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Establishing Naming in Typically Developing Two-Year-Old Children as a Function of Multiple Exemplar Speaker and Listener Experiences

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Naming is a verbal developmental capability and cusp that allows children to acquire listener and speaker functions without direct instruction (e.g., incidental learning of words for objects). We screened 19 typically developing 2- and 3-year-old children for the presence of Naming for 3-dimensional objects. All 9 3-year-olds had Naming, and 8 of 10 2-year-olds lacked Naming. For the 2-year-old children who lacked Naming, we used multiple-probe designs (2 groups of 4 children) to test the effect of multiple exemplar instruction (MEI) across speaker and listener responses on the emergence of Naming. Prior to the MEI, the children could not emit untaught listener or speaker responses following match-to-sample instruction with novel stimuli, during which they had heard the experimenter tact the stimuli. After MEI with a different set of novel stimuli, the children emitted listener and speaker responses when probed with the original stimuli, in the absence of any further instruction with those stimuli. Seven of 8 children acquired the speaker and listener responses of Naming at 83% to 100% accuracy. We discuss the basic and applied science implications.

Key words: multiple exemplar instruction, naming, verbal behavior, learn unit, mand, tact, intraverbal

We capitalize *Naming* as a verbal developmental capability to distinguish it from the layperson's usage of naming to describe verbally labeling or tacting objects in the environment (Greer & Ross, 2008; Greer & Speckman, 2009). The Naming capability has been identified as (a) the beginning of being truly verbal (Barnes-Holmes, Barnes-Holmes, & Cullinan, 2001; Greer & Speckman, 2009; Horne & Lowe, 1996), (b) a facilitator of categorization (Lowe, Horne, Harris, & Randle, 2002; Lowe, Horne, & Hughes, 2005; Lowe, Horne, & Randle, 2004; Lowenkron, 1991; Miguel, Petursdottir, Carr, & Michael, 2008), (c) a behavioral developmental capability and cusp (Greer, 2008; Greer, Corwin, & Buttigieg, in press; Greer & Keohane, 2005; Greer & Ross, 2008; Greer & Speckman, 2009; Greer, Stolfi, Chavez-Brown, & Rivera-Valdez, 2005; Greer, Stolfi, & Pistoljevic, 2007; Horne & Lowe, 1996), and (d) a bidirectional higher order operant (Catania, 2007). We suggest that it is a developmental cusp (Rosales-Ruiz & Baer, 1996) that is also a verbal developmental capability because the onset of Naming allows children to learn new language without direct instruction. Also, Naming apparently allows children in first grade to profit from teacher demonstrations of operations, whereas, first-graders without Naming do not profit from teacher demonstrations (Greer et al., in press). Hence, once Naming is present children can learn in ways they could not before (Greer & Ross, 2008; Greer & Speckman, 2009).

Children with the Naming capability acquire both the speaker and listener responses to stimuli as a result of observing stimuli while hearing others say the ''names'' or tacts (Skinner, 1957) for the stimuli, and they do so without direct instruction in the form of reinforcement or error corrections (Horne & Lowe, 1996, p. 191). Also, if they learn either the listener or speaker response for stimuli by direct instruction, they can emit the untaught response without direct instruction. Naming has also been identified as one component of reading comprehension (Helou-Care, 2008; Reilly-Lawson, 2008). Moreover, it has been argued (Greer & Speckman, 2009) that the Naming capability may be responsible for the

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rapid vocabulary growth of 3-year-old children identified by Hart and Risley (1995).

Chomsky (1959) theorized that the rapid growth of language found in typically developing children could not be attributed to reinforcement or learning because of what he termed the ''poverty of the stimulus.'' However, recent experiments have identified certain instructional histories associated with children's contact with stimuli that have made Naming possible in children with language delays or autism spectrum disorders (Feliciano, 2006; Fiorile & Greer, 2007; Greer et al., 2005; Greer et al., 2007; Helou-Care, 2008; Longano, 2008; Pistoljevic, 2008). These findings suggest the possibility that similar histories of incidental experiences may act to induce Naming in typically developing children, and that these histories may be one environmental source for the rapid growth of language that occurs at about 3 years of age (Hart & Risley, 1995).

In the studies that induced Naming in children with language delays, experimental designs controlled for maturation and instructional history. These studies reported that Naming emerged in children who were missing it as a function of: (a) multiple-exemplar instruction (MEI; Fiorile & Greer, 2007; Greer et al., 2005; Greer et al., 2007; Helou-Care, 2008; Nirgudkar, 2005), (b) intensive tact training (Pistoljevic, 2008), and (c) conditioned reinforcement by visual and vocal stimulus-stimulus pairings (Longano, 2008). While Horne and Lowe (1996) suggested that Naming developed at about age 2, to our knowledge, no studies have tested for the presence and absence of Naming in young, typically developing children and no experiments have tested the effects of interventions on inducing the Naming capability in typically developing children who were missing it. We tested whether 2-year-old children who lacked the Naming repertoire would acquire it as a function of MEI across listener and speaker responses with training sets of stimuli.

METHOD

Participants

The eight 2-year-old children who participated in this experiment were recruited from a day care center comprised of children from upper-middle class professional families in a suburb of a major metropolitan area. We selected this population because Hart and Risley (1995) reported that the children from upper middle class professional families had ''rich language'' experiences (i.e., they received more language experiences than children from welfare and blue collar worker families). Also, their data suggested that children's language explosion began at around the age of 3 years. Horne and Lowe (1996) proposed that Naming probably developed around 2 years of age. We reasoned that because they had rich language experiences, this population of 2- and 3-year-olds would be most likely to have the Naming capability at the earliest age.

We first screened 19 typically developing children from the center, who were between the ages of 2 years 1 month and 3 years 7 months, for the presence or absence of the Naming capability using the *CABAS International Curriculum and Inventory of Repertoires from Pre-School through Kindergarten* (PIRK; Greer & McCorkle, 2003). The PIRK is a criterion-referenced assessment and curriculum that includes an assessment of the presence or absence of Naming for three-dimensional objects (Waddington & Reed, 2009). The procedures to assess Naming in the PIRK are the same as those used in the present experiment as described later in our method section. Prior to the PIRK Naming assessment, children must be able to (a) perform visual-visual match-to-sample (MTS) tasks in the form of placing items or pictures on top of identical items or pictures, and (b) point to common items upon hearing their names. In the assessment of Naming in the PIRK, children first receive visual-visual MTS instruction, during which they hear the teacher say the names of the stimuli to be matched. Children are considered to have Naming if, following this training, they are able to vocally tact the stimuli and respond as listeners to their spoken names by pointing to the appropriate stimuli in no-feedback probes.

The components of the PIRK that assess Naming were used to test 10 2-year-old children and 9 three-year-old children. All of the three-year-old children demonstrated Naming. Of the 10 two-year-olds who were

Table 1
Characteristics of the Two-Year-Old Children Without Naming Who Participated in the Experiment

Student	Gender	Age	Match to sample Stimulus Categories In repertoire from PIRK assessment	Repertoires
Group 1 of Four Children Without Naming				
Mean – 2 years, 4 months, 2 weeks				
Child O	Female	2.6 years	1/7	Listener/Beginning speaker
Child K	Female	2.3 years	2/7	Listener/Speaker
Child C	Female	2.4 years	1/7	Listener/Speaker
Child T	Male	2.5 years	1/7	Listener/Beginning speaker
Group 2 of Four Children Without Naming				
Mean – 2 years, 3 months, 1 week				
Child BY	Female	2.3 years	1/7	Listener/Beginning speaker
Child BA	Female	2.2 years	2/7	Listener/Speaker
Child N	Male	2.1 years	1/7	Listener/Speaker
Child A	Male	2.7 years	1/7	Listener/Beginning speaker

assessed, 2 demonstrated Naming and 8 children did not. All of the 8 children who lacked Naming demonstrated at least one accurate PIRK MTS response to criterion out of seven that were assessed (see Table 1). The criterion for a MTS response on the PIRK is 90% on two successive sessions.

