. The *Boehm Test of Basic Concepts 3rd Edition – Preschool Version* (BTBC3-P) identifies gaps in language concepts to guide instruction. Bancroft (2017) identified that on average, after controlling for age, students with BiN in repertoire performed better than those without BiN on the BTBC3-P; however, BiN data were categorical and did not identify whether the continuum of Naming scores were correlated with BTBC3-P score percentiles. Since the “80% correct responding” criteria were used by Bancroft (2017) in assessing whether students possessed or did not possess BiN in repertoire, there remains a need in the research to identify whether a Naming continuum exists that takes into

account that students who do not meet criterion for either UniN or BiN on traditional Naming probes may still indicate some level of proficiency on tests of basic concepts that is related to their “level” of Naming in repertoire.

Primary Research Question for Experiment III

1. Is a preschool student’s BiN repertoire correlated with scores on standardized measures of basic concepts (namely, the BTBC3-P); that is, does a BiN “continuum” exist that is related to proficiency on standardized measures of basic concepts?

Chapter IV

EXPERIMENT III

Method

Participants

The participants in this study were 42 preschool students ($n=42$; $n_{\text{males}}=34$; $n_{\text{females}}=8$) recruited from CABAS® classrooms at the same school described in Experiments I and II. 31% of participants ($n=13$) attended school in an inclusion classroom with 12 students, 1 teacher, and 2 teaching assistants, while 69% of participants ($n=29$) attended school in a self-contained classroom with 8 students, 1 teacher, and 2 teaching assistants. Participants ranged in age from 36 months to 64 months ($M_{\text{age}}=48.69$ months, $SD=8.27$ months). Of the participants, 37 had IEPs and 5 did not have an educational classification/diagnosis. Table 9 provides a further description of the participants.

Table 9

Description of Participants

<i>Variable</i>	<i>N</i>	<i>Percent</i>
Gender	M = 34 F = 8	M = 94.7% F = 5.3%
Age (Years. Months)	3.0-3.5 = 12 3.6-3.11 = 5 4.0-4.5 = 14 4.6-4.11 = 5 5.0-5.5 = 6	3.0-3.5 = 28.6% 3.6-3.11 = 11.9% 4.0-4.5 = 33.3% 4.6-4.11 = 11.9% 5.0-5.5 = 14.3%
Educational Classification/Diagnosis	Autism = 8 PWD = 29 None = 5	Autism = 19.0% PWD = 69.1% None = 11.9%
English Language Learner	10	24%

Note. An educational classification of Autism was determined by parent report; all other students with IEPs were classified as PWD. “PWD” stands for Preschooler with a Disability (refer to Tables 1 and 5 for a definition of PWD). Students with the status of English Language Learner were those whose parents’ primary language spoken in the home was not English.

Procedure

Participants were recruited through convenience sampling from CABAS® classrooms located in a publicly funded private ABA preschool for students with and without developmental delays. All classrooms employed the CABAS® method, which involves a data-driven school-wide approach to education based on the application of behavior analysis to schooling (Greer, 1998). Informed consent was obtained from parents and legal guardians of all potential participants. Naming experiences, BiN probes, and BTBC3-P assessments were conducted either at a table in the hallway directly outside of the classroom or in a nearby office so as to minimize distraction for each participant.

Measures

Boehm Test of Basic Concepts 3rd Edition – Preschool Version. The BTBC3-P is an “individually administered standardized assessment of preschool children’s knowledge of basic relational concepts” (Bancroft, 2017, p. 47). Typically, the administration of the BTBC3-P requires approximately 20-30 minutes. For a given child, the assessment evaluates 26 basic concepts commonly used in preschool curricula, each of which is tested twice to determine whether a concept is absent (score=0), emerging (score=1), or mastered (score=2).

Scores on the BTBC3-P are tallied and reported in terms of percent correct, performance range (according to age group), and percentile ranking (according to age group). Performance range allows for students’ scores to be assessed as falling under one of three categories: upper third, middle third, and lower third (Boehm, 2001). According to Boehm (2001), this ranking system is helpful for examining standardization data in larger units and for both parents and teachers to understand a child’s performance in comparison to other children his or her age. A performance range of 1 means the child performed with proficiency of most basic concepts compared to age-level peers. A performance range of 2 means the child performed with proficiency of many basic concepts, but may lack understanding of some key concepts compared to age-level peers. A performance range of 3 means the child performed with extremely low proficiency of basic concepts when compared to age-level peers.

Percentile norms corresponding to BTBC3-P raw scores across age bands can be found in the BTBC3-P Examiner’s Manual (Boehm, 2001, p. 61-62). The standardization sample for the English version of the BTBC3-P consisted of 660 children between the ages of 3.0 and 5.11 (Boehm, 2001). Concepts assessed in the BTBC3-P are defined as falling under one of four categories: Space, Quantity, Time, or Other (See Appendix C; Boehm, 2001). Children between

the ages of 3.0-3.11 are assessed for their responses to the first 26 tasks, while children between the ages of 4.0-5.11 are assessed for their responses to the last 26 tasks within the assessment. The content included in the BTBC3-P is based off of an “extensive review of preschool curricula” (Bancroft, 2017; Boehm, 2001). Appendix C also provides sample pages from the BTBC3-P Experimenter’s Manual and data collection sheet (Boehm, 2001).

Bidirectional Naming Probes. BiN probes were conducted in the same manner as Experiment II across both familiar and unfamiliar stimuli, with the only difference being the omission of a tact response measure. For the purpose of Experiment III, only point-to (listener) and intraverbal (speaker) responses were assessed two hours following match-to-sample instruction of the novel sets of stimuli. Table 10 lists the stimuli used during BiN probes. Participants were randomly assigned to two different groups in order to determine the sets of stimuli used to assess the presence of BiN. An independent samples t-test was conducted to determine that there was no statistically significant difference in responding across the two groups in terms of overall number of correct responses during BiN probes ($p = .969$), overall number of correct responses to familiar stimuli during BiN probes ($p = .532$), and overall number of correct responses to unfamiliar stimuli during BiN probes ($p = .623$). Refer to Appendix A for visual samples of slides that were presented during naming experience sessions and BiN probe trials.

Table 10

Stimuli used during BiN probes

Type of Stimuli	Group 1		Group 2	
	Familiar	Unfamiliar	Familiar	Unfamiliar
	Beagle	Beth	Basil	Lam
	Collie	Haj	Fig	Mek
	Husky	Ox	Guinep	Qop
	Maltese	Tet	Guava	Sade
	Poodle	Yod	Quince	Wem

Note. All stimuli were presented via PowerPoint slides on a computer. During match to sample instruction, participants were asked to point to the target stimulus (which visually matched the model) in a field of three. Unfamiliar stimuli were symbols found in the Phoenician alphabet that were assigned random one-syllable names.

Interobserver Agreement

BiN and BTBC3-P sessions with IOA were conducted by both the experimenter and a trained observer. Trained observers were provided instruction on how to conduct naming experience, BiN probe, and BTBC3-P sessions via modeling, vocal consequences, and TPRA's (Ross et al., 2005). During naming experiences, BiN probes, and BTBC3-P assessment sessions, IOA was calculated by dividing the number of trials with agreement between the experimenter and a trained observer by the number of agreed plus disagreed items and multiplying by 100%. Percent of agreement is reported in terms of point-to-point agreement across participant responses for both the experimenter and the trained observer. Since target student behaviors were clearly identifiable (i.e., pointing to 2D images on a computer screen or test booklet and emitting vocal tacts with point-to-point correspondence to a teacher model), percentage of IOA across all sessions remained high throughout the experiment.

Table 11 displays percentage of sessions with IOA, mean percentage of agreement, and range of IOA across Groups 1 and 2. Across all participants, IOA was calculated for 26% of whole BTBC3-P assessments with 100% agreement. During BiN probes for familiar stimuli, IOA was calculated for 71% of whole assessments (including both naming experiences and point-to/intraverbal probe trials) with 99% agreement (range = 95-100%). During BiN probes for unfamiliar stimuli, IOA was calculated for 52% of whole assessments (including both naming experiences and point-to/intraverbal probe trials) with 100% agreement.

