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BRIEF REPORT

The Establishment of Incidental Bidirectional Naming through Multiple Exemplar Instruction: a Systematic Replication

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Abstract

Although many neurotypical children acquire untaught word-object relations incidentally from naturally occurring environmental experiences, many children with and without developmental disabilities require specific intervention. This study examined the effects of rotating listener (match and point) and speaker (tact and intraverbal-tact) responses with added echoics during multiple exemplar instruction (MEI) with training sets of stimuli on the acquisition of Incidental Bidirectional Naming (Inc-BiN). Listener-speaker MEI procedures reported in Hawkins et al. *European Journal of Behavior Analysis, 10*(2), 265–273, (2009) were replicated with procedural modification, new instructors, and new participants (four preschoolers with and without disabilities). The listener-speaker MEI with added echoics consisted of rotating across four response operants: match-with-echoics, point-with-echoics, tact, and intraverbal-tact responses. We measured the establishment of Inc-BiN through the number of the correct untaught listener (point) and untaught speaker (intraverbal-tact) responses for untaught stimuli during the listener-speaker MEI with added echoics. We found that listener-speaker MEI with added echoics was effective in establishing Inc-BiN for 3 of 4 participants.

Keywords Bidirectional naming · Echoics · Multiple exemplar instruction · Unidirectional naming

Bidirectional Naming (BiN) is a verbal developmental cusp that allows children to acquire verbal functions and untaught word-object relations in the absence of direct reinforcement (Greer & Keohane, 2005; Horne & Lowe, 1996; Miguel, 2016; Miguel & Petursdottir, 2009). Horne and Lowe's (1996) initial *naming* theory

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conceptualized that language mediates the development of stimulus classes. They described two ways by which equivalence classes are formed when an individual functions as a *speaker-as-own-listener*: (a) bidirectional relation between listener and speaker behaviors (common BiN) and (b) bidirectional relation between intraverbal or word-pair responses (intraverbal BiN; Miguel, 2016). Many researchers focused on the naming theory in applied settings as it facilitates the establishment of emergent categorization and untrained behaviors (Eikeseth & Smith, 1992; Greer & Ross, 2008; Hawkins et al., 2018; Horne & Lowe, 1996; Jennings & Miguel, 2017; Miguel et al., 2008)

Verbal Behavior Development Theory (VBDT; Greer & Speckman, 2009) has further examined how the stimulus control for BiN develops from experience and the behavioral developmental cusps leading up to the joining of the listener (i.e., hear-do, conditioned reinforcement for observing responses) and speaker (i.e., tacts) repertoires, which makes it possible for children to learn names incidentally (Greer et al., 2020). VBDT refers to this phenomenon as *Incidental Bidirectional Naming* (Inc-BiN; Hawkins et al., 2018). Inc-BiN is a continuum that consists of two components: (a) Incidental Unidirectional Naming (Inc-UiN), or the incidental acquisition of listener responses, and (b) Inc-BiN, or the incidental acquisition of both listener and speaker responses. Following an initial observation of a caregiver naming a stimulus (i.e., "Look, a firetruck"), a child with Inc-UiN will learn to point to the firetruck without instruction while continuing to require instruction to tact "firetruck." A child with Inc-BiN will learn to point and tact a firetruck without direct instruction (Greer et al., 2011). VBDT research has found that (a) the acquisition of multiple conditioned reinforcers for observing responses (i.e., listening to an auditory stimulus and looking at a visual stimulus) along with echoic behaviors allow individuals to contact natural reinforcement (i.e., attention) which are prerequisite skills for learning names (Cahill & Greer, 2014; Cao & Greer, 2018; Longano & Greer, 2015) and (b) the joining of listener-speaker responses allows the incidental learning of names as a listener and a speaker through interactions in the environment (Carnerero & Pérez-González, 2014; Greer et al., 2020; Greer & Longano, 2010). VBDT researchers have further examined ways to establish Inc-BiN, how children can be best taught, and what they can be taught (Greer & Du, 2015; Greer et al., 2011; Hranchuk et al., 2019).