Profiles of the participants are shown in Table 1. The participants who were selected for this study because they lacked Naming demonstrated the prerequisite verbal developmental cusps and capabilities for Naming as identified in Greer & Ross (2008) and Greer & Speckman (2009). That is, each child was classified either as a listener/speaker or a listener/beginning speaker on the PIRK. Typically, as speakers, they emitted some intraverbals and pure tacts and mands, and they emitted vocal verbal approximations or full echoics to words heard from their mothers and fathers. They made eye contact and sat still during activities with the experimenter and parents, and they followed two-step directions. As listeners, they discriminated objects by either giving them to their parents, the experimenter or pointing to them.

The participants echoed vocal-verbal behavior produced by the experimenter and emitted pure mands, pure tacts, and social intraverbals during sessions. Most emitted tacts using several autoclitics. The eight participants were matched in pairs by age and PIRK results, and the members of each pair randomly assigned to different groups, such that there were two groups of children of similar ages and repertoires. After the first group completed the experiment, we replicated the experiment with the second group. The experiment was completed over a six-week period.

Materials and Stimuli

For each participant, Naming was probed with a set of three-dimensional kitchen utensils and other objects with which the children were not likely to be familiar. A different set of unknown objects was used during MEI. A total of six stimulus sets were

Table 2
Sets of Stimuli Used Across Speaker and Listener Responding

Stimuli (3 exemplars of each)	Experimenter's spoken words	Stimuli (3 exemplars of each)	Experimenter's spoken Words
Set 1		Set 4	
meat cleaver	pounder	turner	turner
bottle stopper	stopper	potato masher	masher
whisk	whisk	corn holder	holder
Set 2		Set 5	
timer	timer	strainer	strainer
ladle	ladle	battery	battery
tongs	tongs	lock	lock
Set 3		Set 6	
electric adapter	adapter	scouring pad	scourer
bottle opener	opener	spreader	spreader
spatula	spatula	phone jack	jack

used in the experiment, but only two sets were used for each participant, one for the Naming probes and one for MEI. As shown in Table 2, each stimulus set included three types of objects, and each type of object was assigned a one- or two-syllable name that was either the conventional name of the item or a simplified version. To control for difficulty in sets, the specific sets that were used for the Naming assessment and MEI varied across participants as shown in Table 3.

For each type of object included in a stimulus set, the set contained three visual variants of the object; for example, different colors, sizes, and shapes of meat cleavers, bottle stoppers, whisks, timers, ladles, locks, and phone jacks. Thus, each set included 9 object variants as shown in Table 4.

Setting and Habituation Procedures

The study was conducted in the eight residential homes of the participating families. The children experienced from 20 to 25 visits from the experimenter. The initial 5 to 7 visits functioned to build rapport and instructional control with the children. The remaining 15 to 18 visits were devoted to the experimental protocol. Each visit ranged between 60 to 105 minutes. The visit time frame depended on the current activity the children were engaged in when experimenter arrived (e.g., eating, playing, or watching television). After the children completed the activity they were engaged in at the time of the experimenter's arrival, the experimenter presented a preferred activity to engage in solely with the experimenter. The mothers identified the activities their children preferred when playing with their parents and the location or locations in the home where they played most frequently with their children. These activities were used to habituate the children to the experimenter and the experiment was conducted in the area of the home identified by the mothers.

When the experimenter entered the home, the child walked with the experimenter and mother to the designated play area. The experimenter and child sat on the floor as the experimenter opened a large duffle bag with toys specifically chosen for the child based on the play history provided by the mother. The toys in the duffle bag were changed after each visit. While the child chose a toy, the mother left the room. The experimenter praised or otherwise reinforced manipulating the toy, sitting appropriately, showing the toy to the experimenter, making eye contact, and emitting mands, tacts, or verbal approximations. After the children were comfortable with playing with the experimenter, the experiment began.

Measurement

Response definitions. The dependent variable was a measure of the presence or absence of Naming. Naming was assessed in

Table 3
Sets of Stimuli Used for Individual Participants in the Groups

	Probes for untaught listener and speaker responding (point and tact)	MEI instruction
First Group of Children Without Naming		
Child O	Set 1	Set 3
Child K	Set 2	Set 4
Child C	Set 5	Set 6
Child T	Set 6	Set 5
Second Group of Children Without Naming		
Child BY	Set 1	Set 3
Child BA	Set 2	Set 4
Child N	Set 5	Set 6
Child A	Set 6	Set 5

no-feedback pre- and post-MEI probe trials of the children's untaught listener and speaker responses in the presence of novel variants of three-dimensional objects from the probe set of stimuli. Before the pre-MEI probes, the participants had completed auditory-visual MTS with one variant of each object in the probe set. Naming was probed with the two remaining variants of each object in the probe set.

In the pre- and post-MEI probes, the listener response consisted of pointing to a stimulus, in an array of three stimuli, of which one was correct, after the experimenter said its name (i.e., ''Point to spatula''). A response was scored as correct if the participant pointed to the correct object within 3 s; it was scored as incorrect if the participant pointed to a different object or did not respond. The speaker response consisted of the participants saying the word for the stimulus when the experimenter presented the stimulus one at a time to the child and asked, ''What is this?'' A correct response consisting of the child vocalizing the name of the object within 3 s, and an incorrect response consisted of saying a different name or not responding. Thus, the speaker responses could be characterized as tacts of the visual stimuli under intraverbal control of the instruction.

In addition, MTS responses with the novel stimulus variants were probed immediately before the pre-MEI probe. A correct MTS response consisted of the child placing her sample stimulus object (e.g., a spatula) next to an identical comparison (e.g., an exact match spatula) in an array of three stimuli within 3 s. An incorrect response consisted of the child placing her sample on a nonidentical comparison (e.g., an object that was not a spatula) or not responding.

In a pre-experimental screening probe, data on MTS responses, speaker responses and listener responses were collected in an identical manner, except that the stimuli included only the variant of each object that was subsequently used during MTS instruction, and not the novel variants.

In addition to probe data, data were collected on target responses during learn units in two instructional conditions, (a) MTS responses during MTS instruction, and (b) MTS responses, speaker responses, and listener responses during MEI. Definitions of correct and incorrect speaker, listener, and MTS responses were identical to those used during probes.

Data collection and interobserver agreement. During probes and training, we recorded the children's responses using a pencil and a data form. Correct responses were recorded with a plus (+) and incorrect responses with a minus (−) when they met the definitions described above.