Table 11

Percentage of sessions with IOA, mean percentage of agreement, and range in percentage of agreement across groups for all BiN and BTBC3-P assessment sessions

	Group 1			Group 2		
	Familiar BiN Probes	Unfamiliar BiN Probes	BTBC3-P	Familiar BiN Probes	Unfamiliar BiN Probes	BTBC3-P
% of sessions with IOA	78%	63%	30%	87%	60%	20%
Mean % of agreement	100%	100%	100%	99%	100%	100%
Range % of agreement	n/a	n/a	n/a	95-100%	n/a	n/a

Results

The primary research question assessed whether there was a correlation between overall degree of BiN (i.e., percentage of correct point-to and intraverbal responses to previously novel stimuli) and BTBC3-P percentile ranking. Pearson correlation coefficients were computed and results demonstrated that there was a significant positive correlation between overall degree of BiN and BTBC3-P percentile ranking, $p(42) = .341$, $p = .027$. A further Pearson correlation

analysis demonstrated a significant positive correlation between percentage of correct BiN responses for familiar stimuli (but not unfamiliar stimuli) and BTBC3-P percentile ranking, $p(42) = .373, p = .015$. A significant positive correlation was also demonstrated between percentage of correct point-to (listener) UniN responses and BTBC3-P percentile ranking, $p(42) = .352, p = .022$.

When controlling for student age, the correlation between overall degree of BiN and BTBC-3 percentile ranking was strengthened, $r(39) = .406, p < .01$. Also when controlling for student age, significant positive correlations were demonstrated between BTBC3-P percentile ranking and (1) percentage of correct BiN responses for familiar stimuli ($r(39) = .460, p < .01$), (2) percentage of correct BiN responses for unfamiliar stimuli ($r(39) = .313, p = .047$), (3) percentage of correct point-to (listener) UniN responses for both familiar and unfamiliar stimuli ($r(39) = .387, p = .013$), and (4) percentage of correct intraverbal responses for both familiar and unfamiliar stimuli ($r(39) = .374, p = .016$). Without controlling for age, Pearson correlation results between BTBC3-P percentile ranking and (1) BiN responses for unfamiliar stimuli and (2) intraverbal BiN responses were not significant at the .05 level.

Analyses were conducted to assess whether gender, educational classification/diagnosis, and/or English language learner status were significant predictors of performance on the BTBC3-P. An independent samples t-test was conducted to determine that there was no statistically significant difference in responding during the BTBC3-P across gender ($p = .168$) or English language learner status ($p = .411$). There was a statistically significant difference between participants grouped in terms of educational classification/diagnosis (Autism, PWD, or none) as determined by one-way ANOVA ($F(2, 39) = 9.618, p < .01$). A Tukey post hoc test revealed that there was no statistically significant difference in BTBC3-P percentile ranking between

Autism and PWD groups ($p = .218$). A second one-way ANOVA was conducted to determine that there was no statistically significant difference between participants' educational classification/diagnosis and performance on BiN probes ($F(2, 39) = 2.305$, $p = .113$).

Analyses were also conducted to test whether BTBC3-P responses to certain types of basic relational concepts (space, quantity, time, and other) were related to types of relational frame responses (coordination, opposition, comparison, spatial, and distinction). Appendix C provides a table listing all of the basic relational concepts assessed in the BTBC3-P according to Boehm (2001) as well as the proposed relational frame that is actually assessed in a given BTBC3-P test trial (See Tables C1 and C2). Figure 13 displays participants' percentage of correct responding to types of BTBC3-P concepts as categorized by Boehm (2001), while Figure 14 displays participants' percentage of correct responding to types of BTBC3-P concepts as categorized by type of relational frame. Mean percentage of correct responding to types of BTBC3-P concepts as categorized by Boehm (2001) ranged from 63%-77% while mean percentage of correct responding to types of BTBC3-P concepts as categorized by proposed type of relational frame ranged from 40%-93% (See Figures 14 and 15).

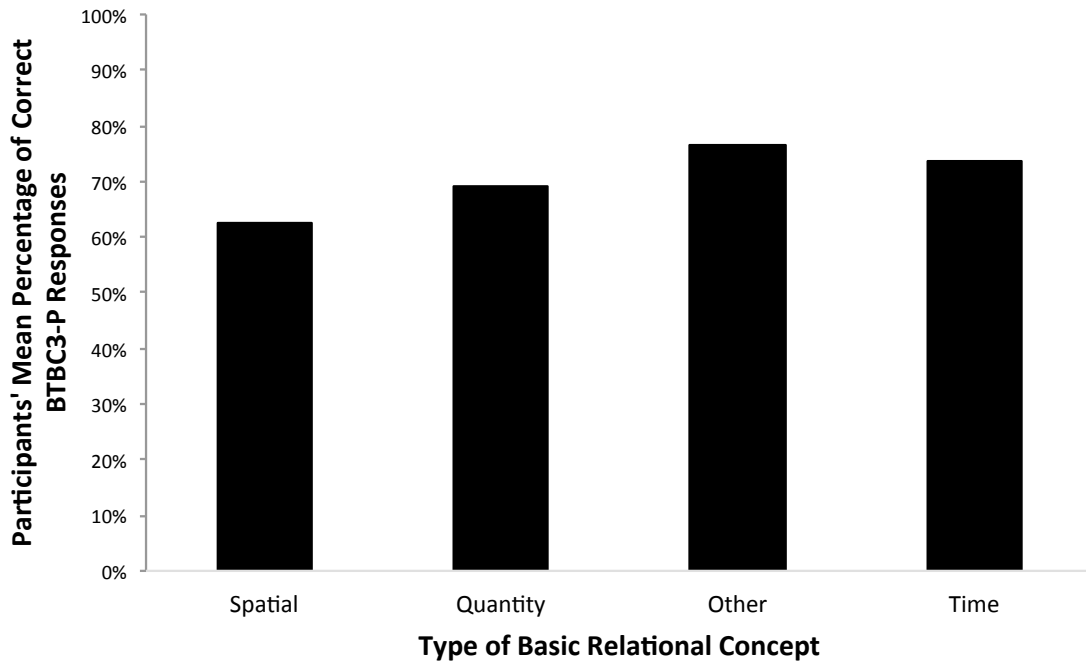


Figure 13. The mean percentage of correct responses across participants to basic relational concepts during BTBC3-P test trials, as categorized by type of basic concept measured (Boehm, 2001)

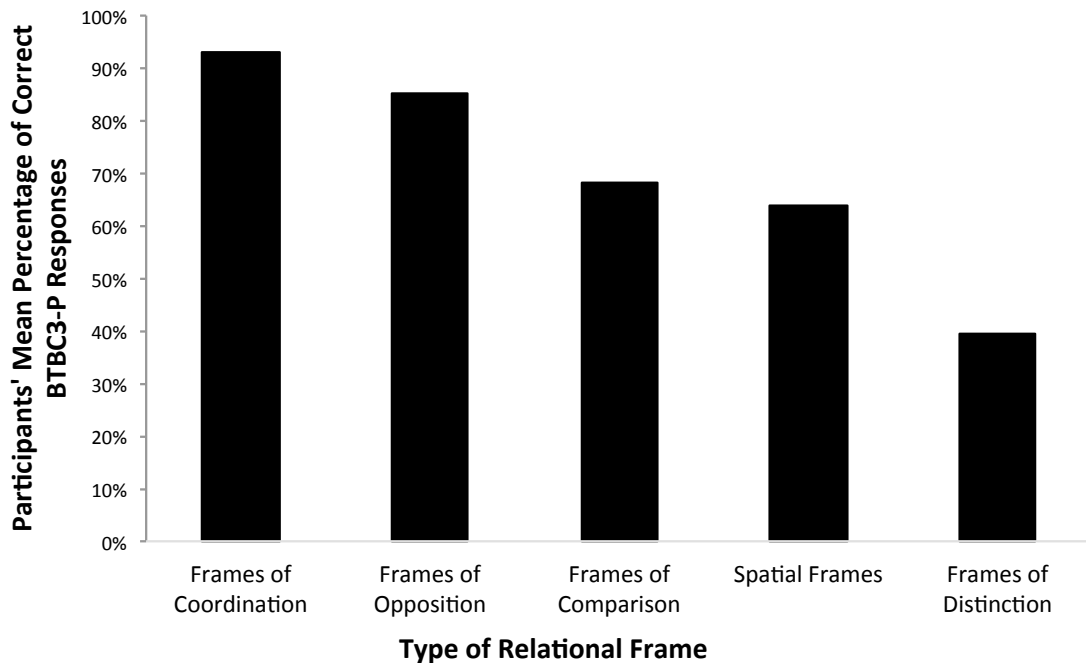


Figure 14. The mean percentage of correct responses across participants to basic relational concepts during BTBC3-P test trials, as categorized by proposed type of relational frame measured

Discussion

Results of the present experiment mirror those of Bancroft (2017), indicating that the establishment of higher-order verbal behavior developmental cusps is a significant predictor of students' demonstration of basic concept knowledge. Regardless of educational classification (i.e., PWD or ASD vs. no diagnosis), Bancroft (2017) found that BiN was a significant predictor of students' number of concepts reliably demonstrated in the BTBC3-P. The present study added to these findings by utilizing BiN as a continuous variable (rather than a categorical variable), allowing for correlational analyses between each student's percentage of correct responses during BiN probes (i.e., "degree" of BiN) and BTBC3-P percentile ranking.