Most neurotypical children acquire Inc-BiN through their interaction with the environment. However, many children with and without developmental delays require intervention to acquire Inc-BiN (Greer et al., 2011), such as listener-speaker multiple exemplar instruction (MEI). Listener-speaker MEI teaches abstraction for multiple responses to novel stimuli and the acquisition of the stimulus control to learn these responses from observational exposure alone. The MEI procedure consists of systematic rotation across the listener (i.e., match and point) and speaker (i.e., tact and intraverbal-tact) responses to a single stimulus to bring independent operants under joint stimulus control (Engelmann & Carnine, 1991; Greer & Ross, 2008; LaFrance & Tarbox, 2020). The listener responses require identity matching and pointing to the visual stimuli (i.e., auditory-visual conditional discrimination) when the target stimuli were presented with two non-targets. Speaker responses require labeling the target stimuli when shown a picture (i.e., tact) and labeling the target stimuli following a question, "What is this?"

(i.e., intraverbal-tact). Researchers have found the listener-speaker MEI procedure to be effective in joining the match, point, tact, and intraverbal-tact responses, which have led to the establishment of Inc-BiN (Greer et al., 2007; Olaff et al., 2017). However, limited research is available on the effects of the variations of listener-speaker MEI other than the study by Hawkins et al. (2009).

Hawkins et al. (2009) tested the effects of a standard listener-speaker MEI and listener-speaker MEI with added echoics on the establishment of Inc-BiN with three participants with autism. The echoic, a verbal response with one-to-one correspondence with the preceding verbal stimulus (Skinner, 1957), was required when participants matched the target stimulus or pointed to the visual stimulus (e.g., saying "Apple" while matching or pointing to the picture of *apple*). Hawkins et al. (2009) found that the standard listener-speaker MEI did not lead to Inc-BiN for two of the three participants, but these two participants demonstrated Inc-BiN following the listener-speaker MEI with added echoics requirement. Thus, the purpose of this study was to replicate the effects of listener-speaker MEI with added echoics on the establishment of Inc-BiN for four preschoolers with and without disabilities. Participants had a history of listener-speaker MEI but did not demonstrate Inc-BiN. Additionally, we conducted multiple assessments prior to listener-speaker MEI to try to control for history and maturation, which were absent from some previous research.

Method

Participants, Setting, and Materials

Four children with speech and language delays served as participants: John (4 years 2 months), Mary (4 years 11 months), Rob (4 years 8 months), and Jane (4 years 7 months). John, Rob, and Jane had educational classifications of a disability; none of the participants had known medical diagnoses. The participants all demonstrated prerequisite skills (Table 1) but did not acquire Inc-BiN with standard listener-speaker MEI.

The study took place in a private preschool for children with and without disabilities. Participants attended the same integrated classroom with 12 students, one headteacher, and two teaching assistants. All sessions took place in the classrooms at the participants' tables during regular instructional hours. Researchers used seven sets of novel stimuli with five characters in each set. The stimuli consisted of two-dimensional, colorful, cartoon characters that had one or two-syllable names (Table 2). Researchers presented the stimuli on a PowerPoint® using an iPad® for Inc-BiN probe sessions and colored pictures printed on laminated white index cards for listener-speaker MEI sessions.

Measurement

Our primary dependent variables were the percentage of untaught point and intraverbal-tact responses during Inc-BiN probe sessions. We defined a correct point response (i.e., auditory-visual conditional discrimination) as pointing to the