We trained the observers by providing them with written instructions and had them observe sample videotaped responses prior to their observing experimental sessions. Once they achieved 90% agreement for two

Table 4
Descriptions of the Different Visual Variants of the Stimuli in Each Set

Stimuli	Descriptions of the different exemplars of the stimuli
Set 1	
Meat cleaver	Large steel
	Small wooden
	Black plastic
Bottle stopper	Black top with red bottom
	Grey soft plastic
	Red hard plastic
Whisk	Large red plastic
	Small egg bottom with steel top
	Steel with ball shaped whisk on top
Set 2	
Timer	Old fashion clock with white face
	Yellow circle timer
	Strawberry shaped timer
Ladle	Large black plastic
	Small steel
	White plastic toy
Tongs	Small wooden
	Steel with black sides
	Metal with finger holders
Set 3	
Electrical adapter	Single orange
	Three-way, grey color
	White European-style adapter
Bottle opener	Blue plastic
	Stainless steel
	Red handle with steel top
Spatula	Clear handle with purple top
	Black handle with small blue top
	Blue handle with rectangular white top
Set 4	
Turner	Black handle with green top
	Black trim with steel handle and steel top
	Slotted steel handle with slotted top
Potato masher	Black with grey trim
	Steel with black trim
	Blue with circular bottom
Corn holder	Steel wide handle
	Slim yellow corn handle
	White round ball handle
Set 5	
Strainer	Small steel
	Orange plastic with basket
	Small blue plastic

Table 4, *cont.*

Stimuli	Descriptions of the different exemplars of the stimuli
Battery	9 volt
	Battery camera
	Flat circle
Scouring pads	Flat green rectangle
	Thick purple ovals
	Small circular silver with center circle
Set 6	
Locks	Black push button
	Steel with red bottom
	Steel with black circle dial
Spreader	Steel tip with wide black base
	Small rectangle tip with floral multicolor base
	Plastic white long tip with white handle
Phone jack	Grey one line jack with one opening
	Tan 3 way jack with openings next to each other
	White 3 way jack with openings on each of the 3 sides of box

consecutive sessions, they began observation of the actual experimental sessions that were videotaped. The observers watched the videotaped observations played back on a VCR and tallied the participants' responses to learn units and probe trials independently. The observers were naïve to the conditions of the experiment and whether the sessions they observed occurred before or after the MEI intervention. Interobserver agreement (IOA) was collected on 35% of the videotaped sessions. Point-to-point agreement was calculated by dividing agreements by agreements plus disagreements and converting the outcome to a percentage. The mean IOA across all participants for probe and learn unit sessions was 97%, with a range of 93% to 100%.

Procedure

Experimental design. There were two, non-concurrent multiple probe designs, one for each of the two groups of four-children. We matched the eight children according to age and PIRK repertoires such that there were four pairs of participants of equivalent repertoires and we then randomly assigned one in each pair to either the first group or the second group. Thus, the groups were comparable in age and repertoires. For each group of children, we assessed the effects of MEI in a multiple probe design, but at different times. After pre-experimental assessment and screening probes for both groups, Group 1 completed the experiment, during which time no further contact was made with Group 2. After Group 1 had completed the experiment, pre-experimental screening probes were repeated for Group 2, followed by Group 2's completion of the experiment.

Sequence of procedures. The sequence of procedures is described below and illustrated in Figure 1. First, all eight children were probed for MTS, speaker and listener responses with only one of the three variants of each of the three stimuli in each child's probe set (different probe sets were used for different participants as shown in Table 4). This pre-experimental screening probe was done to ensure that the children were not familiar with the stimuli, sine the stimuli were not contrived. Second, Group 1 received MTS instruction while hearing the experimenter speak the word for the stimuli (e.g., ''Match spatula''). This constituted an opportunity to learn the words for the stimuli incidentally. MTS instruction was conducted with one variant of each stimulus in the probe set; the same variant used in pre-experimental probes. Third, Group 1 received MTS

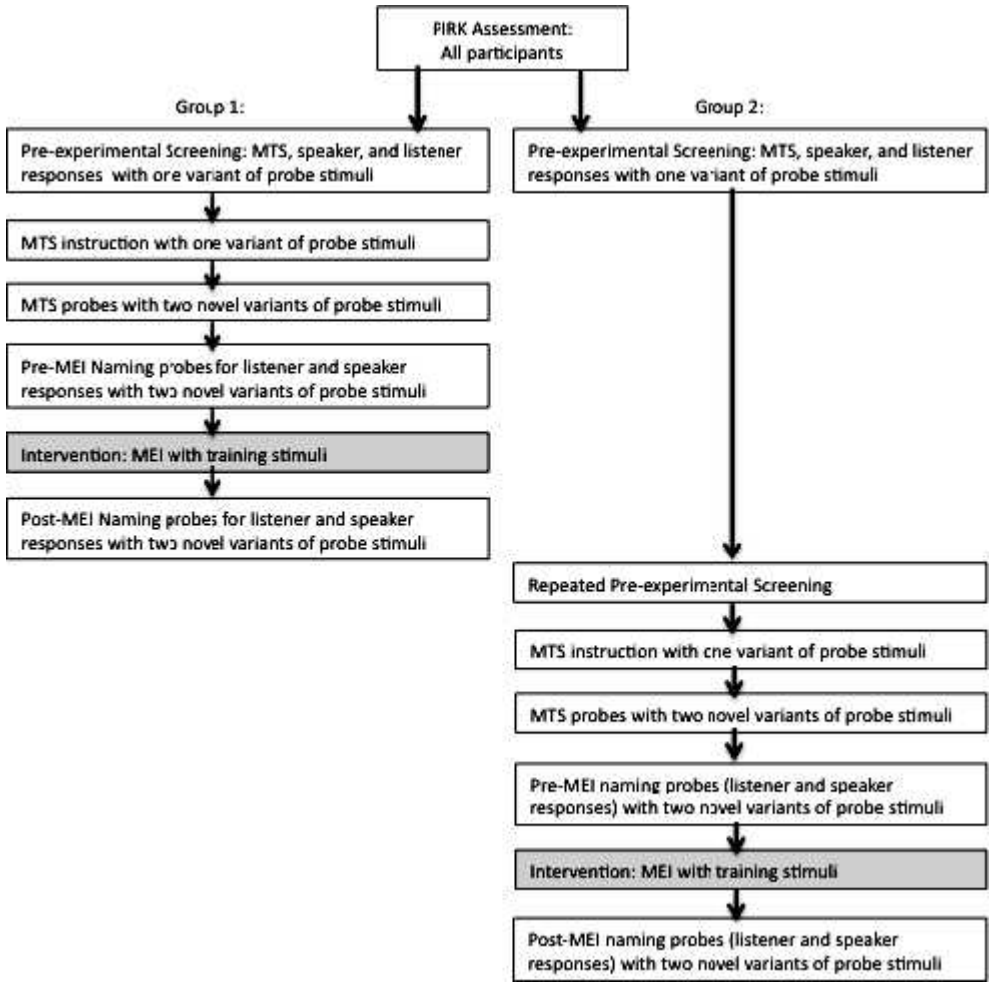

Figure 1. Shows the stages of the experiment for Group 1 and Group 2 in relation to the passage of time.

probes and pre-MEI Naming probes with the two stimulus variants from the probe set that were not included in MTS instruction. The MTS probes tested for generalization of MTS responses from the stimulus variants used in MTS instruction to the two other variants, and did not require the child to have listener or speaker responses. The pre-MEI Naming probes tested for the listener component and speaker component of Naming. Fourth, Group 1 received MEI with MEI stimulus set (see Table 4). Fifth, following MEI, Group 1 completed the post-MEI Naming probes with the probe set stimuli. Sixth, pre-experimental probes were repeated for Group 2 to test for the possibility that the children in the second group might have acquired listener or speaker responses for the stimuli used for the probe sets as a function of instructional history in the home or at the child care center that the children attended during the period that the first group underwent the experiment. Seventh, Group 2 underwent the same experiment as described for Group 1. Each of these procedures is described in detail below and shown in Figure 1.

Pre-experimental screening and MTS instruction. The stimuli used for MTS instruction included two identical copies of one of the three variants (see Table 4) of each of the three objects in the participant's probe set. Before MTS instruction, MTS responses, speaker responses and listener responses

were probed with these same stimulus variants, using procedures similar to those used during pre-MEI probes (described in a later section).