Without controlling for confounds, statistically significant correlations ($p < .05$) were found between BTBC3-P percentile ranking and (1) overall degree of BiN, (2) percentage of correct listener and speaker responses to familiar stimuli during BiN probes, and (3) percentage of correct listener responses to both familiar and unfamiliar stimuli during BiN probes. These results support findings of several previous studies that demonstrate listener responses to new words as being a prerequisite for independent speaker behavior (Greer et al., 2005; Lo, 2016). Similarly, many prior studies have indicated that new words for familiar stimuli (e.g., animals, foods, familiar people, cartoon characters, and toys) are often acquired prior to unfamiliar/contrived stimuli such as letters and symbols (Greer & Han, 2015; Lo, 2016; Kleinert, 2018). Overall, results indicate that BiN is significantly correlated with performance on a widely used measure of preschool language performance (BTBC3-P). While the present results cannot determine whether the establishment of BiN is a precursor for students' improvement in their demonstration of basic concept knowledge or vice-versa, several previous studies have demonstrated that the establishment of BiN is functionally related to the onset of incidental word

learning (Greer et al., 2005; Fiorile et al., 2007; Greer et al., 2007; Greer & Longano, 2010; Gilic & Greer, 2011; Greer et al., 2011).

Exposure to a greater number of words and experiences across a variety of environments is critical for ensuring the development of an expanded vocabulary, both as a listener and a speaker (Colombo, 1982; Hart & Risley, 1995; Ingram, 1989; Mayberry & Lock, 2003; Mayberry, Lock, & Kazmi, 2002). When controlling for age, significant positive correlations ($p < .05$) were demonstrated between BTBC3-P percentile ranking and percentage of correct BiN responses for both familiar and unfamiliar stimuli; further, significant positive correlations ($p < .05$) were demonstrated between BTBC3-P percentile ranking and percentage of correct listener and speaker BiN responses.

While Boehm (2001) categorized responses in the BTBC3-P as assessing a student's understanding of spatial, quantity, time, and other types of basic relational concepts, it is of note that selection (i.e., listener) and production (i.e., speaker) responses are both necessary for assessing a student's true verbal capability (Greer et al., 2007; Greer & Keohane, 2005; Horne & Lowe, 1996; Lodhi & Greer, 1989). Since the BTBC3-P is comprised solely of selection (listener) responses to antecedents, analysts of verbal behavior are left wondering whether a critical component of a student's verbal repertoire is omitted by this assessment. Further, certain responses simply require a student to match two identical visual stimuli ("this is an apple; now point to *another* one) and some require a student to identify the one visual stimulus that is different from the others ("point to the clown who is *missing* a hat," when presented with three clowns who are wearing hats and one clown who is not). These two responses can be categorized as measuring frames of coordination and frames of opposition, respectively. Other BTBC3-P trials assess frames of comparison, which require a greater verbal repertoire and instructional

history of the comparative nature of the given trial (“point to the *smallest* fish,” when presented with four fish of varying sizes), while some assess spatial frames that require a greater verbal repertoire as well (“point to the cat that is on *top* of the car,” when presented with a car and four cats in various positions on the page). The most complex trials assess frames of distinction, which require complex verbal behavior and involve responding to one stimulus in terms of its lack of coordination with the others (“point to the jar that has *some, but not many* bugs,” when presented with four jars that hold varying numbers of bugs). In the future, research should address ways in which concepts presented in the BTBC3-P could be assessed for speaker responses, thereby assessing a more complete verbal repertoire of any given child.

It is critical to consider limitations of the present study. As is true with any study, a larger sample size would be more indicative of responding across a larger population of students. Further, since the present study was conducted in an ABA preschool, it is possible that participants were more accustomed to participating in assessments similar to the BTBC3-P and BiN probes. While the school provides an ideal, objective environment for instruction on a day-to-day basis for the students who attend, replicating the study in a greater variety of school and classroom settings would allow for greater generalizability. We also did not take into account socioeconomic status (SES) as a confounding demographic variable. Prior research has indicated that SES is correlated with rate of language development, as students from high-SES households are exposed to a greater number and variety of words (Hart & Risley, 1995); however, in Bancroft’s (2017) study on the BTBC3-P and verbal behavior development, results did not indicate a significant correlation between BTBC3-P performance and SES. Finally, the present study lacked a gold standard formal diagnosis of any given disability. Since all students from the preschool in which the study took place come from homes in a variety of school districts, IEP

information across participants was not always comparable (i.e., a variety of diagnostic tests and assessments were used across participants to determine a potential diagnosis). Because of this, an educational classification/diagnosis of Autism was determined by parent report; otherwise, students with IEPs were classified as PWD (preschooler with a disability). Standardization of educational classification/diagnosis would allow for a greater number of analyses of BTBC3-P and BiN responses as they are correlated with diagnostic status.

These findings add to the body of literature supporting the importance of BiN for language acquisition and academic success in the classroom. Preschool students are expected to fluently respond appropriately to classroom instructions that require an understanding of the locations, characteristics, order, and other attributes communicated via basic concept terms such as *both*, *another*, and *before* (Boehm, 2001). As children progress into kindergarten, they are expected to engage in problem-solving activities, test instructions, and other behaviors that require identifying increasingly difficult concepts and terms both receptively and expressively (Boehm, 2001). The reliable demonstration of novel words as both a listener and speaker becomes increasingly important for academic success in both the classroom and on standardized assessments of academic skills as children progress through kindergarten and beyond; however, it is likely that word learning becomes increasingly difficult with age. Research on the acquisition of a second language indicates that a “critical period” exists for which learning a new language is easier for children when they are young (approximately until the age of 5 years old) and becomes more difficult as children get older (Colombo, 1982; Ingram, 1989; Mayberry et al., 2002; Mayberry & Lock, 2003). Thus, it is critical that preschool students who do not reliably demonstrate adequate BiN repertoires participate in curricular interventions and strategies to establish the capability as soon as possible (Greer & Keohane, 2005; Greer & Ross, 2008).

Chapter V

GENERAL DISCUSSION

Relevant Literature

Major Findings of Experiments I and II

Results of the present study suggest that BiN is an essential prerequisite for learning academic skills via observation. Upon the establishment of BiN, students may learn in a new way (by observing teacher models) in the absence of direct learn unit contingencies; further, students with UniN may learn by observing teacher models for listener tasks in the absence of direct learn unit contingencies. This is likely due to embedded reinforcement within the teacher model for students with BiN (and, for listener responses, students with UniN). Within the realm of VBDT, this is comparable to the concepts underlying generalized imitation (Du & Greer, 2014) and observational learning (Greer, Dudek-Singer, & Gautreaux, 2006). When in repertoire, generalized imitation allows for children to mimic the actions of others across large- and small-motor movements in the absence of direct instruction; similarly, observational learning allows for children to (1) mimic the performance of others, (2) acquire new operants via observation, and (3) acquire new reinforcers via observation. Direct teacher-presented learn unit contingencies are not necessarily evident in each of these instances, yet students with generalized imitation and observational learning in repertoire consistently demonstrate the acquisition of new operants, actions, and reinforcers via observation. Principles of behavior maintain that reinforcement must therefore be embedded within teacher-presented models (Skinner, 1953) and that teacher models select out observing responses when necessary cusps are present. It is

possible that the reinforcer for learning via IDLU instruction is the production of a response that corresponds with what was observed.