Table 1 Description of listener and speaker prerequisite skills

Prerequisite Skills	Description
Conditioned reinforcement for 2D stimuli	Observes and attends to four out of five pages with small 2-dimensional prints for 10 consecutive seconds. Each page consists of 15 to 20 pictures, words, and numbers in black and white or colors (Pereira-Delgado et al., 2009). Observing 2-dimensional prints serves as a conditioned reinforcer.
Generalized Matching	Matches novel identical and non-identical objects or prints with 100% accuracy (Du et al., 2015). Fluent matching repertoire serves as evidence of an observing response occurring as a result of conditioned reinforcement for observing prints and objects.
Echoic Behaviors	Echoes 10+ multi-syllabic words and 10+ six-word phrases with 90% accuracy. Observing responses to the auditory stimuli and the production of an auditory response with one-to-one correspondence serve as conditioned reinforcers.
Advanced Listener Literacy (Hear-Do)	Demonstrates a hear-do, vocal instruction by responding to simple 1-step directions in the presence of a visual distractor with 80% success (Choi et al., 2015). Auditory stimuli serve as conditioned reinforcers.
Independent Mands and Tacts	Demonstrates speaker repertoires. Emits 20+ independent mands and tacts with autoclitics. Social consequences serve as conditioned reinforcers.

The prerequisite skills have been tested using the CABAS® *International Curriculum and Inventory of Repertoires for Children from Preschool through Kindergarten* (C-PIRK; Greer, 2014) and the *Verbal Behavior Development Assessment-Revised* (VBDA-R; Greer, 2010)

targeted visual stimulus. We defined a correct intraverbal-tact response as labeling the presented stimulus following a vocal question, "What is this?" If the participant responded correctly to 80% of the point trials, we considered Inc-UiN criterion met. If the participant responded correctly to 80% of the point trials and 80% of the intraverbal-tact trials, we considered Inc-BiN criteria met.

Table 2 Examples of stimuli

Set	Stimulus 1	Stimulus 2	Stimulus 3	Stimulus 4	Stimulus 5
4	Keke	Zola	Eby	Pete	Creed
					
5	Abu	Marvi	Beeno	Nini	Greg
					

We also measured participant responses during the Naming Experience and listener-speaker MEI with added echoic sessions. During the Naming Experience, we measured the number of observing responses defined as a correct identity-matching response to stimuli presented on a PowerPoint® using an iPad®. During listener-speaker MEI with added echoics sessions, we measured the correct (a) match-with-echoic, (b) point-with-echoic, (c) tact, and (d) intraverbal-tact responses (Hawkins et al., 2009; see Table 3 for operational definitions).

Experimental Design

We used a concurrent multiple probe design (Horner & Baer, 1978) with a simultaneous replication across pairs to test the effects of listener-speaker MEI with added echoics on the establishment of Inc-BiN. We implemented the Naming Experience and the Inc-BiN probe session at the same time with all participants. Then, we conducted two additional probe sessions with John and Mary before introducing intervention. Once they completed the intervention, the researcher conducted a post-intervention Inc-BiN probe with John and Mary and additional pre-intervention Inc-BiN probes with Rob and Jane. Researchers used a novel set of stimuli for each Inc-BiN Probe and each MEI phase except for the second post-MEI probe for Jane (Fig. 1).

Procedure

Naming Experience

The Naming Experience (i.e., match-to-sample instruction in Hawkins et al., 2009) preceded each Inc-BiN probe to expose the participants to novel sets and determine whether exposure to Naming alone would lead to Inc-BiN. The researcher presented a novel set of stimuli for each Naming Experience and Inc-BiN probe session. The researcher and the participant sat across from one another at a table while the researcher presented the Naming Experience using an iPad®. Each slide consisted of the sample stimulus on the upper half of the slide and three comparison stimuli (one correct stimulus and two incorrect stimuli with positions randomized) on the lower half of the slide. Each session consisted of 20 opportunities (five samples with four opportunities per sample stimulus). The researcher named the sample stimulus (i.e., “Look at Zola!”) and instructed the participant to match (i.e., “match Zola”). The participants used their fingers on the iPad® touchscreen to drag the presented stimulus to the identical picture. No model was provided as the participants had a match repertoire using an iPad®. The researcher praised correct responses and provided error correction (see Table 3) after incorrect responses. No programmed consequences were contingent on echoics. The Naming Experience continued until the participant emitted 90% correct matching responses across two consecutive sessions.

