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The Effects of the Interspersal of Related Responses on the Emergence of Intraverbals for Children With Autism Spectrum Disorder

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Abstract

The present study evaluated the emergence of intraverbals for 2 children diagnosed with autism spectrum disorder. Prior to baseline, both children demonstrated tact, tact function, listener, and listener by function responses with 12 pictorial stimuli, yet they failed to demonstrate intraverbals related to the function of the items (e.g., "What do you do with [item]?" and "What do you use to [function]?"). Following baseline, previously mastered *related* tact, tact function, listener, and listener by function tasks were presented prior to probe trials for the target item-function and function-item intraverbals. Results showed that interspersal of the related tasks for a subset of the intraverbals led to the emergence of untrained item-function and function-item intraverbals for both participants. In Experiment 2, the long-term effects of this remedial training on the emergence of untrained intraverbals was evaluated as new tact and listener responses were trained. Results of Experiment 2 showed that tact function and listener by function training was sufficient to establish the emergence of item-function and function-item intraverbals in the absence of related-task interspersal. These results are discussed in relation to current explanations for emergent responding.

Keywords autism · emergence · intraverbal · tact · listener responding · verbal behavior

Responses under intraverbal control (Palmer, 2016) are thought to make up a substantial portion of our day-to-day interactions, making these verbal behaviors critical for individuals with autism spectrum disorder (ASD). As noted by Sundberg and Sundberg (2011), "it is nearly impossible to have much of a discussion about any specific topic with only echoics, mands, and tacts" (p. 24). Children with ASD sometimes struggle to learn intraverbals because they have difficulty responding to formal prompts, they have

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limited tact and listener repertoires, and their responses are often dependent on tangible reinforcement (Cihon, 2007). It has also been suggested that the relative complexity of intraverbals may be an impediment for learners with ASD, as these responses often require simultaneous discrimination of multiple verbal stimuli (Sundberg & Sundberg, 2011), which are fleeting in nature (Axe, 2008).

A substantial body of literature exists related to best practices for directly training intraverbals using transfer of stimulus control procedures (for a review, see Axe, 2008; Stauch, LaLonde, Plavnick, Bak, & Gatewood, 2017). To train an intraverbal in this manner, the verbal antecedent is presented and then paired with or followed by a supplementary stimulus to prompt the correct response. These prompts are systematically delayed, such that correct responding occurs following the verbal antecedent stimulus alone (Coon & Miguel, 2012). Various types of supplementary stimuli have been evaluated in the literature (verbal, textual, or pictorial), though findings from Coon and Miguel (2012) suggest that the relative efficacy of different prompts is a product of the participant's learning history. More recently, transfer of stimulus control procedures have been combined with blocked trials (e.g., Haggar, Ingvarsson, & Braun, 2018; Ingvarsson, Kramer, Carp, Pétursdóttir, & Macias, 2016) and differential observing responses (e.g., Kisamore, Karsten, & Mann, 2016) to establish complex intraverbals. These studies have been essential in developing effective procedures to directly teach intraverbals or, as Palmer (2016) recently clarified, "instances in which reinforcement of contiguous or correlated usage with a verbal antecedent has been observed or can plausibly be inferred" (pp. 103–104). However, less is known about interventions to promote generative, untrained responses under intraverbal control. In these instances, verbal responses emitted by the individual have no specific training history, and multiple variables are likely controlling the response (Palmer, 2016). Considering the flexible, generative nature of adult conversation in the absence of explicit training histories for each individual utterance, clinicians and researchers need to develop procedures that produce these types of outcomes for learners with disabilities.

One approach to establishing generative, untrained intraverbal responses can be found in the emergence literature. Untrained intraverbals may be established following training of related skills, such as tact or listener responses. For example, Grannan and Rehfeldt (2012) trained two children with ASD to tact items, tact the same items by category, and emit match-to-sample responses according to category membership. Following training, both participants emitted untrained intraverbals when asked to list members of a specified category. May, Hawkins, and Dymond (2013) trained three adolescents with ASD to tact monsters and each monster's favorite snack and then tested for the emergence of related intraverbals (e.g., "What does [monster's name] eat?" and "Which monster eats [food]?"). Following training, all participants emitted correct untrained intraverbals.

Listener training by feature or function has also been applied to establish untrained intraverbals with individuals with ASD, though with varying degrees of success. For example, Smith et al. (2016) trained participants to select a picture from an array of comparisons when presented with a verbal antecedent stimulus pertaining to a feature or function of the target (e.g., "What's an animal that flies?" and the participant selected the picture of a bird). Once mastery criteria were met in training, intraverbal probes were conducted, which consisted of the presentation of the same verbal antecedent

stimulus (e.g., "What's an animal that flies?") with no comparison array present. Emergence of intraverbals (e.g., saying "bird" when asked, "What's an animal that flies?") was observed for four of the five participants. Similar procedures have been applied by Vallinger-Brown and Rosales (2014) and Keintz, Miguel, Kao, and Finn (2011), with idiosyncratic findings reported.

Although results of these studies demonstrate that tact and listener training can lead to the emergence of intraverbals, this is not always the case (Keintz et al., 2011; Smith et al., 2016; Vallinger-Brown & Rosales, 2014), and sometimes remedial procedures are necessary (Shillingsburg, Frampton, Cleveland, & Cariveau, 2018). For example, Shillingsburg et al. (2018) trained participants to emit listener responses by feature or function (e.g., "Who says meow?" and the participant selected the cat from an array) and then tested for the emergence of untrained intraverbals (e.g., "Who says meow?" and "What does a cat say?"). If intraverbals did not emerge, tact feature or function training was provided (e.g., when shown the cat and asked, "What does this one say?" the participant was prompted to say "meow"). If intraverbals did not emerge, the intraverbals were directly trained one at a time using transfer of stimulus control procedures (e.g., "What does a cat say?" and the participant was prompted to say "meow"; "Who says meow?" and the participant was prompted to say "cat"). This training of one relation at a time was repeated across two to three sets of stimuli, and eventually all participants demonstrated emergence of untrained intraverbals. Thus, when listener training alone did not produce intraverbals, additional speaker training produced emergence of intraverbals within the same class. For four of the participants, these effects were not isolated to the classes in the intervention, as improvements in intraverbal responding were observed across untrained classes.