In Experiment I, all participants learned math and reading objectives at an accelerated rate following the establishment of BiN. Additionally, all participants learned even faster via IDLU instruction following the establishment of BiN as compared to SLU instruction. While three of the four participants learned at relatively similar rates across the two instructional methods prior to the establishment of BiN, discrepancies were more evident in post-intervention measures of IDLU/SLU instructional sessions. These findings support prior research by Corwin (2011), who identified that participants without BiN in repertoire learned faster via IDLU instruction following the establishment of BiN. With the added assessment of learning via SLU instruction, Hrachuk et al. (in press) identified that students with BiN learned at an accelerated rate via IDLU instruction as compared to SLU instruction. The results of Experiment I indicate a functional relation between the establishment of BiN and accelerated learning via instructional teacher models as compared to SLU instruction in the absence of teacher modeling, indicating that the establishment of BiN is critical for students to acquire new operants in the absence of direct instruction.

The aim of Experiment II was to identify whether full BiN repertoires are necessary for learning via IDLU instruction to occur, or whether students with only the listener component of BiN in repertoire (i.e., UniN) can learn listener responses to novel stimuli via IDLU instruction. Results of Experiment II indicate the efficacy of using IDLU instruction across speaker and/or listener tasks for students with different components of BiN in repertoire. Participants with full BiN repertoires learned novel contrived (i.e., unfamiliar) symbols at an accelerated rate via IDLU instruction across both listener (point-to) and speaker (tact) tasks. Notably, participants

with UniN in repertoire learned the same novel contrived symbols at an accelerated rate via IDLU instruction for listener tasks; however, participants with UniN in repertoire learned speaker tasks at the same rate across IDLU and SLU conditions. These findings have important implications for how teachers should design instruction for students with unique verbal behavior repertoires. To promote efficient instruction, teachers should provide IDLU instruction at all times for students with BiN, and during listener tasks for students with UniN. It is critical for students to learn through the observation of teacher models in a general education setting; therefore, interventions to establish full BiN repertoires should be imposed for students with UniN in order to further expedite instruction across both listener and speaker tasks in the classroom setting.

By displaying accelerated learning via IDLU instruction for students with BiN in repertoire, Experiments I and II provide further evidence of the sources of reinforcement for BiN. Most commonly, VBDT theorists propose the echoic as the initial source of reinforcement for BiN (Greer & Longano, 2010; Horne & Lowe, 1996). Children who do not encounter conditioning opportunities for echoing words in the home or school setting may not acquire BiN incidentally. Hart and Risley (1996) noted that children from homes that were language-impooverished (i.e., homes in which few words were spoken or in which words lacked variety) did not acquire language as quickly or achieve as much educational success as children from language-rich homes (i.e., homes in which a variety of words were spoken at a high rate). It is proposed that children from language-rich homes flourish in an educational setting due to the high frequency with which reinforcement conditioning opportunities occur for the emission of verbal behavior. Similarly, many children with developmental delays may not benefit from naturally occurring language experiences if they lack reinforcement for observing the behavior of

other people in the environment. Across all children who do not acquire conditioned reinforcement for emitting words naturally, language experiences must occur in a contrived setting to establish BiN in order for incidental word learning to occur.

Major Findings of Experiment III

Results of Experiment III mirrored the findings of Bancroft (2017), indicating a statistically significant correlation between degree of BiN in repertoire and BTBC3-P percentile ranking. The present study added to Bancroft's (2017) findings by utilizing BiN as a continuous variable (rather than a categorical variable), allowing for more accurate correlational analyses between percentage of correct responses during BiN probes (i.e., "degree" of BiN) and BTBC3-P percentile ranking. Results of the present study also indicated significant correlations between BTBC3-P percentile ranking and percentage of correct (1) listener (point-to) responses during BiN probes, and (2) responses to familiar stimuli during BiN probes. Gender and English language learner status were not significant predictors of performance on the BTBC3-P. Differences between performance on the BTBC3-P and educational classification/diagnosis (i.e., Autism, PWD, or none) were statistically significant; however, the same cannot be said for differences between educational classification/diagnosis and performance on BiN probes. These data support the notion that verbal behavior developmental repertoires are more significant predictors of performance on age-appropriate measures of basic concept proficiency than educational classification/diagnosis or other demographic variables alone (Bancroft, 2017).

In Experiment III, degree of BiN was significantly correlated with BTBC3-P performance regardless of age, gender, educational classification/diagnosis, or English language learner status. Using BiN as a categorical variable, Bancroft (2017) also found that BiN was more highly correlated with BTBC3-P performance than diagnostic status. The addition of BiN

as a continuous variable in the present study further emphasizes how important it is for educators to attend to the individualized nature of each child's verbal behavior repertoire. A student's repertoire of verbal behavior cusps and capabilities informs both the skills that should be taught and the most effective way to teach them (Corwin, 2011; Greer et al., 2011; Greer & Longano, 2010; Greer & Ross, 2008; Hranchuk et al., in press).

Results of Experiment III indicate significant correlations between degree of BiN and BTBC3-P percentile ranking; however, since the BTBC3-P only measures listener responses, I propose that categorizing the basic relational concepts in terms of the type of relational frame that is assessed is more telling of a student's current verbal repertoire. In a given test trial, the BTBC3-P prompts the assessor to display an image and ask the student to "point to" a target stimulus (as an example, refer to Appendix C, Figure C1). Boehm (2001) proposes that analyzing student responses in terms of trends in responding to spatial, quantity, time, and "other" concepts should drive the type of curricula that are presented to a given student. However, results of the present study indicate relatively stable rates of correct responding to Boehm's (2001) categories of basic concepts (See Figure 13). When categorized by proposed type of relational frame assessed, responding is in alignment with RFT theorists (Barnes-Holmes et al., 2004), indicating that certain types of responses are more basic than others. For example, frames of coordination (which assess a student's identification of identical/similar stimuli) are acquired before more complex frames like frames of distinction, which require complex verbal behavior and prior experience with the terms that are presented (Hughes & Barnes-Holmes, 2016). Figure 14 displays participants' mean percentage of correct responses to basic relational concepts as categorized by proposed type of relational frame measured. These data indicate trends that are in alignment with prior RFT research (Hughes & Barnes-Holmes, 2016) and

suggest that the BTBC3-P determines more of a student's overall verbal capability than his or her "knowledge" (i.e., reliable demonstration) of spatial, quantity, time, and "other" basic relational concepts. While RFT theorists propose a hierarchy of frames, there is a limited amount of research on the ordinal nature of RFT frame families in terms of level of difficulty (Hughes & Barnes-Holmes, 2016). Results of the present study add to the body of literature in support of word learning via frames of relation in given contexts.

Educational Implications

Results of Experiment I indicate that BiN is necessary for learning via observation at an accelerated rate. In Experiment II, it became evident that students with UniN in repertoire can learn listener tasks via observation at an accelerated rate compared to SLU instruction. The type of instruction presented by teachers should be determined by the capabilities of their students; therefore, instruction must be individualized for every student. CABAS® classrooms utilize a variety of assessments such as the VBDA-R® (Greer, 2010) and C-PIRK® (Greer, 2014) in addition to constant data collection and analysis of data in order to determine best-fit curricular objectives for each student. Present findings should be considered when training new teachers in order to ensure that IDLUs are used to instruct students with BiN across all curricular objectives and students with UniN across all listener objectives in order to accelerate learning.

IDLUs are not beneficial for students who do not yet have UniN or BiN in repertoire (Greer et al., 2011), and direct consequences in the form of SLUs are necessary across all listener and speaker objectives until the capability is established. For students who do not acquire BiN incidentally, protocols should be implemented as soon as all prerequisite cusps and capabilities are attained (including conditioned reinforcement for observing voices and faces, conditioned reinforcement for two- and three-dimensional stimuli, capacity for sameness across the senses,

generalized motor imitation, listener literacy, echoic-to-mand/echoic-to-tact, and observational learning) in order to improve students' educational prognoses (Greer & Ross, 2008).