Table 3 Operational definitions of operants for listener-speaker MEI with added echoics

Operant	Antecedent	Behavior	Consequence
Match with echoic	Present three stimuli (one target and two non-targets) horizontally on the table. Give an identical target stimulus (e.g., Keke) and say, "match Keke."	The participant will match the given picture by placing it on the identical picture and say "Keke" within 5s of the vocal instruction.	Correct Deliver praise and high-fives Incorrect (1) Repeat "match Keke," (2) Model matches and says "KeKe," (3) Repeat "match Keke," (4) Participant matches and echoes, and (5) no praise
Point with echoic	Present three stimuli (one target and two non-targets) horizontally on the table. Say, "point to Keke."	The participant will point to the target stimulus and say "Keke" within 5s of the vocal instruction.	Correct Deliver praise and high-fives Incorrect (1) Repeat "Point to Keke," (2) Model points to and says "KeKe," (3) Repeat "point to Keke," (4) Participant matches and echoes, and (5) no praise
Tact	Present a target stimulus by placing it on the table No vocal antecedent.	The participant will vocally name the presented stimulus within 5s of the presentation.	Correct Deliver praise and high-fives Incorrect (1) Present the stimulus (2) Model says "KeKe,"(3) present the stimulus, (4) Participant tacts, and (5) no praise
Intraverbal-tact	Present a target stimulus by placing it on the table Say, "What is this?"	The participant will vocally name the presented stimulus within 5s of the vocal question.	Correct Deliver praise and high-fives Incorrect (1) Repeat "What is this?" (2) Model says "KeKe," (3) Repeat "What is this?" (4) Participant responds, and (5) no praise