During MTS instruction, the participants matched identical objects while hearing the experimenter say their names. The child and the experimenter sat side by side on the floor with the stimuli to be matched in front of them on the floor. For example, the experimenter said, ''Put spatula with spatula,'' and the child was to match a spatula she had next to an exact match spatula, when a spatula and the two-non-spatula objects from the stimulus set were present on the floor in front of the child. The experimenter held the stimulus to be matched and handed it to the child after the instructions to match. MTS instruction consisted of blocks of 18 learn-unit presentations that included 6 opportunities to respond to each of the stimuli variants (e.g., clear spatula, black spatula, and blue spatula).

During MTS instruction, while hearing the experimenter say the words for the stimuli, correct responses were reinforced with social praise specific to the children's history of reinforcement as reported by the respective parent. If the children responded incorrectly, the experimenter modeled the correct response (showed a correct match). The children were required to repeat the corrected match and the correction response was not reinforced. The instruction included all of the components of the learn unit that is based on research suggesting that the learn unit is a necessary, if not sufficient condition, for effective instruction (Albers & Greer, 1991; Emurian, 2004; Emurian, Hu, Wang, & Durham, 2000; Greer & McDonough, 1999). Once the children in each group had mastered the MTS responding at 90% accuracy or more in one session we tested for Naming and MTS responding with different visual versions of the stimuli.

MTS probes and pre-MEI Naming probes. After a participant met the mastery criterion for MTS while hearing the experimenter say the names of the objects, the participants received (a) MTS probes and (b) pre-MEI Naming probes that tested the listener and speaker components of Naming. Both types of probes were conducted with the two untrained variants of each object in the probe set. For example, if MTS training included spatulas with clear handles and purple tops, the MTS probes and Naming probes included a spatula with a black handle and a small blue top, and a spatula with a blue handle and a rectangular white top (see Table 4). Each type of response (MTS, listener, and speaker responses) was probed separately in massed and unconsequated trials. There were three objects in the probe stimulus set, two variants of each that were tested, and two identical trials for each variant, for a total of 12 MTS trials, 12 listener trials, and 12 speaker trials.

First, we did 12 successive trials for MTS after hearing the word for the stimuli. MTS probe trials were identical to learn units during MTS instruction except that no consequences were provided for correct or incorrect responses. The MTS probe provided the child another opportunity to hear the word for the stimuli with different versions of the stimuli, and ensured that joint attention was present (i.e., we affirmed that the child was attending to the stimulus). The MTS responses could be accurate with or without the child having the listener or speaker response, since the child could simply respond to the visual stimuli alone. These MTS probe trials occurred only before the pre-MEI Naming probes and not before the post-MEI Naming probes. After these probes, the participants did not hear the names of the stimuli under matching conditions again.

Next, we did 12 consecutive probe trials for pointing to the stimuli as a listener response on the floor as done in the MTS trials. These trials began with the experimenter delivering an instruction to point (e.g., ''Point to spatula'') and presenting an array of three objects in front of the child side by side; one positive comparison that represented the correct response, and two negative comparisons. Finally, we did 12 consecutive trials for speaker responses, in which the experimenter presented a stimulus and asked, ''What is this?''. No consequences were provided for correct or incorrect responses in listener or speaker trials. For the speaker component of the dependent variable, the intraverbal tacts, the children was asked, ''What is it?'' when the experimenter presented the stimuli. The experimenter held the target stimulus when she asked, ''What is this?''. There were no consequences delivered for the probe trials.

MEI intervention with training sets. The independent variable consisted of multiple exemplar instruction across listener and speaker responses with a training set of stimuli (the MEI set) that were unrelated to the probe stimuli as shown in Table 3. All three variants of each object were included in training. The children were presented with rotated instructional trials that met the criterion for learn unit instruction. The learn units included MTS learn units while hearing the words for the stimuli, listener learn units, and speaker learn units. In the rotated presentations, the children first responded to (a) a MTS learn unit that included the experimenter saying the word for an object while the child matched the object (i.e., the child matched objects with objects while hearing the experimenter say the word for the object). Next, the children received (b) a listener learn unit on pointing to an object when its name was spoken by the experimenter (not the same stimulus that was matched in the previous learn unit), and then (c) a speaker learn unit in which they were asked to say the name of an object that the experimenter presented (again, a different stimulus than the one presented in the prior learn unit). Stimulus presentation and instructions were identical to those described previously for MTS learn units and pre-MEI Naming probes. Correct responses were reinforced and incorrect responses were corrected by having the children repeat the correct response after the experimenter demonstrated it. Corrected responses were not reinforced, consistent with the learn unit protocol. The rotation across matching and the speaker and listener presentations continued until each of the three stimuli (with three versions each) in the training set of stimuli were presented two times for each match, point, and intraverbal tact topography (six presentations for each stimulus variant). When the children mastered one of the responses before the other responses, the mastered responses were continued as part of the rotation until 94% correct responding was achieved for each of the topographies. Sessions consisted of 54 learn units (presented in blocks of 18) that included 18 learn units for each response topography (MTS, speaker, and listener). The 18 learn units for each response topography included two learn units for each of the three variants of each of the three stimuli.

Post MEI probes for the emergence of Naming. Each of the participants in the two groups received probes for the emergence of Naming when the participant completed his or her MEI intervention. These probes were conducted as described in the pre-intervention test for Naming, but were not preceded by MTS probes.

RESULTS

Pre-Experimental Screening and Pre-MEI Probes for Naming

During pre-experimental screening, the children did not emit any correct listener or speaker responses to the stimuli, showing that they were unfamiliar with them (Table 5 and Figures 2 and 3). They also did not respond correctly during MTS trials. Since they had demonstrated that they had could respond to the MTS tasks with familiar stimuli in their PIRK assessments, we surmised that they probably could not match the unfamiliar stimuli. As shown in Table 5 and Figure 3, none of the children in Group 2 responded correctly on the second pre-experimental probe, showing that they had not acquired the responses during the period when the first group was undergoing the experiment. They could follow instructions to match and point as evidenced by the PIRK assessments; however, they had no experience with guessing, and this may have explained the lack of any correct MTS responses.

In the subsequent MTS instruction we taught the MTS responses for one variant of the probe stimuli to mastery (see Figures 4 and 5). The children in both groups required from 54 to 90 instructional trials to master MTS (Table 5), after which we conducted (a) MTS probes with the novel stimulus variants from the probe set, and (b) pre-MEI probes for the listener and speaker components of Naming. Table 5 shows data from the MTS probes, and combined data on listener and speaker responses from the pre-MEI Naming probes. Separate data on listener and speaker responses from these probes are also shown in Figure 2 for Group 1 and Figure 3 for Group 2. The children demonstrated mastery

Table 5
Percentage Correct on Pre-Experimental Screening Probes, Trials to Criterion in MTS Instruction, Percentage Correct on MTS Probes With Novel Stimulus Variants, and Percentage Correct on pre-MEI Naming Probes

	First Group of Four Children Without Naming			
	Pre-experimental screening (% correct MTS, listener, and speaker combined)	MTS InstructionalTrials to 90% criterion	MTS probes with novel variants of the stimuli (% correct)	Pre-MEI probes: Listener and speaker responses combined (%)
Child O	0	72	72	4
Child K	0	90	83	25
Child C	0	90	72	12
Child T	0	54	77	4

	Second Group of Four Children Without Naming				
	Pre-experimental screening (% correct MTS, listener, and speaker combined)	Repeated pre-experimental screening (% correct MTS, listener, and speaker combined)	MTS Instructional trials to 90% criterion	MTS probes with novel variants of the stimuli (% correct)	Pre-MEI probes: Listener and speaker responses combined
Child BR	0	0	54	72	12
Child BA	0	0	72	82	42
Child N	0	0	72	82	8
Child A	0	0	90	76	4

of MTS responding with the new visual version of the stimuli but did not acquire the listener and speaker responses. Thus, while the children did not yet have Naming, they did emit visual MTS to new forms of the stimuli from 72% to 83% as shown in Table 5. This probe also provided an additional opportunity to hear the words for the stimuli, but even with this additional opportunity they still could not emit the listener and speaker responses.