Results of Experiment III add to the body of literature supporting the importance of BiN for language acquisition and academic success. Results of Experiment III indicate a significant correlation between degree of BiN and performance on the BTBC3-P, a standardized assessment of basic relational concept proficiency (Boehm, 2001). Basic relational concept instruction for preschool and young elementary-age students is linked not only to gains in performance related directly to basic relational concepts, but also to improvement on standardized achievement tests (Armour-Thomas, 1984). Basic concepts are part of the directions included in major intelligence tests used during early childhood education and preschool (Bracken, 1987; Cummings & Nelson, 1980; Flanagan, Alfonso, Kaminer, & Rader, 1995; Kaufman, 1978). The body of VBDT research indicates that BiN is a necessary capability for acquiring new words as both a listener and a speaker in the absence of direct instruction; therefore, BiN is a critical prerequisite for basic concept proficiency (Greer & Longano, 2010). To improve educational outcomes, children who do not acquire BiN independently should participate in interventions and strategies such as MEI or ITI to establish the capability as soon as all prerequisite cusps are attained (Greer & Keohane, 2005; Greer & Ross, 2008).

Limitations

One limitation across both Experiments I and II is the sample size. In Experiment I the study was limited to two dyads for a total of four participants, while Experiment II included five participants. Ideally, more participants would have been recruited for the study in order to test the reliability of results. Another limitation of Experiment I was the omission of a second pre-intervention BiN probe for Dyad 1. If multiple pre-intervention probes had been conducted, it

would have been possible to assess whether improvements made by Participant K and P on BiN assessments were already occurring as a result of maturation.

In Experiment I, IDLU/SLU math and reading objectives were not uniform across participants. This may be considered a limitation as differences between objectives could have potentially influenced the rate at which they were mastered. However, a uniform set of objectives would have been problematic since each participant had a unique learning history with math and reading skills. As was noted by Hranchuk (2016), academic objectives can “never truly be uniform if children enter into the learning environment with their own individual histories that affect their performance” (p. 91).

Another limitation of Experiment I was the discrepancy in rate of responding across math and reading objectives prior to the establishment of BiN, particularly for Participant H. During the second set of IDLU/SLU reversal conditions prior to the establishment of BiN, Participant H required a mean of 110 more SLUs and 70 more IDLUs to acquire objectives than he did during the first set of IDLU/SLU reversal conditions (See Figure 3). This indicates that the second set of math and reading objectives was likely more advanced for him than the first, which may have skewed the mean number of SLUs and IDLUs required for him to meet criterion during pre-intervention IDLU/SLU sessions. Nevertheless, Participant H displayed a significantly faster rate of learning via IDLUs and SLUs after BiN was established.

One limitation of Experiment II was the omission of students who did not have BiN or UniN in repertoire. Perhaps including participants without BiN or UniN (but with all necessary prerequisites for BiN in repertoire) would have further reiterated the importance of acquiring the capability to learn efficiently via teacher models. Further, only contrived (i.e., unfamiliar) stimuli were used during Experiment II to assess the effect of BiN level (BiN or UniN) on rate of

learning via IDLUs. Some may argue that the inclusion of academic objectives that mimic more realistic classroom curricula across speaker and listener tasks may have further substantiated the credibility of using IDLUs to improve teaching efficiency for certain objectives. However, perhaps the use of unfamiliar stimuli was critical for testing the reinforcement value of learning new listener and speaker responses to stimuli that looked completely unlike anything participants had encountered in the past. Advanced mathematics, for example, involves the identification of many new symbols that are entirely unfamiliar.

As is true with any study, a larger sample size for Experiment III would have been more indicative of responding across a larger population of students. Participants were also recruited from an ABA preschool, and while the school provides an ideal environment with individualized curricular objectives based on constant data analysis, replicating the study in a greater variety of school and classroom settings would allow for results to be applicable to a larger population of students. Lastly, limitations included the omission of SES as a confounding demographic variable and a lack of a gold standard formal diagnosis for any given disability. Many studies, including that which was conducted by Hart and Risley (1995), have acknowledged the impact of SES on language exposure; however, Bancroft's (2017) study on the BTBC3-P and verbal behavior development did not indicate a significant correlation between BTBC3-P performance and SES. Finally, for the purpose of the present study, educational classification/diagnosis of Autism was determined by parent report because all students at the school in which the study took place came from homes in a variety of school districts with IEPs that were not always comparable.

Future Research

It has been noted that BiN results in an “exponential expansion” of language, including the emission of many more words in both social and isolated settings (Greer & Longano, 2010, p.75). In addition to learning new tasks via observation, participants in Experiment I gained many social benefits following the establishment of BiN. Prior research has noted that the establishment of BiN results in increased independent language usage in non-instructional settings such as the free-play area, playground, or lunch table amongst peers (Nirgudkar, 2005). The addition of verbal operant probes across non-instructional settings to future research on BiN and IDLU instruction would further emphasize BiN as a critical capability for both academic and social proficiency.

Results of Experiment II highlight the critical nature of UniN (the listener component of BiN) for acquiring new listener behaviors incidentally. For the purpose of the present study, unfamiliar (i.e., contrived) stimuli were taught across listener and speaker objectives for Experiment II in order to test whether degree of BiN in repertoire (BiN or UniN) was a predictor of learning via IDLU instruction. Future research should aim to apply these findings to more typical curricular instruction such as math, reading, and writing objectives. Participants in Experiment II were also limited to students with UniN and students with BiN in repertoire. The inclusion of students without UniN or BiN in repertoire, but with all necessary prerequisites, would further emphasize whether the listener and/or speaker components of BiN are necessary for the acquisition of certain listener and/or speaker tasks via observation.

For Experiment III, the BTBC3-P was used as a standardized assessment of basic concept performance. The BTBC3-P is comprised solely of listener responses; however, as was made evident in Experiment II, both the listener and speaker components of BiN are required for

students to acquire new language most efficiently. In the future, a speaker component of basic concept proficiency should be added to further inform teachers and parents of their students' verbal capabilities. Findings of Experiment III also suggest a link between degree of BiN and performance on measures of RFT hierarchical frames, which should be analyzed to a further extent in future studies.

Conclusion

The goal of this study was to contribute to the body of literature on incidental language acquisition and basic relational concepts for preschool students. Findings support previous studies on BiN and its significance for allowing children to learn via observation, and add to the literature the critical nature of UniN in learning listener tasks via observation. Utilizing BiN as a continuous variable in Experiment III allowed for the analysis of potential correlations between BiN and basic concept performance on the BTBC3-P. Across all three experiments, it is evident that the establishment of BiN for young children is critical for social and academic success at school. Teachers and parents should attend to the verbal behavior capabilities of their students and plan both curricular objectives and method of instruction in alignment with students' unique repertoires. Finally, in order to improve the social and academic prognoses of preschool students who do not reliably demonstrate adequate language learning, educators should work to establish BiN as soon as possible.

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Appendix A

BiN Naming Experiences and Probe Trials

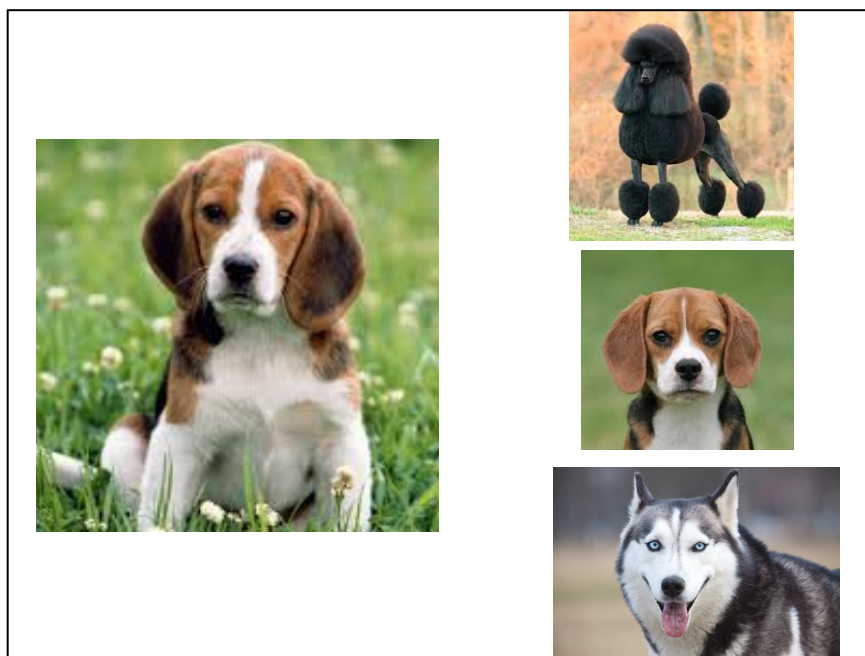


Figure A1. A sample of a slide displayed during a BiN match-to-sample naming experience. For the given naming experience, the experimenter pointed to the image of the beagle on the left and said “this is a beagle.” Then, the student was asked to “match ‘beagle’ with ‘beagle.’” The student was reinforced with praise/playful physical contact and a correct BiN match to sample response was recorded with a plus (+) if the student pointed to both “beagle” exemplars or if he/she pointed to the target “beagle” exemplar in the right-hand column.