Remedial effects on emergent responding have also been reported in the multiple-exemplar instruction (MEI) literature. When three preschool children did not demonstrate consistent tact and listener responses following a matching activity in which the instructor named the stimuli (e.g., "Match ball."), Greer, Stolfi, Chavez-Brown, and Rivera-Valdes (2005) applied MEI, which consisted of the mixed presentation of matching-to-sample, listener, and tact responses related to the same stimuli. Results showed emergence of tact and listener responses when subsequent sets were exposed to the matching activity alone, suggesting the MEI procedure produced a lasting remedial effect on responding. This tactic has resulted in emergence of mands and tacts (Nuzzolo-Gomez & Greer, 2004), tacts and listener responses (Fiorile & Greer, 2007), and intraverbal spelling and textual responses (Greer, Yuan, & Gautreaux, 2005) with children with ASD. The MEI approach (rapidly alternating and training relations across stimuli) and the procedures used by Shillingsburg et al. (2018; training across relations one by one) share some common procedures. Both approaches require participants to explicitly behave as speakers and listeners with respect to the stimuli. Furthermore, both approaches demonstrated that intervention with training stimuli produced emergent relations with subsequent sets of stimuli.

Additional research is needed to identify effective strategies to remediate failed emergence of intraverbals for individuals with ASD. The purpose of Experiment 1 was to extend findings from the MEI literature (e.g., Fiorile & Greer, 2007; Greer, Stolfi, et al., 2005; Greer, Yuan, & Gautreaux, 2005; Nuzzolo-Gomez & Greer, 2004) and Shillingsburg et al. (2018) by systematically evaluating a remedial procedure to promote the emergence of untrained intraverbals for learners with ASD. Two participants with ASD demonstrated mastery of tact, tact function, listener, and listener by function

responses for 12 targets yet failed to emit item-function and function-item intraverbals for the same stimuli. We interspersed related tasks (i.e., listener, tact, listener by function, and tact function responses) in rapidly alternating trials) before the presentation of an intraverbal probe (item-function or function-item). In Experiment 2, the long-term effects of this remedial training on the emergence of untrained intraverbals were evaluated as new tact and listener responses were trained.

Experiment 1

Method

Participants and setting The study was conducted with two children: Michael, a 4-year-old male, and Cody, a 5-year-old male. Both children received 2 hr daily of one-on-one behavioral services targeting skill acquisition. All sessions were conducted at the work area (i.e., table and chair) in the classroom where the children received their clinical services.

Michael was given a provisional diagnosis of ASD at the age of 35 months by a licensed psychologist, and he had received therapy services for 5 months when the study was initiated. The Verbal Behavior Milestones Assessment and Placement Program (VB-MAPP; Sundberg, 2008) was conducted with Michael approximately 4 months prior to the initiation of this study. His overall score on the VB-MAPP was 97, with skills primarily in the 18- to 30-month range (Level 2). Michael scored 8 in the tact and listener domains and 1.5 in the intraverbal domain. At the start of the study, Michael emitted multiword mands and answered multiple questions about one object. Michael acquired new tacts and listener responses with minimal teaching, though his spontaneous utterances primarily consisted of mands. Michael demonstrated emergence of untrained tacts following listener training and emergence of untrained listener responses following tact training.

Cody was given a provisional diagnosis of pervasive developmental disorder–not otherwise specified (PDD-NOS) at the age of 34 months by a licensed psychologist and had received therapy services for 10 months when the study was initiated. The VB-MAPP (Sundberg, 2008) was conducted with Cody approximately 11 months prior to the initiation of this study. His overall score on the VB-MAPP was 52, with skills primarily in the 0- to 18-month range (Level 1), though he demonstrated some emerging skills in the 18- to 30-month range (Level 2). Cody scored an 8 in the tact domain, a 5 in the listener domain, and a 0 in the intraverbal domain. These scores were consistent with skill development between 18 and 30 months. At the start of the study, Cody emitted multiword mands and answered multiple questions about one object. Cody typically required more instructional time than Michael did to acquire new skills, though Cody spontaneously emitted mands, tacts, and rote social intraverbals (i.e., greetings that followed a particular script) while interacting with his clinical team. Cody also demonstrated emergence of untrained tacts following listener training and emergence of untrained listener responses following tact training.

Materials Materials typical to the participants' programming were present, including, but not limited to, data sheets, tokens, token boards, pictorial stimuli, and preferred

items. Identification of items and activities that may potentially serve as reinforcers was a component of ongoing clinical services. These assessments were not repeated for the purposes of this procedure, as the clinical team members serving the participants during daily clinical sessions were the same individuals conducting the experimental procedures. One picture, 6.3 cm × 8.9 cm, was used to represent each target item. Pictures were printed and glued to white index cards (7.6 cm × 12.7 cm).

During clinical intervention, both Michael and Cody had been trained to emit a variety of tact, tact function, listener, and listener by function skills related to household items and body parts. Review of clinical records indicated that despite mastery of tact, tact function, listener, and listener by function skills, related intraverbals (i.e., item-function and function-item) failed to emerge for all targets. For example, the participants tacted "ball"; selected the ball; tacted "throw" when shown a ball and asked, "What do you do with this?"; and selected the ball when asked, "What do you throw?" However, when asked, "What do you throw?" and "What do you do with a ball?" the participants failed to emit correct responses. Mastery criteria during clinical services for intraverbals, tact, tact function, listener, and listener by function skills were considered three consecutive correct responses on probe trials. For both participants, 12 target items were identified for which "prerequisite" skills (i.e., tact, tact function, listener, and listener by function responses) met mastery criteria but related intraverbals (i.e., function-item and item-function) did not. Once targets were identified through the records review, formal pretesting was conducted (see the Pretesting section). See Tables 1 and 2 for target items and responses.