Figure 2 shows that following MTS instruction but prior to MEI, Child O and Child T emitted no correct speaker responses, while the other children in Group 1 emitted 1–3 correct speaker responses. Child O and T had 1 correct response as a listener (8%) while Child K emitted 3 correct responses as a listener (25%) and 3 correct responses as a speaker (25%). Child C emitted 2 correct responses as a listener (16%) and 1 correct response as a speaker (8%). Similarly, Figure 3 shows that in Group 2, Child BR, Child N, and Child A had no correct speaker responses and Child Ba emitted 4 correct speaker responses. Child A had 1 correct listener response (8%). Child Br emitted 3 correct listener responses (25%) while Child Ba emitted 6 correct listener responses (50%), slightly better than 33% chance responding. Child N emitted 2 correct listener responses (16%). The children did not demonstrate that they had incidentally acquired the listener or speaker halves of Naming.

Multiple exemplar instruction was then presented for a new set of stimuli (see Table 4). All eight children in Groups 1 and 2 met criterion for each of the topographies during MEI instruction within 4

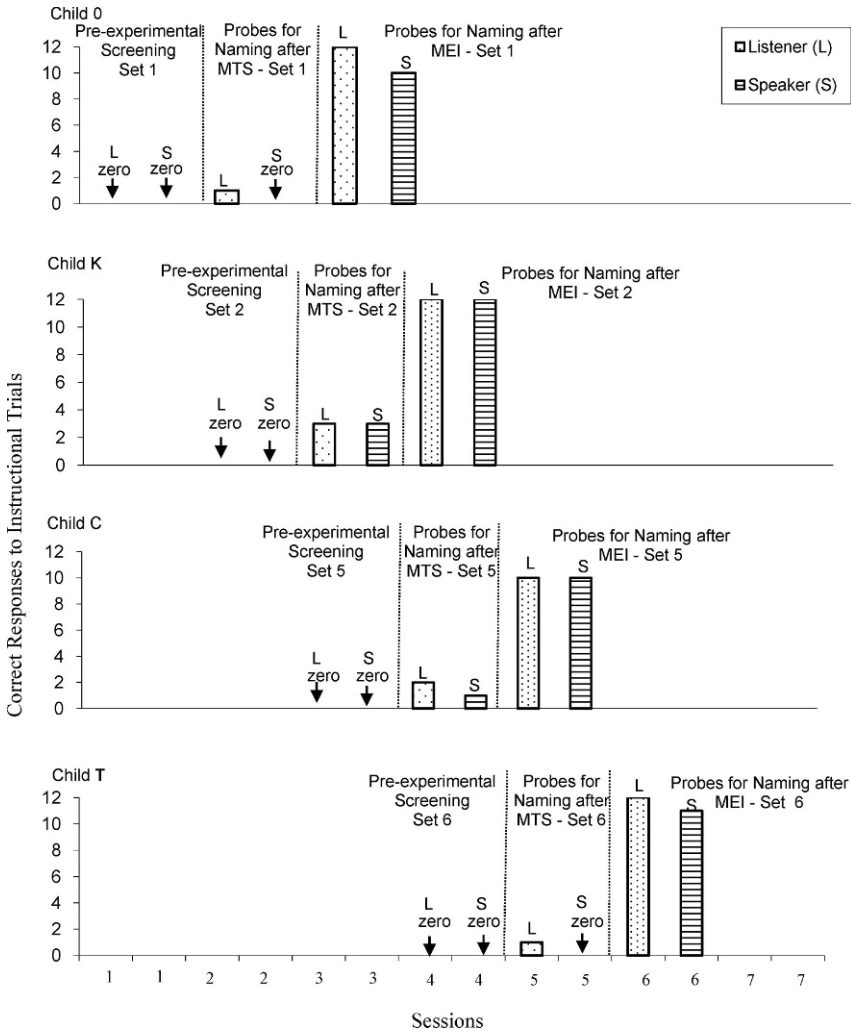

Figure 2. Shows responses to screening trials and untaught listener and speaker responses before and after the MEI intervention for the first group of four children.

sessions for Group 1 and 4 or 5 sessions for Group 2 (Figure 4 and Figure 5). All children mastered the point response prior to the speaker.

Post-MEI Probes for Naming

Following the MEI phase with the training set, we probed the pre-experimental set of stimuli for the untaught listener and speaker responses. Figure 2 shows that all the children in Group 1 emitted the both listener and speaker responses for Naming at 83% level or higher. In prior studies we determined that 80% accuracy or better in each response topography indicated the presence of Naming. Child K emitted 100% correct responses for all probes post-MEI instruction. Child O emitted 83% correct speaker responses and 100% correct listener responses and Child C emitted 83% correct speaker responses and 100% correct listener responses. Child T and Child O emitted 92% correct speaker responses and 100% correct listener responses. Figure 2 shows that all the children in Group 2 also emitted increased listener and speaker responses. Child Br emitted 83% correct speaker responses and 92% correct listener responses, Child Ba emitted 91% correct speaker responses and