Figure A2. A sample of a BiN probe trial for a point-to response. For the given probe trial, the experimenter asked the student to “point to the beagle.” If the student pointed to the target stimulus within 3s, a plus (+) was recorded; if the student emitted an incorrect response or did not respond within 3s, a minus (-) was recorded. No reinforcement or correction was provided during probe trials.

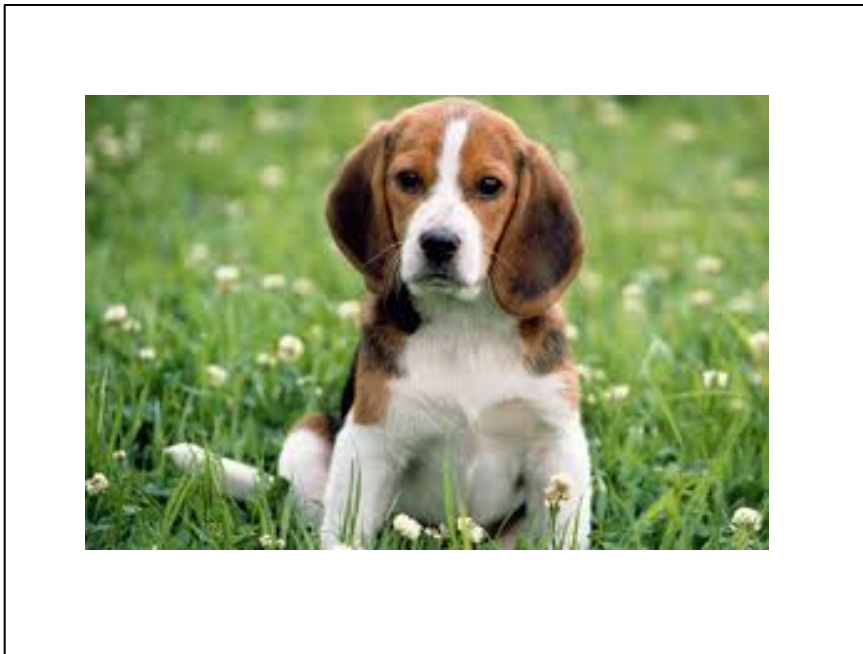


Figure A3. A sample of a BiN probe trial for an intraverbal or tact (speaker) response. For the given probe trial, the experimenter prompted the student to say the name of the stimulus by pointing to the image and (a) saying “what is this?” (for an intraverbal probe trial) or (b) providing no vocal antecedent (for a tact probe trial) If the student said the correct name (“beagle”) or an approximation of the name within 3s, a plus (+) was recorded; if the student emitted an incorrect response or did not respond within 3s, a minus (-) was recorded. No reinforcement or correction was provided during probe trials.

Appendix B

Experiment I Intervention Data

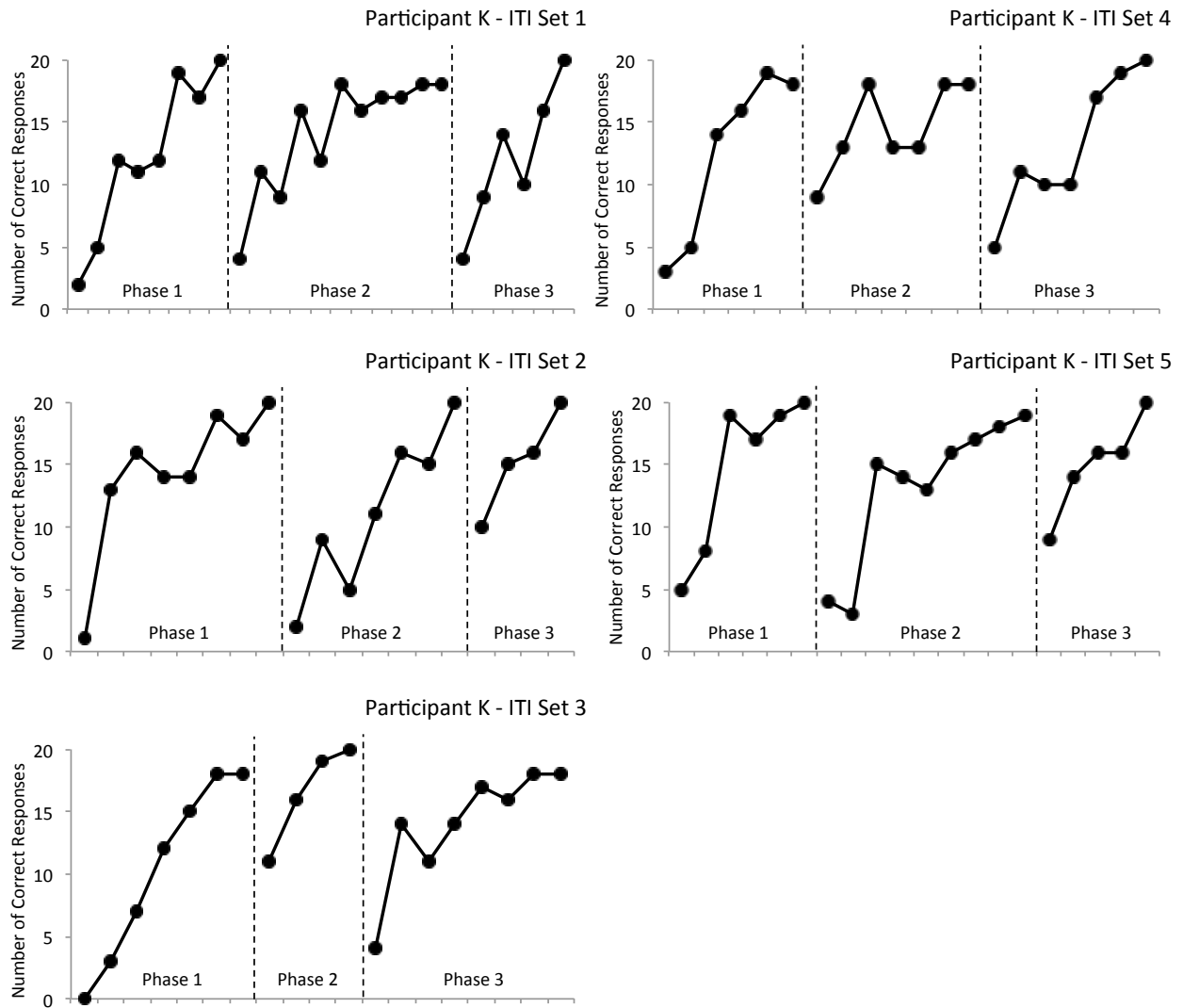


Figure B1. Experiment I ITI intervention data for Participant K, indicating the number of correct tact responses during 20-learn unit instructional sessions.