Dependent variables and response definitions The primary dependent measure was the number of correct item-function and function-item intraverbals emitted during daily probes. To be considered correct, the vocal response had to be emitted within 5 s of the verbal antecedent presented by the instructor. Responses were scored as correct if they were under control of all verbal antecedent stimuli presented by the experimenter. For example, if the participant emitted the response "water" following the question "What do you swim in?" this would be scored as correct, though the expected response was "pool." However, if the participant said "fish," this would be scored as incorrect, as it was not under control of all verbal antecedent stimuli. If the participant echoed the verbal antecedent stimulus, an additional 5 s to respond was allowed in the event that the echoic was part of a possible verbal mediation strategy (e.g., "What do you do with a book?" "Book . . . read"), as described by Vallinger-Brown and Rosales (2014). Trials with only an echoic, no response, or a response that did not correspond to the question were considered incorrect. Intraverbals were categorized as either intraverbals exposed to interspersal treatment or untrained intraverbals (if the target was never exposed to the interspersal treatment). Additionally, the cumulative number of correct intraverbals emitted over the course of the experiment was tracked. For this measure, the first time that a correct response was emitted, it was added to the total number of correct intraverbals for that daily probe session and added to the cumulative number of correct intraverbals calculated across sessions. This measure was included to capture the point in the experimental progression that the first occurrence of an intraverbal took place.

Mastered tasks were incorporated throughout the study, though the types of tasks that were included varied depending on the condition. Because the systematic application of the related, mastered tasks was a primary component of the treatment condition,

Table 1 Intraverbal Targets for Michael (Experiment 1)

Target	Number	Relation	Discriminative Stimulus	Response
Book	1	AE1	"What do you do with a book?"	"Read"
		CD1	"What do you read?"	"Book"
Block	2	AE2	"What do you do with a block?"	"Stack"
		CD2	"What do you stack?"	"Block"
Shoe	3	AE3	"What do you do with a shoe?"	"Wear"
		CD3	"What do you wear?"	"Shoe"
TV	4	AE4	"What do you do with a TV?"	"Watch"
		CD4	"What do you watch?"	"TV"
Marker	5	AE5	"What do you do with a marker?"	"Color"
		CD5	"What do you use to color?"	"Marker"
Ball	6	AE6	"What do you do with a ball?"	"Kick"
		CD6	"What do you kick?"	"Ball"
Chair	7	AE7	"What do you do with a chair?"	"Sit"
		CD7	"What do you sit on?"	"Chair"
Nose	8	AE8	"What do you do with your nose?"	"Smell"
		CD8	"What do you use to smell?"	"Nose"
Pool	9	AE9	"What do you do with a pool?"	"Swim"
		CD9	"What do you swim in?"	"Pool"
Ear	10	AE10	"What do you do with your ear?"	"Hear"
		CD10	"What do you use to hear?"	"Ear"
Car	11	AE11	"What do you do with a car?"	"Drive"
		CD11	"What do you drive?"	"Car"
Wagon	12	AE12	"What do you do with a wagon?"	"Ride"
		CD12	"What do you ride?"	"Wagon"

the approximate number of total trials per daily probe (i.e., trials of mastered tasks and probe trials) was held constant across the baseline and posttreatment conditions: 24 probe trials and 48 mastered tasks (more if error corrections occurred). This matched inclusion of mastered-task trials also allowed us to rule out the ameliorating effects of behavioral momentum (Nevin, Mandell, & Atak, 1983) alone as a mechanism for change in the treatment condition. Across all mastered tasks, the target response had to occur within 5 s to be considered correct. During daily probes, mastered motor-imitation and unrelated listener tasks (i.e., clap, wave, stomp your feet) were interspersed prior to the presentation of an intraverbal probe. These motor-imitation and listener tasks had been mastered during clinical services and were commonly used as high-probability responses to establish behavioral momentum. Correct motor-imitation responses consisted of the display of an identical physical action following the instructor's model, paired with the vocal instruction "Do this." Correct unrelated listener responses consisted of the participant displaying a target action following the instructor vocally stating a desired action (e.g., "Touch your nose."). During interspersal treatment (and daily probes for the targets in interspersal treatment), mastered and related

Table 2 Intraverbal Targets for Cody (Experiment 1)

Target	Number	Relation	Discriminative Stimulus	Response
Nose	1	AE1	"What do you do with your nose?"	"Smell"
		CD1	"What do you use to smell?"	"Nose"
Rattle	2	AE2	"What do you do with a rattle?"	"Shake"
		CD2	"What do you shake?"	"Rattle"
Ear	3	AE3	"What do you do with your ear?"	"Hear"
		CD3	"What do you use to hear?"	"Ear"
Oven	4	AE4	"What do you use to cook?"	"Oven"
		CD4	"What do you do with an oven?"	"Cook"
Razor	5	AE5	"What do you do with a razor?"	"Shave"
		CD5	"What do you use to shave?"	"Razor"
Trampoline	6	AE6	"What do you do with a trampoline?"	"Jump"
		CD6	"What do you use to jump?"	"Trampoline"
Knife	7	AE7	"What do you do with a knife?"	"Cut"
		CD7	"What do you use to cut?"	"Knife"
Keyboard	8	AE8	"What do you do with a keyboard?"	"Type"
		CD8	"What do you use to type?"	"Keyboard"
Blanket	9	AE9	"What do you do with a blanket?"	"Keep warm"
		CD9	"What do you use to keep warm?"	"Blanket"
Straw	10	AE10	"What do you do with a straw?"	"Sip"
		CD10	"What do you use to sip?"	"Straw"
Fan	11	AE11	"What do you do with a fan?"	"Cool off"
		CD11	"What do you use to cool off?"	"Fan"
Towel	12	AE12	"What do you do with a towel?"	"Dry"
		CD12	"What do you use to dry?"	"Towel"

tact, listener, tact function, and listener by function tasks were presented. Correct tact responses consisted of the participant vocalizing the item or object tact following the instructor presenting a picture and asking, "What is it?" A correct listener response consisted of the participant selecting a picture from an array of four pictures following the instructor saying, "Point to [item]." A correct tact function response consisted of the participant stating the function of an item when shown a picture and asked, "What do you do with this?" A correct listener by function response consisted of the participant selecting a picture from an array of four when asked, "What do you use to [function]?" Of note, data were not collected on correct or incorrect performance of these responses; however, the clinician checked a box on the data sheet to indicate that a mastered related or unrelated task was presented.