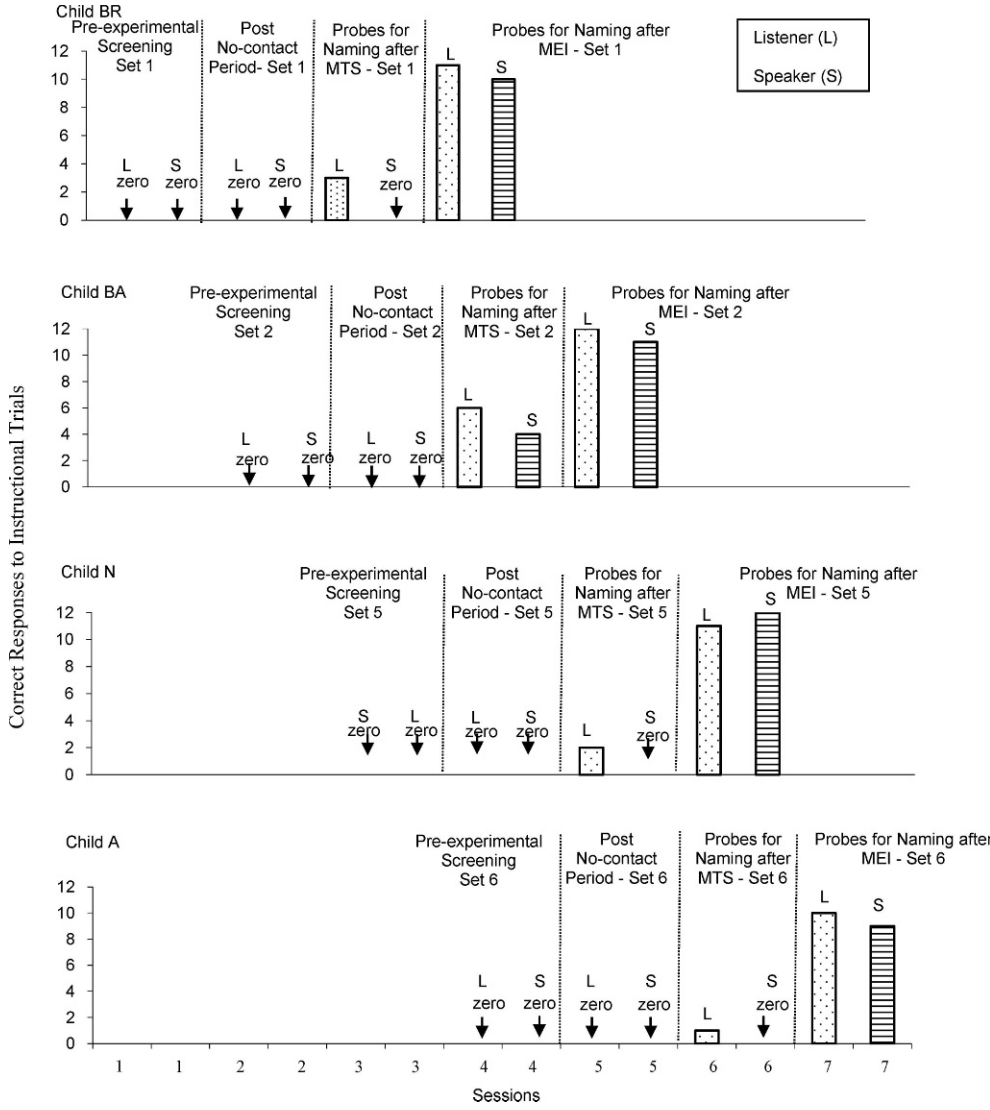

Figure 3. Shows correct responses to screening trials and untaught listener and speaker responses before and after the MEI intervention for Group 2, with an additional pre-MEI probe that occurred when the first group received their post-MEI probe.

100% correct listener responses and Child N emitted 91% speaker responses and 100% correct listener responses. Child A emitted 75% correct speaker responses and 83% correct listener responses. All of the students met the 80% criterion for Naming except Child A, who emitted 75% accuracy for the speaker responses. Overall, Naming emerged following the MEI intervention for seven out of the eight children in Groups 1 and 2, and the eighth almost achieved Naming.

DISCUSSION

We found that the multiple exemplar instruction across training sets resulted in the emergence of Naming for seven of the eight children, and the other three demonstrated significant increases in the capability to learn the words as listeners and speakers. The child who did not achieve Naming might have done so had we completed MEI with a second training set. In several of the other

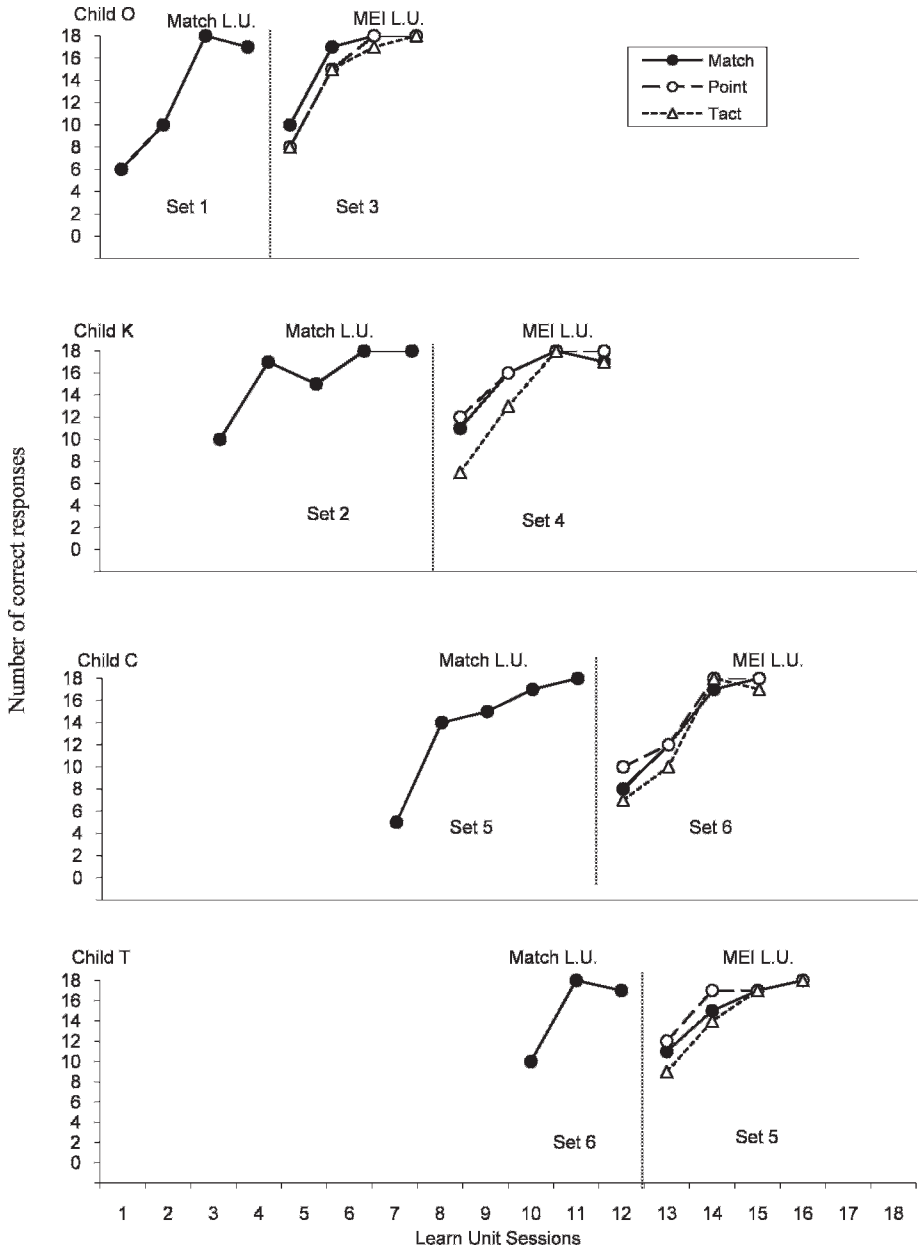

Figure 4. A display of the responses to learn units for the first four children showing their correct responses to MTS instruction for their probe sets and multiple exemplar instruction to training sets of stimuli (the independent variable).

published and unpublished studies, completing another training set with children who are this close to achieving Naming has resulted in their meeting the criterion (Fiorile & Greer, 2007; Greer et al., in press; Greer et al., 2007; Lee-Park, 2005; Longano, 2008). We did not do an additional set with these children because of lack of access. In the other experiments, the children were accessible for additional training sets.