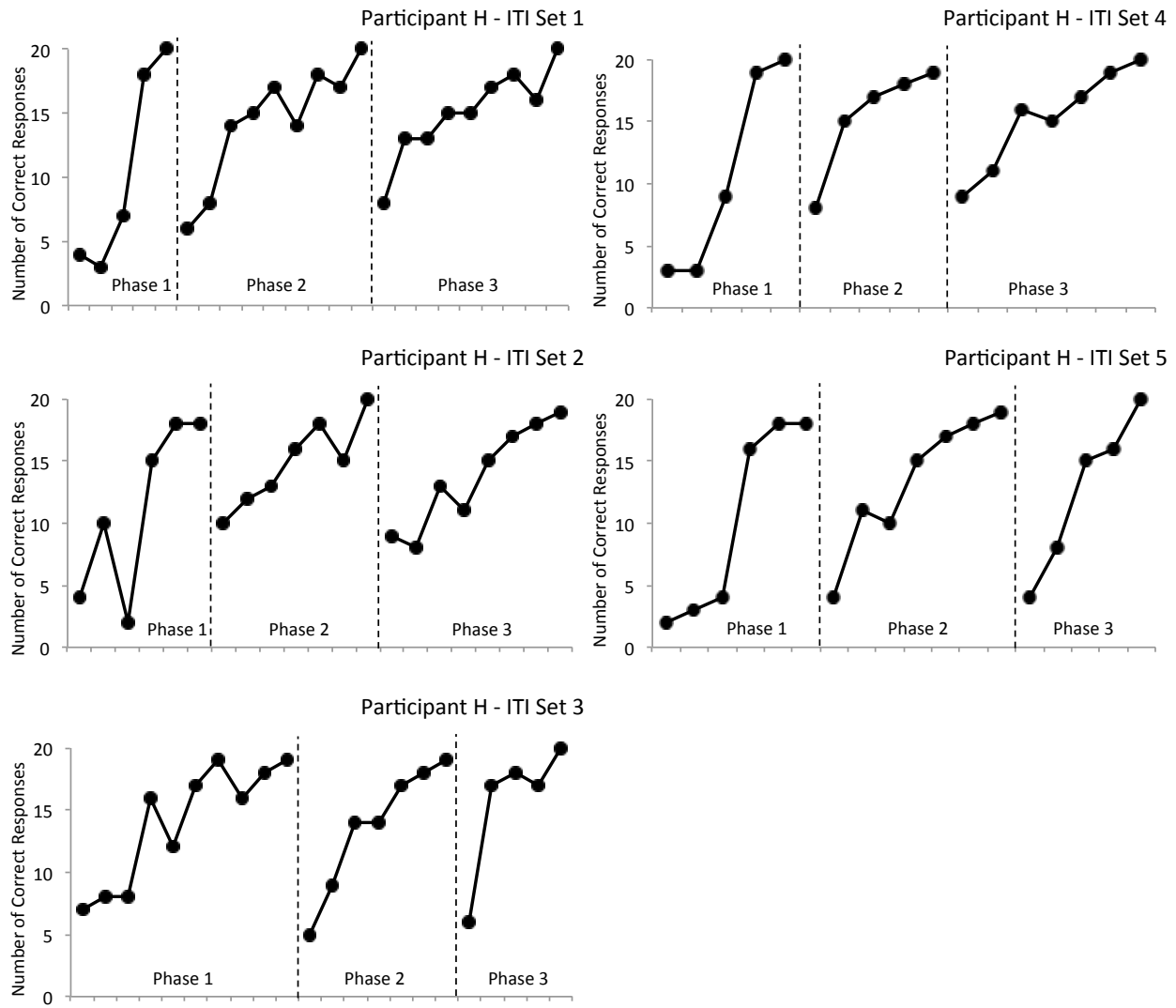


Figure B2. Experiment I ITI intervention data for Participant H, indicating the number of correct tact responses during 20-learn unit instructional sessions.

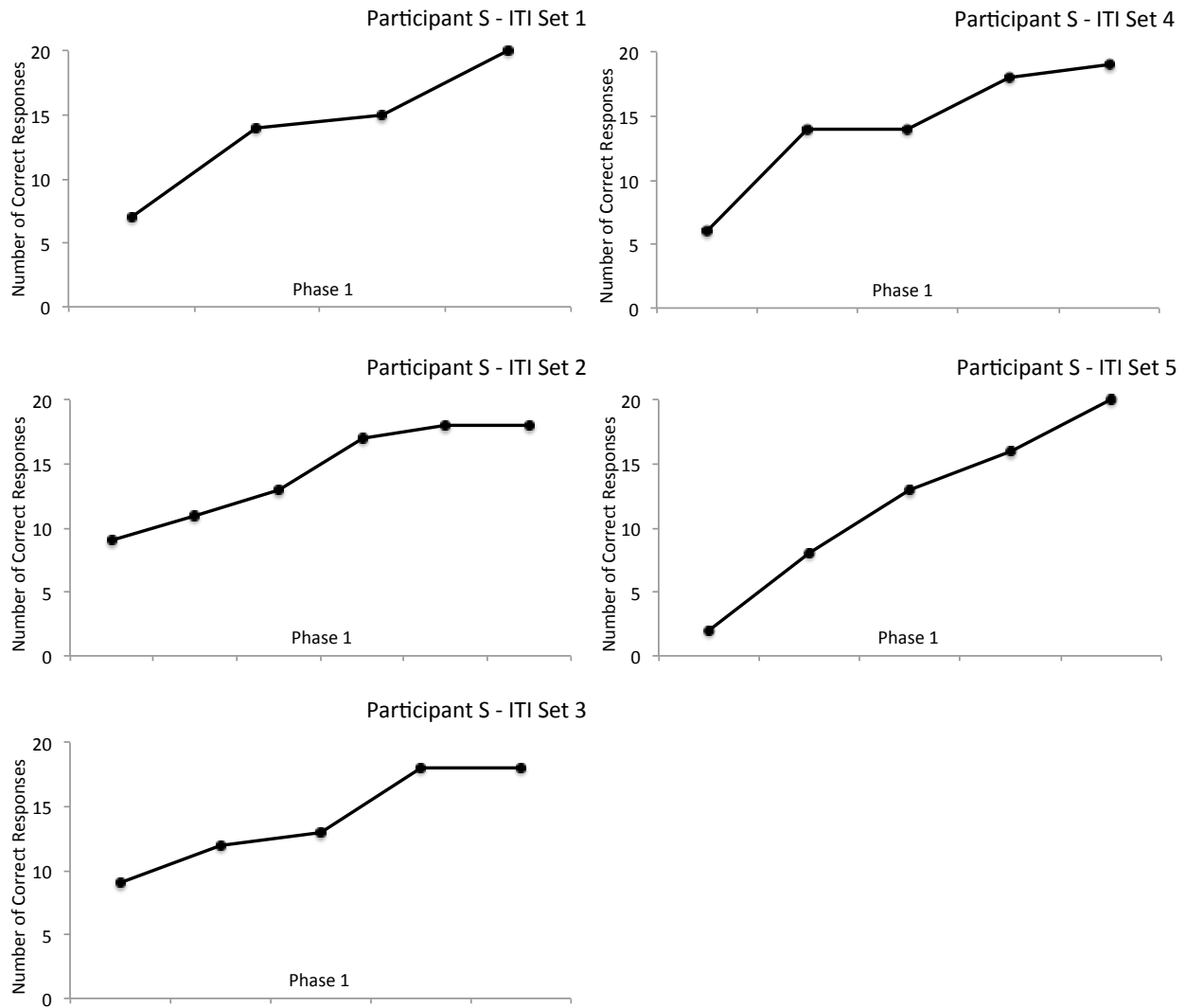


Figure B3. Experiment I ITI intervention data for Participant S, indicating the number of correct tact responses during 20-learn unit instructional sessions.