Stimuli and responses were assigned unique alphabetical designations: the dictated item tact (A), the picture of the item (B), the dictated function assigned to the item (C), the spoken item tact (D), and the spoken function assigned to the item (E). Therefore, the skills evaluated are represented as such: tact (BD), listener (AB), listener by function (CB), tact function (BE), item-function intraverbal (AE), and function-item

intraverbal (CD). See Fig. 1 for a diagram of the relations. Target items were assigned a number, and these alphanumeric designations were applied for consistency across studies and for brevity (see Tables 1 and 2). AE and CD intraverbals were the responses of primary interest, and once in interspersal treatment, they were evaluated as a pair because they shared the same related responses. For example, AE1 and CD1 for Cody both related to nose (e.g., "What do you use to smell?" and Cody says "nose" and "What do you do with your nose?" and Cody says "smell"), and the mastered tact (BD), listener (AB), listener by function (CB), and tact function (BE) tasks corresponded to both intraverbals. Across conditions, intraverbals were scored as correct independent of one another, though decisions to begin or suspend interspersal treatment were based on both intraverbals in the pair meeting mastery criteria. These mastery criteria considered three consecutive correct responses on daily probe trials for both intraverbals in the pair (i.e., AE and CD).

Interobserver agreement Reliability data were collected by a secondary trained observer during Michael's and Cody's sessions. Interobserver agreement (IOA) was calculated by taking the total number of agreements and dividing this number by the sum of the total agreements and disagreements, then multiplying by 100. For Michael, reliability data were collected on 58% of daily probe sessions with a mean agreement of 99.7% (range 95.8%–

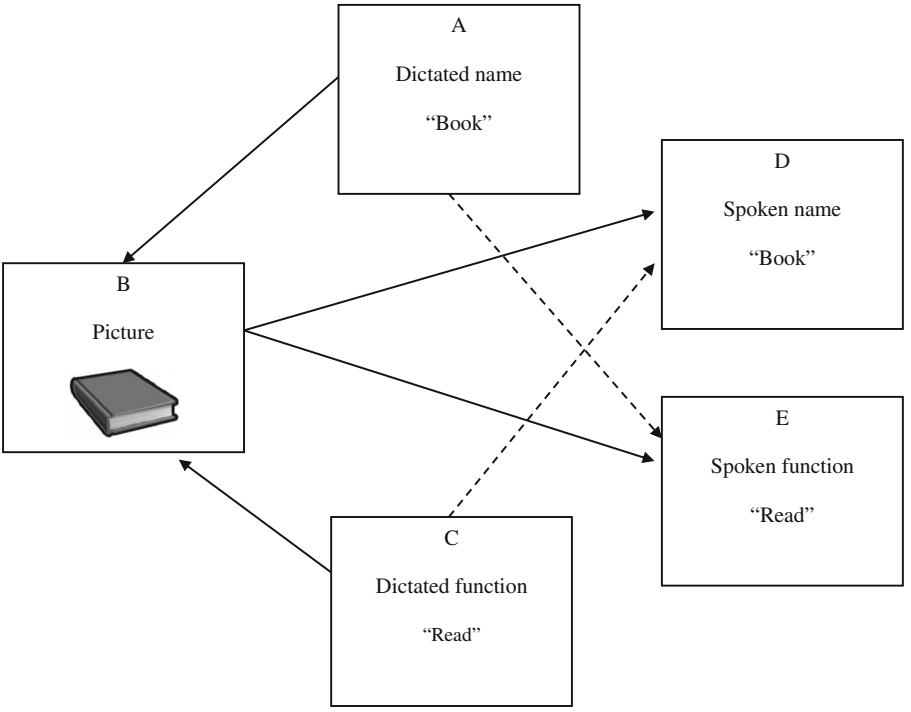

Fig. 1. Map of relations evaluated for each target. Relations shown with a solid black line indicate existing skills, evaluated in pretraining. These include the AB relation (listener), BD relation (tact), CB relation (listener by function), and BE relation (tact function). Relations shown with a dashed black line indicate skills to be evaluated within the protocol. These include the AE relation (item-function intraverbal) and CD relation (function-item intraverbal)

100%). Reliability data were collected on 69% of treatment sessions with a mean agreement of 100%. For Cody, reliability data were collected on 24% of daily probe sessions with a mean agreement of 99.7% (range 95.8%–100%). Reliability data were collected on 14.3% of treatment sessions with a mean agreement of 100%.

Design A nonconcurrent multiple-baseline (Watson & Workman, 1981) across-participants design was used to evaluate the effects of interspersal treatment on the number of correct intraverbals during daily probes. For each participant, an initial baseline was conducted to evaluate the occurrence of intraverbals (CD and AE) during daily probes. Next, interspersal treatment was introduced for one intraverbal pair (i.e., AE1 and CD1: "What do you throw?" and "What do you do with a ball?") at a time, and effects on that pair and all untreated pairs were examined (i.e., AE2–12 and CD2–12). Once mastery criteria were met for the target pair, interspersal treatment was withdrawn for that pair, and maintenance was evaluated in the posttreatment condition. This process was repeated with subsequent intraverbal pairs until emergence was reliably observed.