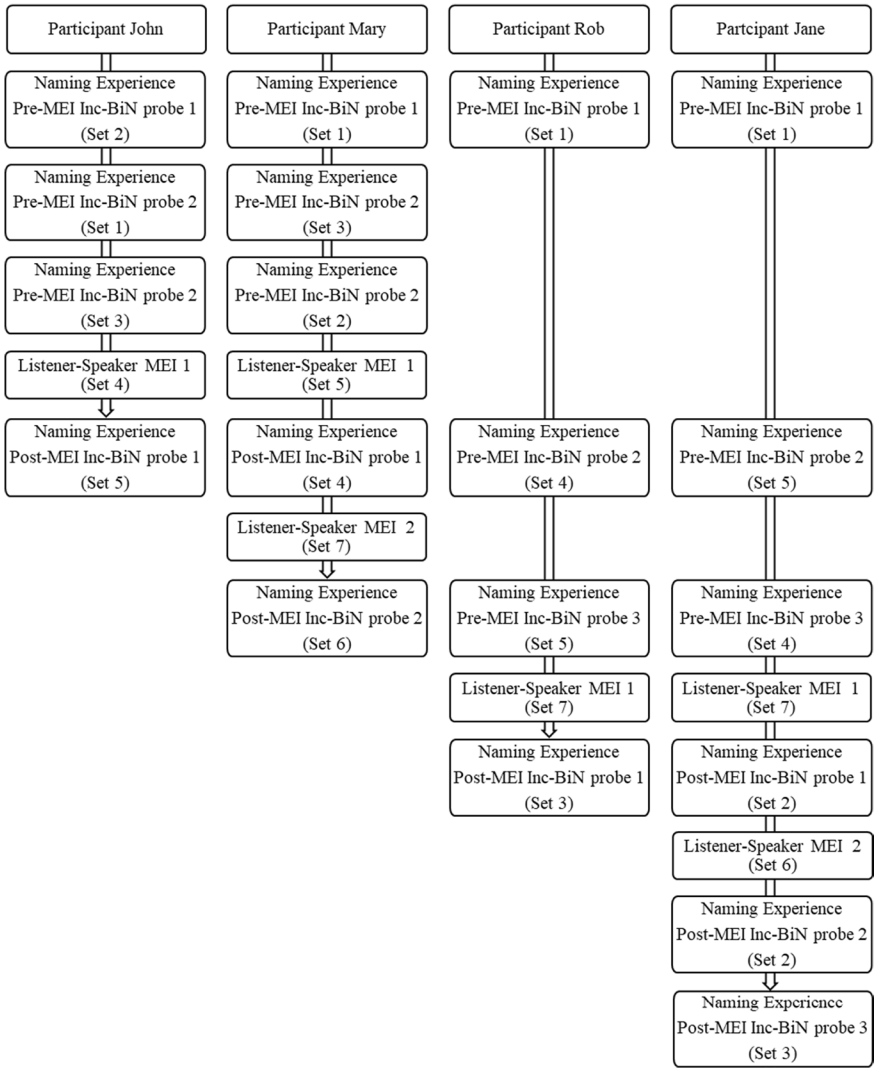


Fig. 1 Sequence of Phases and Stimuli Sets. *Note. Inc-BiN*, incidental Bidirectional-Naming; *MEI*, listener-speaker multiple exemplar instruction with added echoics

Inc-BiN Probe

An Inc-BiN probe was conducted two hours after the Naming Experience was terminated to test for the emergence of untaught point (i.e., listener response) and intraverbal-tact responses (i.e., speaker response). The researcher showed stimuli using an iPad® and conducted 10 consecutive trials per type of response with two nonconsecutive opportunities to respond to each stimulus. The researchers did not provide

Fig. 2 Inc-BiN Probe and Listener-Speaker MEI with Added Echoics Intervention Data. *Note.* The ▶ downward arrow on session 13 depicts 0 untaught speaker response emitted by Jane; *Inc-BiN,* incidental Bidirectional-Naming*; MEI*, listener-speaker multiple exemplar instruction with added echoics

feedback following correct or incorrect responses but provided praise for appropriate participation and attending behaviors.