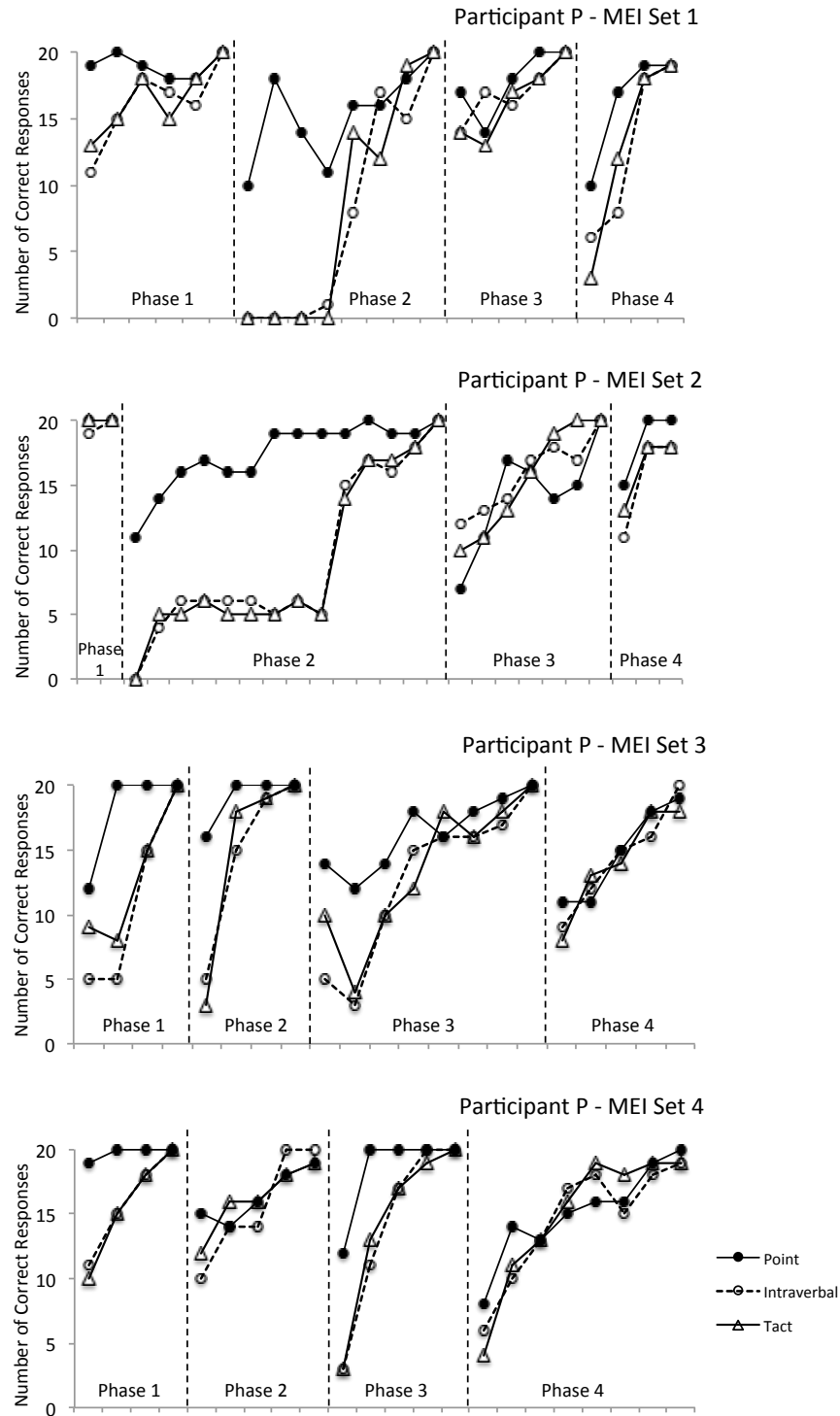


Figure B4. Experiment I MEI intervention data for Participant P, indicating the number of correct tact, intraverbal, and point-to responses during 60-learn unit instructional sessions. In a given session, 20 learn units of each response topography (tact, intraverbal, and point-to) were presented.

Appendix C

BTBC3-P

Table C1

BTBC3-P Concepts Assessed by Category and Age Band (Boehm, 2001)

BTBC3-P Concepts by Category for Ages 3.0-3.11			
Space	Quantity	Time	Other
Top	Empty	Finished	Missing
Down	Full		Another
Under	All		Different
Highest	Smallest		Same
Next	Longest		
Up	Both		
Outside	Tallest		
Nearest	Many		
Across	Most		
In front	Largest		
Around			
BTBC3-P Concepts by Category for Ages 4.0-5.11			
Space	Quantity	Time	Other
Nearest	Smallest	Finished	Different
Across	Longest		Same
In front	Both		
Around	Tallest		
Before	Many		
Farthest	Most		
Lowest	Largest		
Last	Shortest		
Bottom	Some, but not many		
Together	Last		
Middle			
First			
Between			

Table C2

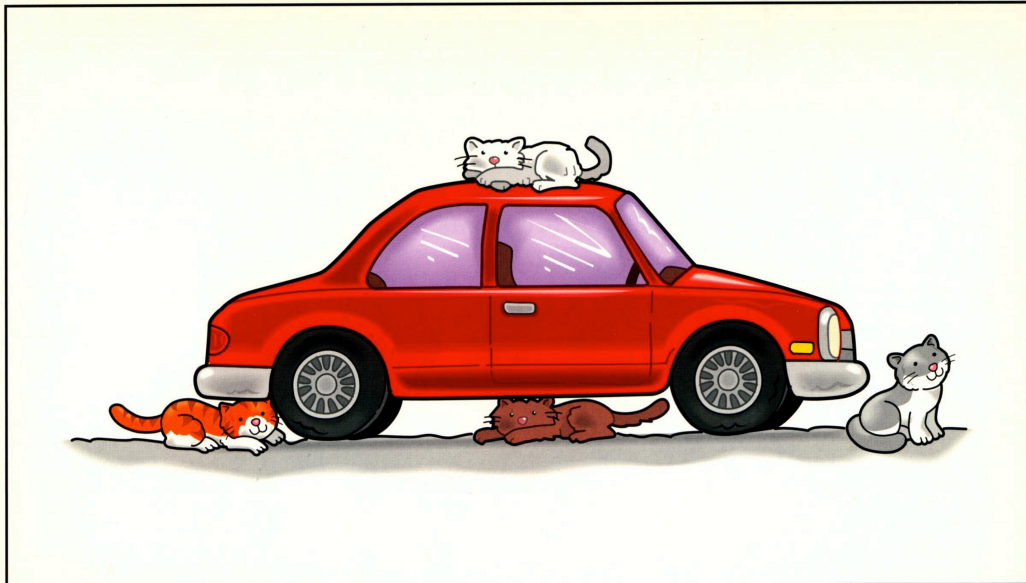
BTBC3-P Concepts Assessed, Basic Relational Concept Categories, and Proposed Types of Relational Frames

	Basic Relational Concept Category	Proposed Type of Relational Frame
Top	Space	Spatial
Down	Space	Opposition
Empty	Quantity	Opposition
Under	Space	Spatial
Highest	Space	Comparison
Missing	Other	Opposition
Next	Space	Spatial
Another	Other	Coordination
Up	Space	Spatial
Full	Quantity	Distinction
Outside	Space	Opposition
All	Quantity	Coordination
Nearest	Space	Comparison
Finished	Time	Opposition
Smallest	Quantity	Comparison
Across	Space	Spatial
Different	Other	Opposition
Longest	Quantity	Comparison
In front	Space	Spatial
Both	Quantity	Coordination
Around	Space	Spatial
Tallest	Quantity	Comparison
Many	Quantity	Distinction
Same	Other	Coordination
Most	Quantity	Comparison
Largest	Quantity	Comparison
Before	Space	Spatial
Farthest	Space	Spatial
Lowest	Space	Spatial
Shortest	Quantity	Comparison
Last	Space	Spatial
Bottom	Space	Spatial
Together	Space	Distinction
Some, but not many	Quantity	Distinction
Middle	Space	Spatial
First	Space	Spatial
Between	Space	Distinction
Least	Quantity	Comparison

1. "Point to the cat that is on *top* of the car."

"Señala el gatito que está en la parte *más alta* del carro".

Ages 3-0 to 3-11 Start Here



1

Figure C1. Sample page from the BTBC3-P experimenter manual (Boehm, 2001). For the given page, the experimenter was prompted to ask the participant to "point to the cat that is on **top** of the car."

Administer Items 1-52 to Ages 3-0 to 3-11				Administer Items 25-76 to Ages 4-0 to 5-11			
Item	Concept	Picture	Score	Item	Concept	Picture	Score
1.	Top Más alta			13.	Top Más alta		
2.	Down Hacia abajo			14.	Down Hacia abajo		
3.	Empty Vacío			15.	Empty Vacío		
4.	Under Debajo			16.	Under Debajo		
5.	Highest El más arriba			17.	Highest El más arriba		
6.	Missing Falta			18.	Missing Falta		
7.	Next Al lado			19.	Next Al lado		
8.	Another Otra			20.	Another Otra		
9.	Up Subiendo			21.	Up Subiendo		
10.	Full Lleno			22.	Full Lleno		
11.	Outside Afuera			23.	Outside Afuera		
12.	All Todos			24.	All Todas		

Figure C2. Sample BTBC3-P data collection sheet (Boehm, 2001). For each page in the experimenter manual, the experimenter was required to record a one (1) if the student responded correctly, a zero (0) if the student responded incorrectly or did not emit a response within 5s, and the letter “A” (for “antonym”) if the student pointed to the opposite of the correct response.