Pretesting Pretesting was conducted to ensure that BD, AB, CB, and BE responses were mastered prior to beginning the intervention. Probe trials consisted of the presentation of the discriminative stimulus, a 5-s response interval, and a neutral response from the instructor. No reinforcement was provided during probe trials. Unrelated motor-imitation and listener tasks were interspersed, and compliance was reinforced with access to a tangible item (Michael) or a token (Cody). Tangible items were identified prior to sessions based on the participants' vocal mands or gestures (e.g., reaching for an item). Once Cody earned 10 tokens, he exchanged them for a desired item or activity, consistent with his regular clinical programming. For each related, prerequisite response (i.e., BD1–12, AB1–12, CB1–12, and BE1–12), mastery criteria consisted of three consecutive correct responses on probe trials. If responding was below mastery criteria, additional teaching during clinical sessions was conducted until mastery criteria were met or additional targets were evaluated. Once criteria were met for these prerequisite responses, intraverbals (AE1–12 and CD1–12) were probed to confirm they did not meet mastery criteria prior to beginning the study.

General procedures for daily probes Each intraverbal (AE1–12 and CD1–12) was evaluated once per day for a total of 24 daily probe trials. Prior to the presentation of each intraverbal, the participant was presented with one to two trials of mastered and unrelated motor-imitation or listener tasks. For instance, the instructor might present a motor-imitation task (e.g., clap hands), followed by a listener instruction (e.g., wave), and then conduct an intraverbal probe (e.g., "What do you do with your nose?"). Correct responses to the mastered tasks resulted in praise. Incorrect responses were followed by error correction consisting of the instructor re-presenting the instruction, followed by an immediate prompt (physical or gestural), immediately followed by another presentation of the instruction in the absence of a prompt. This was repeated until a correct response occurred on the unprompted trial. All responses on intraverbal probes were followed by neutral statements (e.g., "OK," "uh-huh"). During daily probe sessions, no differential consequences were provided following intraverbals to ensure that any changes in responding could be attributed to the effects of the intervention,

rather than to direct effects of reinforcement. To prevent extinction within the session, a correct response to an unrelated mastered motor-imitation or listener task was reinforced with a tangible item (for Michael) or a token (for Cody) after an average of three intraverbal probes.

Baseline Daily probes were conducted as described previously. Cody emitted some correct responses in baseline, but he did not consistently emit both intraverbals in a pair; thus, these targets were still included in the study.

Interspersal treatment Once stability was observed within and across intraverbal pairs during baseline daily probes, one intraverbal pair was exposed to interspersal treatment sessions. Each interspersal treatment session took place following the completion of the daily probe session. During interspersal treatment, both intraverbals in the target pair (e.g., AE1 and CD1) were presented on 6 trials for a total of 12 trials per session. These presentations were all considered probes, as no transfer of stimulus control procedures were used to occasion correct responses. Prior to the presentation of an intraverbal probe during the interspersal treatment session, the four mastered, related tasks (e.g., BD1, AB1, CB1, and BE1) were presented in varied sequence. An example instructional sequence could consist of (a) the tact function for nose, "What do you do with this?" (BE); (b) the listener nose, "Point to nose." (AB); (c) the listener by function for *nose*, "What do you use to smell?" (CB); (d) the tact nose, "What is it?" (BD); and then (e) an intraverbal probe for nose, "What do you do with your nose?" (AE). The instructor randomly presented the related tasks to avoid patterning. Correct responses to the mastered, related tasks led to praise, and incorrect responses resulted in error correction. If an incorrect response occurred on the intraverbal probe, a neutral statement was provided (e.g., "OK" or "uh-huh") and a mastered, related task (e.g., BD1, AB1, CB1, or BE1) was presented again, followed by a tangible item (Michael) or a token (Cody). The response to the mastered task was reinforced to prevent responding from being extinguished during the session. If an incorrect response occurred for the mastered task, the error correction was conducted, and reinforcement followed a correct response on the independent trial.

If a correct response occurred on the intraverbal probe, praise and access to the tangible item (Michael) or the token (Cody) were immediately provided. Following the occurrence of a correct intraverbal on a probe (either AE or CD) during the interspersal treatment session, a differential reinforcement schedule was implemented for the remainder of that session (Karsten & Carr, 2009). From that point on, during interspersal treatment, only correct responses on intraverbal probes were reinforced with access to a tangible item or token. If an incorrect intraverbal response occurred on a probe, a neutral statement was provided, a mastered, related task was presented, but only praise was provided. As in Karsten and Carr (2009), this schedule would reset when the next interspersal treatment session was conducted. Correct responding on intraverbal probes was measured during interspersal treatment sessions; however, performance during these sessions was not used to determine mastery. Only performance during the daily probes was used to determine whether the interspersal treatment sessions should continue.

When an intraverbal pair was put into the interspersal treatment condition, the daily probe procedures were modified slightly from baseline for that pair only (i.e., AE1 and

CD1). All other intraverbal pairs (i.e., AE2–12 and CD2–12) remained in baseline with no changes to the probe procedures. For the target pair, the one to two trials of mastered, unrelated tasks (i.e., motor-imitation and listener instructions) were replaced with one to two trials of mastered, related tasks (i.e., BD, AB, CB, or BE) prior to the intraverbal probe. An example instructional sequence consisted of (a) the tact nose, "What is this?" (BD); (b) the listener by function for nose, "What do you use to smell?" (CB); and then (c) an intraverbal probe for nose, "What do you do with your nose?" (AE). As described previously, correct responses to mastered tasks led to praise, and incorrect responses were followed by error correction. The instructor randomly presented the one to two mastered, related tasks to avoid any order or sequence patterns. Mastery criteria for the target pair were three consecutive correct responses during daily probe sessions. When mastery criteria were met during daily probes, the interspersal treatment was discontinued for that pair, and the posttreatment evaluation began.