Listener-Speaker MEI with Added Echoics

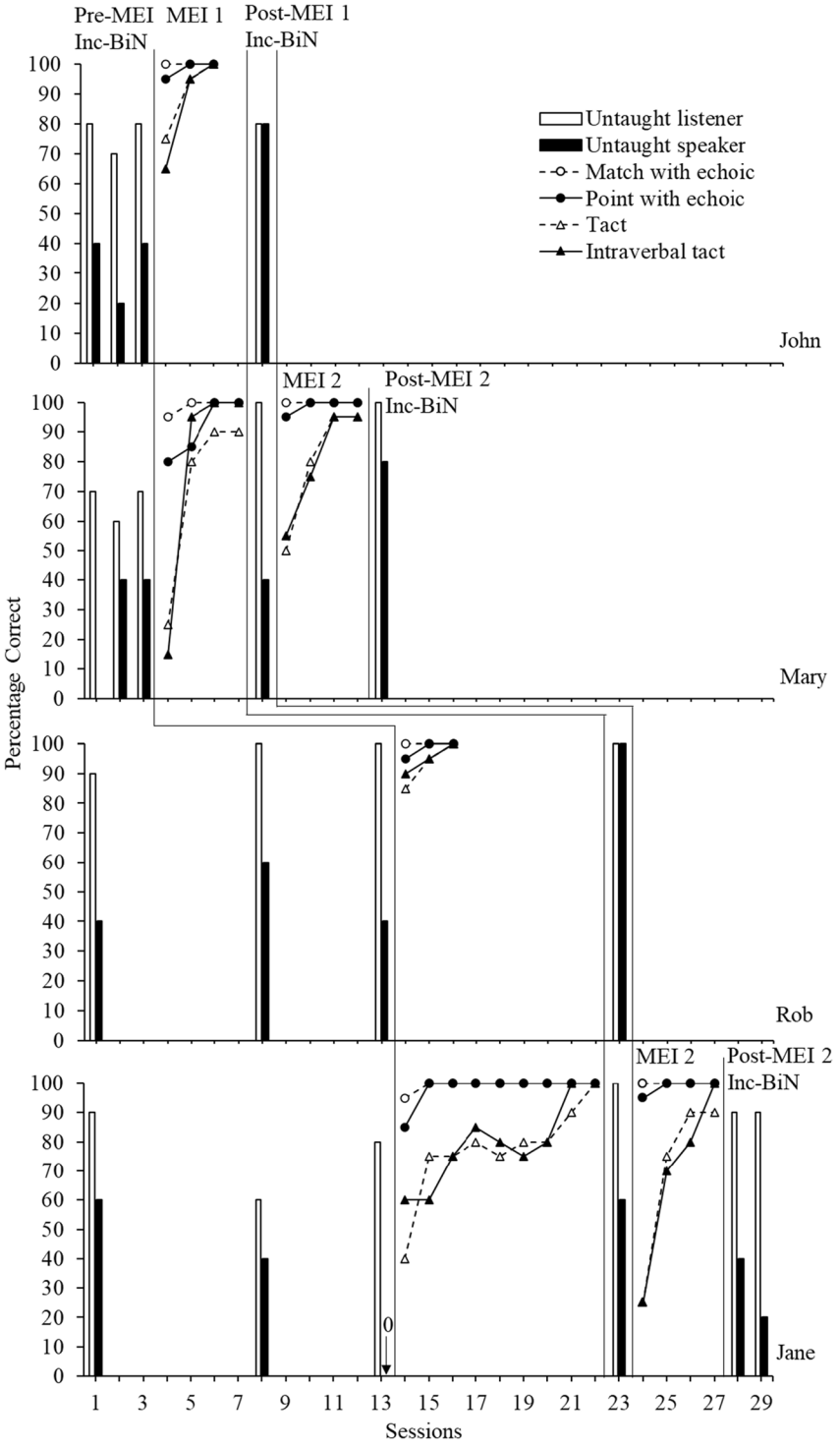
Listener-speaker MEI with added echoics consisted of 80-trial sessions (20 per operant) with systematic rotation of instruction across match-with-echoic, point-with-echoic, tact, and intraverbal-tact operants, and a novel set of five stimuli for each phase (see Fig. 1). For each of the five stimuli, the participant emitted four match-with-echoic, point-with-echoic, tact, and intraverbal-tact responses, and the researcher rotated across all stimuli and responses in each 80-trial session such that there was no consecutive repetition of the same stimulus or operant. The researchers used learn-unit instruction during the intervention, which is a teaching style for direct training of skills (Albers & Greer, 1991). The antecedents, behaviors, and consequences for each operant are described in Table 3. The mastery criterion for listener-speaker MEI with added echoics was 100% correct responses for one 80-trial session or 90% accuracy across two consecutive 80-trial sessions.

Interobserver Agreement and Procedural Integrity

We used the Teacher Performance Rate and Accuracy Scale (TPRA; Ingham & Greer, 1992) to collect data for interobserver agreement (IOA) and procedural integrity. An independent observer collected data on participant responses during 32% of Naming Experience sessions, 32% of Inc-BiN probe sessions, and 13% of listener-speaker MEI with added echoics sessions. Trial-by-trial data were compared, and agreement was 100%. To assess procedural integrity, an independent observer recorded the accuracy of the researcher's delivery of antecedents and consequences using the TPRA for 13% of listener-speaker MEI with added echoics sessions. Integrity was calculated as the number of correctly implemented components divided by the total components and multiplied by 100 and was 100%.