After determining that the children could not tact or respond to any of the stimuli, we provided pre-intervention conditions to provide the opportunity to learn the words for

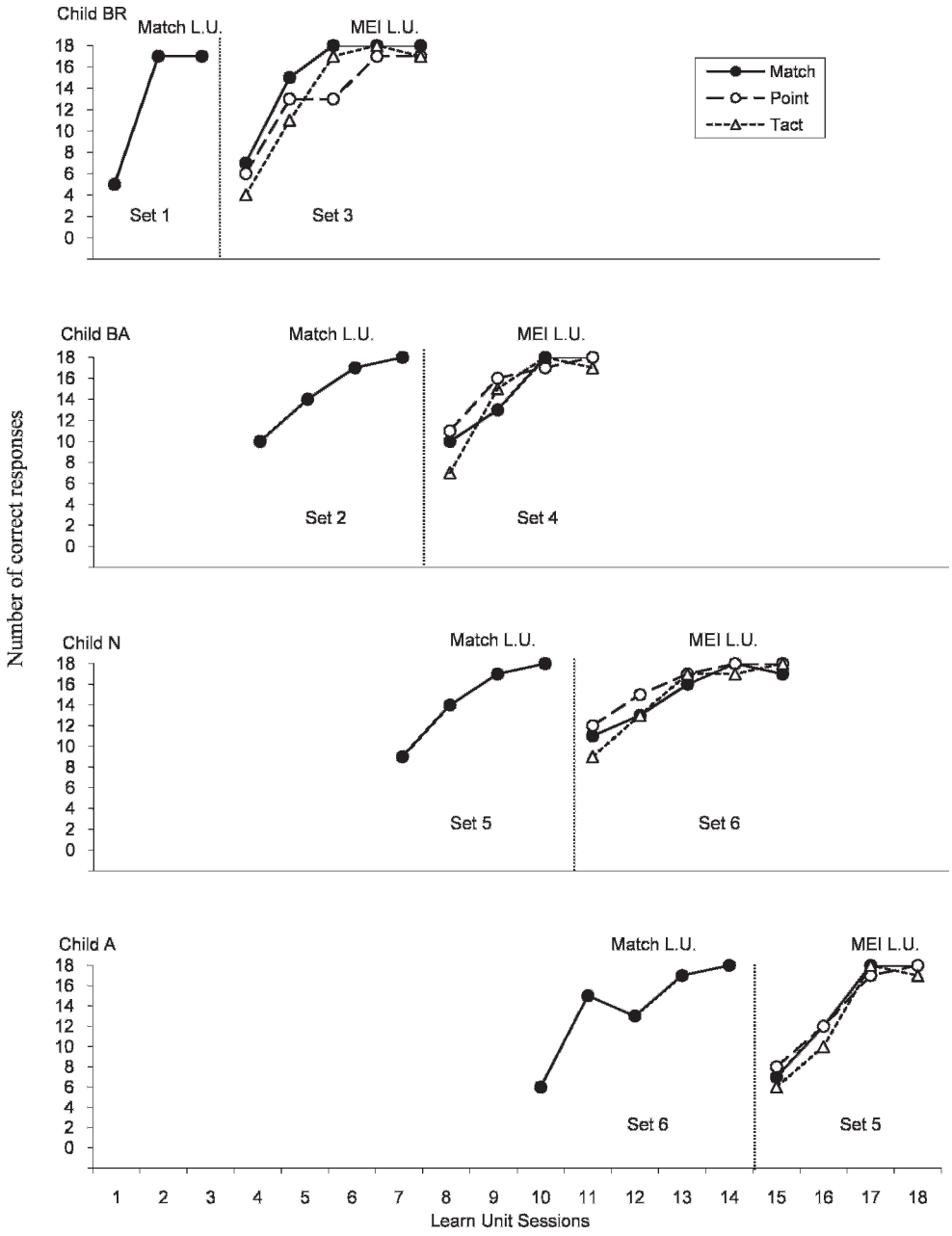

Figure 5. A display of responses to learn units for the second group of four children showing their correct responses to MTS instruction for their probe sets and multiple exemplar instruction to training sets of stimuli (the independent variable).

the stimuli (i.e., Naming experiences) in the form of an observational experience in which the children heard the experimenter say the word for the object, while they mastered MTS responding visually. This simulated the natural conditions under which children who have the Naming capability can acquire both speaker and listener responses without direct instruction (Horne & Lowe, 1996). Unlike previous experiments, the participants in the present experiment potentially received additional MTS instruction, while hearing the

tact for one of the stimuli in the MTS probes with novel visual versions of the stimuli as one of the probe conditions. In the pre-experimental probes, the children did not emit accurate MTS responding, possibly because they had no experience with guessing. Once they received the MTS instruction with the stimuli they demonstrated MTS with the novel variants of the stimuli, but did not emit untaught listener or speaker responses. An MTS probe was not done after the MEI intervention. Thus, the post-MEI probes provided were not accompanied by any MTS experiences while hearing the words for the stimuli. The participants responded as listeners and speakers after periods of several days of not having heard the words for the stimuli under MTS conditions.

The results with these typically developing two-year-old children were consistent with prior studies on the effects of MEI on the emergence of Naming in children with language delays (Fiorile & Greer, 2007; Greer, Stolfi, Chavez-Brown, et al., 2005; Greer et al., 2007; Helou-Care, 2008; Lee-Park, 2005; Longano, 2008; Nirgudkar, 2005; Pistoljevic, 2008; Speckman-Collins, Park, & Greer, 2007), thereby, suggesting the generality of the MEI effects to typically developing children like those in the present experiment. We think that the MEI intervention led to the joining of the listener and speaker responding, such that the objects came to control speaker responses at the same time that the corresponding spoken words came to control listener responses with respect to the objects. However, the fact that we did not test the children with novel stimuli was a limitation.

The MEI intervention, that involved alternation of listener and speaker responses, apparently acted to join the listener and speaker responses in what might be termed a higher order operant, relational frame, and developmental cusp and capability (Catania, 2007; Greer & Longano, 2010; Greer & Speckman, 2009; Healy, Barnes-Holmes, & Smeets, 2000). Since the MTS responding in the MTS probes conducted before MEI showed that the children could match different visual versions, they did hear the words for the stimuli and once the MEI joined the listener and speaker responses for novel stimuli, the MEI experience allowed the joining of the listener and speaker responses with the initial stimuli as it appears to have done in the prior experiments. We think that either covert or overt echoic responding is an important component as Longano found (2008).

We speculate that the children learned to attend to the vocal stimulus and the visual stimulus simultaneously and this resulted in stimulus control across both the listener and speaker responses. The observational experience of hearing the tact for the visual stimuli might be described as an experimental simulation of Naming experiences, not unlike natural conditions that would provide a child to become acquainted with the *name* of an object. Two to three weeks separated the experience of mastering the MTS responses while hearing the word spoken for the stimuli and the final probes for untaught listener and speaker responses. It would seem that the children had much of the listener response even though they did not perform accurately on the pre-MEI pointing probes. We speculate that this is because they did not have the reinforcement history for guessing that results from experiences with reinforced and corrected instructional trials. Once they received the MEI experience the listener response was accessed. Doing the listener probe first appears to provide opportunities for the child to echo what they have learned as a listener and in doing so completes the joining of listener and speaker.

In the initial probes, where the participants did not emit any correct matching responses in spite of a 33% probability of a correct matching response by chance, it is possible that the children had no experience in guessing since they had not had experience with instructional presentations in which guessing was reinforced. In prior studies, the participants had those experiences, whereas the children in the present study probably did not. The MEI training possibly taught them that guessing led to reinforcement on occasion.

During MEI, most of the children had, or rapidly acquired, the listener side in the intervention (i.e., they could point to the stimuli when asked to do so), but the speaker responses were acquired more slowly. This has been consistently the case in the prior studies. Since the conditions for acquiring

incidental language (i.e., the MTS mastery while hearing the spoken words for the stimuli) were not repeated for the original stimuli after the pre-intervention probes, the results suggest that the MEI training resulted in the integration of the listener and speaker responses (Greer & Ross, 2008; Greer & Speckman, 2009). Other prior and more recent studies, that also combined single case and group design features, showed that an intervention in which the different topographies (i.e., MTS, listener, speaker) were not rotated but were taught separately in massed or consecutive learn units for each topography did not result in Naming; whereas, the alternation of learn units across topographies did result in Naming (Greer et al., 2007; Pistoljevic, 2008). That is, experiencing different types of learn units so close in time joins the repertoires as it gives the children an opportunity to learn to respond in each trial on the basis of what they have experienced in a different type of trial.