Posttreatment The target intraverbal pair (e.g., AE1 and CD1) were no longer exposed to the interspersal treatment session, and the mastered tasks were again unrelated (i.e., motor-imitation and listener instructions) and identical to baseline.

Retraining For Cody, an additional condition was developed due to suspected deterioration of the tact function (BE) and listener by function (CB) responses. Maintenance for these mastered skills had not been programmed into the experiment, and it is possible that failure to maintain these responses impeded emergence of the related intraverbals. To evaluate this hypothesis, BE and CB probes were added to the daily probe sessions for all 12 targets. Following the daily probe for the intraverbals (AE1–12 and CD1–12) and the tact function and listener by function responses (BE1–12 and CB1–12), a retraining session was conducted. Any BE or CB response that was incorrect during the daily probe was taught during the retraining session. Trials were presented in a randomized order across targets (1–12) and response types (BE and CB). All trials began with an initial independent opportunity, which was followed by reinforcement (i.e., praise and token or praise and tangible) if the response was correct. If the response was incorrect, the training sequence was initiated. During the training sequence, the instruction was re-presented and an immediate prompt (echoic for BE and gestural for CB) was used to occasion the correct response. The instruction was presented again without a prompt, and a correct response was followed by praise. Then, a mastered, unrelated task (i.e., motor-imitation or listener instruction) was interspersed, followed by a final presentation of the instruction. Correct responses were reinforced with praise and a token to end the training sequence. If an incorrect response occurred at any point during the training sequence, the instruction was re-presented and paired with an immediate prompt; the training sequence was then considered over.

Results

Results of daily probes for Cody and Michael are shown in Fig. 2, and sessions to mastery of interspersal treatment are shown in Table 3. In baseline (Fig. 2), Michael emitted no correct item-function (AE) and function-item (CD) intraverbals. After four interspersal treatment sessions (Table 3), Michael's responding met mastery criteria for

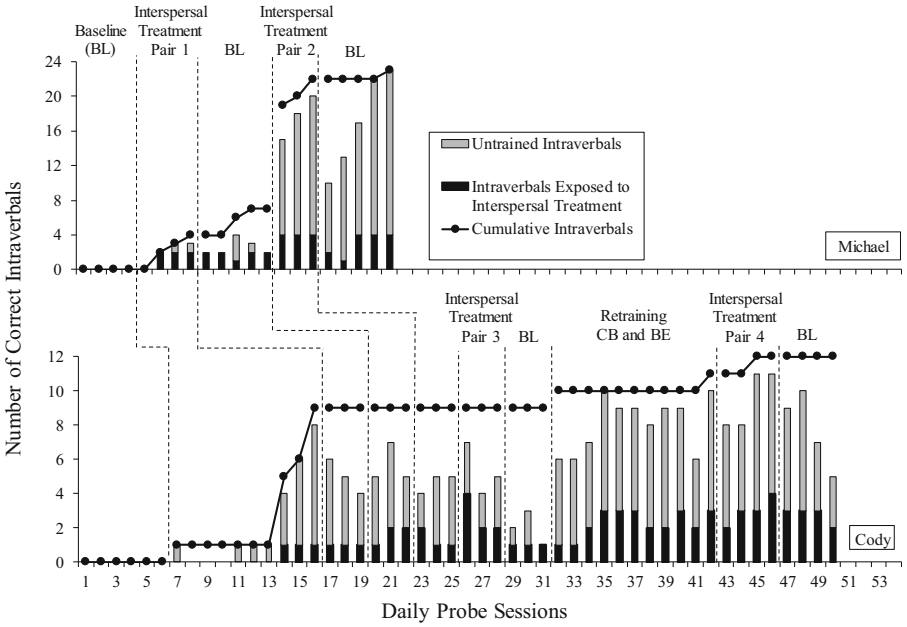

Fig. 2. Results of daily probes are shown for Michael and Cody. Black bars represent the number of intraverbals emitted during the daily probe session that had been exposed to interspersal treatment. Gray bars represent the number of untrained intraverbals emitted during the daily probe session (i.e., not exposed to interspersal treatment). The filled circles represent the cumulative number of intraverbals emitted across daily probe sessions

Pair 1 (Daily Probe 8). He also emitted two untrained intraverbals (i.e., CD6 and CD5), bringing the cumulative number of correct intraverbals up to four (Fig. 2). Posttreatment was in effect for Daily Probes 9–13. Correct responding with Pair 1 maintained with only minor fluctuation, and three additional untrained intraverbals occurred on at least one trial (i.e., AE3, CD10, and AE12), bringing the cumulative number of correct intraverbals up to seven by Daily Probe 13. Pair 2 (CD2 and AE2) was exposed to interspersal treatment, and the target intraverbals occurred during the subsequent probe, Daily Probe 14, along with an additional 11 untrained intraverbals (i.e., CD3, AE4, CD4, AE5, AE6, CD9, CD7, AE11, CD11, AE12, and CD12). Michael's responding met mastery criteria for Pair 2 after three interspersal treatment sessions (Daily Probe 16), and review of the cumulative correct intraverbals indicated that only two

Table 3 Performance During Interspersal Treatment Sessions

Participant	Intraverbal Pair	Sessions to Mastery
Michael	AE1 and CD1	4
	AE2 and CD2	3
Cody	AE1 and CD1	10
	AE2 and CD2	3
	AE3 and CD3	3
	AE4 and CD4	6

intraverbals had yet to emerge (i.e., AE9 and AE7). On Daily Probe 17, posttreatment was implemented for Pair 2. During Daily Probes 17–18, some decrements in correct responding for treated intraverbals were observed, but this stabilized in Daily Probes 19–21. Correct untrained intraverbal responses remained high, and the cumulative number of correct intraverbals reached 23; only AE7 failed to emerge. Thus, for Michael, interspersal treatment for two intraverbal pairs led to correct responses for 23 out of 24 intraverbals.