Results

Figure 2 displays Inc-BiN probes and listener-speaker MEI with added echoics intervention data. When Inc-BiN was assessed following the Naming Experience, all participants emitted at or near criterion-level responding for Inc-UiN (eight correct untaught point responses), but none of the participants emitted criterion-level responding for Inc-BiN (eight correct untaught intraverbal-tact responses). John required three sessions of listener-speaker MEI with added echoics before


Pre-MEI Inc-BiN
MEI 1
Post-MEI 1 Inc-BiN
Untaught listener
Untaught speaker
Match with echoic
Point with echoic
Tact
Intraverbal tact
John
MEI 2
Post-MEI 2 Inc-BiN
Mary
Rob
MEI 2
Post-MEI 2 Inc-BiN
Jane
Percentage Correct
Sessions

demonstrating Inc-BiN. Mary completed listener-speaker MEI with added echoics with two sets of stimuli (4 sessions) before demonstrating Inc-BiN. Rob required three sessions of listener-speaker MEI with added echoics before demonstrating Inc-BiN. Jane completed the listener-speaker MEI intervention with two sets of stimuli (9 sessions, 4 sessions) and demonstrated little to no increase in Inc-BiN. We observed a decrease in correct intraverbal-tact responses during her Inc-BiN probe sessions, so her participation was terminated.

Discussion

All four of the participants failed to demonstrate Inc-BiN until they experienced listener-speaker MEI with added echoics with at least one set of stimuli. Our findings are consistent with the findings of Hawkins et al.'s (2009) study. We found that listener-speaker MEI with added echoics was effective in establishing untaught listener and speaker responses for three out of four participants. This result lends support to the assertion that echoic behavior is important in the acquisition of the speaker component necessary for Inc-BiN (Cao & Greer, 2018; Longano & Greer, 2015), and adding echoics is an effective modification to listener-speaker MEI (Hawkins et al., 2009). However, further research is needed to determine if listener-speaker MEI with the added echoics is more effective than a standard listener-speaker MEI.

Two participants (John and Rob), who demonstrated Inc-UiN prior to the intervention, required one set of stimuli to demonstrate Inc-BiN. Mary demonstrated near criterion level responding for Inc-UiN and required two sets of stimuli to demonstrate Inc-UiN and Inc-BiN, respectively. This finding supports the notion of Inc-BiN as a continuum and that Inc-UiN is acquired before Inc-BiN (Greer et al., 2020). The final participant, Jane, did not demonstrate Inc-BiN in the current study. During Inc-BiN probes, we observed some variability in her listener responses and an overall decreasing trend in her speaker responses, which could be due to the lack of feedback following correct and incorrect responses during probes. Future research should explore Inc-BiN probe arrangements with participants who demonstrate prerequisite skills for Inc-BiN but also demonstrate decreased responding during probe sessions.

The Naming Experience was designed to simulate an interaction with the environment in which a child observes the target stimulus and was necessary to (a) emit correct untaught Inc-BiN responses and (b) determine whether participation in the listener-speaker MEI with added echoics was necessary. All participants required the intervention following the Naming Experience before demonstrating Inc-BiN. A limitation of the study is that we did not record echoics during the Naming Experience. Based on the prerequisite skills required to participate in this study, each participant had a strong echoic repertoire, but it is possible that overt echoics are essential during Naming Experience to learn names incidentally. We suggest future researchers measure participants' echoics during the Naming Experience.

There were limitations to the current study. First, we attempted to control for time and maturation but not the number of assessment exposures. Future research should

conduct more baseline probes and increase the number of participants or pairs for stronger experimental control. The second limitation is that we used stimuli (i.e., monsters) with overlapping features, which could have led to unwanted stimulus generalization across stimuli sets (e.g., naming monsters from the previous sets). This can be prevented with the use of contrived stimuli from varying categories across stimuli sets. Third, we used a novel set of stimuli for each Naming Experience and Inc-BiN probe sessions to limit the number of exposures to the same set of stimuli. Future research should use the same sets of stimuli across pre-intervention and post-intervention sessions. Fourth, we collected IOA and procedural integrity data for only 13% of listener-speaker MEI sessions. Future research should obtain a higher percentage of sessions with IOA and integrity data.

Data Availability All data analyzed during the current study are available from the corresponding author on reasonable request.

Declarations

Informed Consent Each participant's parent consented to the dissemination of research.

Conflict of Interest We have no known conflict of interest to disclose.

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