Two other interventions, identified in unpublished doctoral dissertations, resulted in Naming in addition to the MEI procedure. These interventions included an intensive tact instruction intervention (Pistoljevic, 2008), where Naming emerged after extensive tact instruction (i.e., more than 100 tact learn units taught daily, until 25 new tacts were mastered). Also, echoic training (i.e., participants were required to echo, in training sets of matching and pointing) resulted in Naming as did, visual-vocal stimulus-stimulus pairings in an unpublished dissertation with participants who did not acquire Naming with the echoic or MEI interventions (Longano, 2008). The latter studies suggested that echoics, either covert or overt, appear to be a key component to the joining of speaker and listener responding in Naming. Thus, while the MEI procedure is effective, other recent interventions have resulted in Naming also. This suggests that incidental pairings and intensive experience with learning tacts, where listener and speaker responses are incidentally rotated for the same stimuli, may, in fact, be the more typical and incidental manner in which children acquire Naming. While the intensive tact procedure does not include a direct listener instructional component, the child does have to echo the response while looking at the stimuli in the tact instructional process and this may incidentally provide a listener response opportunity. The MEI protocol may simply provide an intensive exposure to the more basic pairing and tact instructional experiences, but more research is needed to determine if this is the case.

There were several limitations. One major limitation was that we did not provide an observational experience and tests with a novel set of stimuli in addition to the initial untaught sets (i.e., the pre-MEI probe sets), as was done in prior studies where the untaught topographies emerged for the novel sets also (Fiorile, & Greer, 2007; Greer, et al., 2007; Pistoljevic, 2008). This needs to be rectified in future studies with typically developing two-year-old children. It is possible that the children would not have emitted the untaught responses to a novel set. Another possible limitation is that we did not probe the children for the possibility that Naming might emerge after the MTS procedure before the MEI. That is, could the joining occur as a function of the probes alone? While this is possible with these children, both Greer et al. (2007) and Pistoljevic (2008) did provide repeated probes following the MTS training prior to the MEI and Naming did not emerge. Another difference from prior studies and a possible limitation for this study was that we did not provide an additional training set of stimuli for the child who did not achieve the 80% criterion. In prior studies, experimenters completed additional sets of MEI training until the participants achieved the 80% criterion. In the prior studies, Naming also was tested with novel stimuli, and this additional exposure may have assisted in the emission of untaught responses to novel stimuli in those studies. Thus, setting a high criterion may or may not determine the emergence of Naming with novel sets of stimuli. This too needs to be tested.

We conducted the Naming tests with three-dimensional objects, which is the first type of stimuli with which children are likely to acquire the Naming capability. There does appear to be a difference between the acquisition of Naming and types of stimuli. In prior and recent studies we have used pictures with preschool children almost a young as the ones in the present study to

probe and induce Naming. However, all of those students had prior extensive experience with pictures and probably as a result of this experience had no difficulties. But having Naming with three-dimensional stimuli does not automatically result in Naming with pictures (Greer & O'Sullivan, 2007, May).

Children with Naming not only acquire names for things incidentally but they also profit from their teachers' demonstrations of operations, while children who lack Naming do not appear to do so. A recent experiment (Greer, et al., in press), with typically developing 5- and 6- year-old children and children with autism diagnoses, reported that the induction of Naming for two-dimensional stimuli (i.e., pictures and symbols) resulted in more rapid learning of math objectives, such as summing and place value, when models or exemplars for correct responding were provided, but did not result in more rapid learning for children who lacked Naming for two-dimensional stimuli. These data suggest that the acquisition of Naming results in new ways of learning for children (i.e., the children had no direct instruction in listener and speaker responses), affirming that the onset of Naming not only allows children to learn the words for objects and pictures incidentally, but also allows children to profit from instructions that include model demonstrations of what constitutes correct responding. Thus, it appears that Naming allows children to learn from different types of instructional presentations and as such constitutes a developmental learning capability and cusp as argued in Greer and Speckman (2009) and Greer and Longano (2010).

The data suggest that instructional experiences like the MEI procedure can accelerate the acquisition of Naming such that the 2-year-olds performed after the intervention similarly to the 3-year-olds who had Naming. Unfortunately since we did not test the children with a novel set of stimuli, we cannot ascertain that they had Naming for novel stimuli, although it did emerge for the stimuli we probed. While our study is a basic science experiment, it is interesting to speculate on the potential applied benefits of advancing the Naming capability for 2-year-olds. Presumably, the acquisition of Naming a year earlier then appears to typical, at least for our small sample, could provide the 2-year-olds for, whom Naming was induced, with the wherewithal to benefit from a year of learning words for objects that they could not benefit from without Naming. That is, it is possible that their vocabulary explosion would be advanced by several months (Hart & Risley, 1995). Thus, inducing Naming in young children may be an important component that children in early intervention programs that children should receive. This may be especially true for non-native language learners, children who receive free or reduced lunch, and children with language delays (Greer & O'Sullivan, 2007, May; Greer et al., in press). While we can only speculate on this benefit, our results suggest that further study may be promising.

A number of studies have shown that MEI experiences result in Naming and the stimuli associated with those experiences identify the presence of stimuli that result in Naming. There is no ''poverty of stimuli'' and no poverty of conditioning experiences; the experiences with the stimuli are simply located in the child's prior experiences. The multiple exemplar experiences resulted in relational responding. We suggest that it is a higher-order operant as pointed out by Catania (2007). Some have argued that it may facilitate other emergent relations when those relations are verbal, but need not be present to facilitate nonverbal relations (Greer & Longano, 2010; Greer & Speckman, 2009).

The bidirectional component of Naming, or the capability of learning a response as a listener and emitting the untaught speaker response or vice versa is one aspect of Naming that has been associated with research on Naming theory as set forth by Horne and Lowe (1996). The focus of research like ours has been on acquiring the capability to learn *both listener and speaker responses incidentally* an aspect of the original Naming theory. However, the incidental learning hypothesis has only been tested in the verbal behavior developmental studies to date. Incidental learning refers to acquiring the two topographies from a Naming experience in which no direct instruction occurs. There may be at least two components of Naming, (a) the bidirectional component, and (b) the incidental language acquisition component. Perhaps under certain conditions children might learn

the bidirectional component, where the teaching of one of the topographies results in the other, but they still might be missing the incidental language acquisition component. This is a topic for future investigation.

There are numerous questions about the phenomenon that need investigation. Are there different types of Naming for three-dimensional and two-dimensional stimuli? Do different stimuli associated with the different senses require separate experiences (e.g., Naming for olfactory, gustatory, tactile, and visual stimuli)? When Naming is induced, does the way in which children are taught need to be adjusted to build on the new capability as found by Greer et al., in press)? Are there advanced forms of Naming? One possible advanced type of Naming may occur when after hearing a lecture, in which there are no direct or observed reinforcement or corrections, a learner with advanced Naming can emit accurate listener, speaker, and writer responses to much of the content of the lecture.

While there are many remaining questions, the phenomenon appears important and robust. The types of experiences, whereby typically developing children acquire Naming incidentally, may be similar to the kinds of experiences that have been used in experiments that resulted in the emergence of Naming with children with language delays. In this experiment, we present some evidence that the Naming capability was induced in typically developing children who did not have Naming as a function of multiple exemplar instructional experiences.

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