During baseline, Cody emitted several correct item-function intraverbals (i.e., AE1, AE2, AE3, AE4, AE5, AE6, AE7, AE8, AE9, AE10, and AE11) and one function-item intraverbal (CD5). These responses are excluded from Fig. 2 and not counted in the overall number of correct responses during daily probe sessions. Although responses to AE1 occurred during baseline, Pair 1 (CD1 and AE1) was put into interspersal treatment. After 10 interspersal treatment sessions (on Daily Probe 16; Table 3), his responding met the mastery criterion for Pair 1. By Daily Probe 16, eight untrained intraverbals emerged (i.e., CD3, CD11, CD7, CD2, CD10, AE12, CD12, and CD6), bringing the cumulative number correct to nine (Fig. 2). Posttreatment was in effect for Daily Probes 17–19. Responding for CD1 maintained, but no additional untrained intraverbal responses emerged. Following Daily Probe 19, Pair 2 (CD2 and AE2) was put into interspersal treatment. After three sessions of interspersal treatment, Cody's responding met mastery criteria for Pair 2 (on Daily Probe 23). However, no additional untrained intraverbals were emitted. Daily Probes 23–25 were conducted under post-treatment conditions, and some decrements in correct responding to the previously treated intraverbal (CD1) were observed. Following Daily Probe 25, Pair 3 (CD3 and AE3) was put into interspersal treatment. As observed with Pair 2, Cody's responding quickly met mastery criteria following three sessions of interspersal treatment (Daily Probe 28).

During Daily Probes 29–31, a decreasing trend in the occurrence of intraverbals was observed. It was suspected that the previously mastered tact function (BE) and listener by function (CB) prerequisite responses had deteriorated, affecting responding on intraverbal probes. Starting on Daily Probe 32, retraining was initiated, leading to an immediate increase in the overall number of correct intraverbals and the emergence of another untrained intraverbal (CD8). Retraining continued until all the BE and CB relations met mastery criteria. By Daily Probe 42, review of cumulative correct responses indicated that all but one of the intraverbals (CD4) had occurred at least once during daily probes. Thus, the remaining target pair (CD4 and AE4) was put into interspersal treatment. Following six sessions of interspersal treatment (Daily Probe 46), mastery criteria were met for this pair. Posttreatment was in effect for Daily Probes 47–50. Some decrease in intraverbals was observed, though responding for Pair 4 maintained. Thus, for Cody, interspersal treatment for four pairs of intraverbals and retraining of BE and CB relations led to the emergence of 12 intraverbals.

Discussion

Prior to baseline, Michael and Cody tacted each of the 12 pictures (BD), selected them by name (AB), tacted their function (BE), and selected them by function (CB). However, Michael emitted none of the 24 related item-function and function-item intraverbals (CD1–12 and AE1–12), and Cody only emitted 12 of the intraverbals

(AE1–11, CD5). Following interspersal treatment, emergence of intraverbals was observed for both participants. These findings are noteworthy because interspersal treatment did not include transfer of stimulus control procedures, which are commonly used to directly train intraverbals (Axe, 2008). Results of this study show that interspersing related tasks, in close temporal contiguity with a target intraverbal, can result in untrained intraverbals. Possible mechanisms that explain the observed emergence and implications for clinical practice are found in the General Discussion section. At the completion of the study, it was hypothesized that remedial procedures would no longer be needed to produce the emergence of item-function and function-item intraverbals following tact and listener training related to item function. In other words, it was suspected that going forward, as new BE (tact function) or CB (listener by function) responses were trained, the corresponding intraverbals (AE and CD) would also emerge. Thus, the purpose of Experiment 2 was to evaluate the long-term effects of the interspersal treatment.

Experiment 2

Method

Participant and setting Michael, at this point 57 months old, participated in the study. The study was initiated 2 months following the completion of Experiment 1, and sessions were conducted in the same setting as Experiment 1.

Materials Materials were identical to Experiment 1; however, five new targets relating to common items (see Table 4) were identified. As in Experiment 1, pretesting data indicated that Michael could emit tact (BD) and listener (AB) responses but not emit intraverbals (AE and CD) related to the targets.

Dependent variables and response definitions Like Experiment 1, the primary dependent measure was the number of correct intraverbals (CD and AE). Additional dependent variables included the number of correct tact function (BE) and listener by function (CB) responses. The same definitions of correct responses used in Experiment 1 were applied in Experiment 2.

IOA and procedural fidelity Reliability data were simultaneously collected by a second trained observer during Michael's sessions and calculated as in Experiment 1. IOA data were collected on 65% of daily probe sessions with a mean agreement of 99.5% (range 89.47%–100%) and were collected on 65% of treatment sessions with a mean agreement of 100%.

Procedural fidelity data were collected by a trained observer. A data sheet was developed that outlined the correct implementation of each step. For daily probe sessions, data were collected on whether the instructor made preferred items available and waited for a mand to occur, presented mastered tasks correctly, presented the probe trial correctly, and provided reinforcement following correct responses to interspersed mastered tasks only. For treatment sessions, data were collected on whether the instructor made preferred items available and waited for a mand to occur, presented

Table 4 Target Listener Responses, Tacts, and Intraverbals for Michael (Experiment 2)

Target	Number	Relation	Discriminative Stimulus	Response
Battery	13	BE13	"What do you do with this?" + picture	"Power"
		CB13	"What do you use to power?" + array of pictures	Select battery
		AE13	"What do you do with a battery?"	"Power"
		CD13	"What do you use to power?"	"Battery"
Glue	14	BE14	"What do you do with this?" + picture	"Stick"
		CB14	"What do you use to stick?" + array of pictures	Select glue
		AE14	"What do you do with glue?"	"Stick"
		CD14	"What do you use to stick?"	"Glue"
Whistle	15	BE15	"What do you do with this?" + picture	"Blow"
		CB15	"What do you use to blow?" + array of pictures	Select whistle
		AE15	"What do you do with a whistle?"	"Blow"
		CD15	"What do you use to blow?"	"Whistle"
Vacuum	16	BE16	"What do you do with this?" + picture	"Clean"
		CB16	"What do you use to clean?" + array of pictures	Select vacuum
		AE16	"What do you do with a vacuum?"	"Clean"
		CD16	"What do you use to clean?"	"Vacuum"
Zipper	17	BE17	"What do you do with this?" + picture	"Fasten"
		CB17	"What do you use to fasten?" + array of pictures	Select zipper
		AE17	"What do you do with a zipper?"	"Fasten"
		CD17	"What do you use to fasten?"	"Zipper"

mastered tasks correctly, presented the training sequence correctly, and provided reinforcement following correct responses to trained responses. If the step was completed correctly by the instructor, the data collector scored a "+." If the step was completed incorrectly or was not completed, the data collector scored a "–." The procedural fidelity score was calculated by taking the total number of "+" scores within a session and dividing this number by the sum of the "+"' and "–" steps, then multiplying by 100. Procedural fidelity data were collected on 58.6% of daily probe sessions with a mean of 99.6% (range 99.2%–100%). Procedural fidelity data were collected on 65% of treatment sessions with a mean of 100%.

Design A concurrent multiple-baseline across-behaviors (target items) design was used to evaluate the effects of training on the number of correct listener by function (CB), tact function (BE), item-function intraverbal (AE), and function-item intraverbal (CD) responses. As before, daily probes were conducted for all targets. Following an initial baseline, one target was put into treatment. Once mastery criteria were met for Target 13, the posttreatment evaluation was conducted to evaluate maintenance. At that time, Target 14 was put into treatment, and this process was repeated across all targets.

Pretesting Pretesting procedures and mastery criteria were identical to those of Experiment 1. For each target, tact (BD) and listener (AB) responses established during clinical training were selected. The responses were evaluated using the same pretesting

criteria (i.e., correct responses on three consecutive probe trials), as in Experiment 1. Once criteria were met, listener by function (CB), tact function (BE), and intraverbal (AE and CD) responses were pretested to confirm they did not meet mastery criteria prior to beginning the study.

Procedures for daily probes During daily probes, CB, BE, AE, and CD responses for all five targets were presented once in a mixed order for a total of 20 probes. Prior to a probe, the participant was presented with one to two trials of mastered, unrelated motor-imitation or listener tasks (e.g., motor imitation: clap hands; listener instruction: wave; then a tact function probe for glue: "What do you do with this?"). Procedures for daily probes were identical to those of Experiment 1; however, to prevent temporal contiguity of related responses from influencing responding, probes corresponding to the same target item (e.g., BE1 and AE1) were separated by a minimum of 2 min. This was done to avoid presenting trials in a manner similar to interspersal treatment. To do this, the instructor specifically sequenced probes prior to sessions. Once the instructor had presented one probe corresponding to each of the five different targets (e.g., AE1, CD2, BE3, CB4, CD5), she set a timer for 2 min prior to presenting any additional probes. This guaranteed that at least 2 min elapsed before the presentation of another probe related to the same target item. Neutral feedback followed responses on all probe trials, and access to desired items was provided contingent on compliance with a mastered task after an average of three probe trials. Across all phases and target skills, mastery criteria were three consecutive correct responses on daily probes. There were no procedural differences for daily probes during baseline, treatment, and posttreatment.

Treatment The tact function (BE) response was selected first for treatment, as the literature suggests that tact training more reliably leads to the emergence of listener responding (Delfs, Conine, Frampton, Shillingsburg, & Robinson, 2014; Frampton, Robinson, Conine & Delfs, 2017; Wynn & Smith, 2003). If no emergence or limited emergence was observed, the listener by function (CB) response was selected next for training. If no emergence of the intraverbals (AE and CD) was observed following training for both BE and CB, interspersal treatment would have been implemented as in Experiment 1.

Treatment sessions were conducted after daily probe sessions. One to two mastered, unrelated motor-imitation or listener tasks were presented to Michael before each training sequence. Correct responses to mastered tasks resulted in praise; incorrect responses resulted in the same error correction that was used in Experiment 1. When training the tact function (BE), the instructor presented the target picture and asked, "What do you do with this?" When training the listener by function (CB), four pictures were presented in an array, and the instructor asked, "What do you use to [function]?" or "What do you [function]?" (See Table 4.) If a correct response occurred within 5 s, praise and access to a tangible item were provided. If an incorrect response occurred, the instructor used the training sequence described for Cody in Experiment 1 (i.e., re-present the instruction paired with an immediate prompt; re-present the instruction with no prompt; intersperse a mastered, unrelated task; then re-present the instruction a final time). Each treatment session consisted of 12 initial independent opportunities, which resulted in either immediate reinforcement or the training sequence. The percentage of

correct responses on the initial independent opportunity was tracked, though mastery was determined based on performance during daily probes, as described previously.

Results

Michael's results are displayed in Fig. 3. During baseline, Michael emitted no correct responses. After Daily Probe 5, treatment began for tact function for battery (BE13). On the following daily probe, Daily Probe 6, correct responses were observed for BE13, the trained target, and both untrained intraverbals (AE13 and CD13). During Daily Probes 7–10, correct responses were consistently observed for only one intraverbal (AE13). Responses for the other intraverbal (CD13) were less consistent, and no correct responses were observed for the listener by function response (CB13). Thus, treatment began for CB13 following Daily Probe 11. During Daily Probes 11–13, correct responses were observed for BE13, CB13, AE13, and CD13, meeting mastery criteria. Thus, training tact function (BE13) and listener by function (CB13) responses was sufficient to produce the emergence of the intraverbals (i.e., AE13 and CD13). Target 13 progressed to the posttreatment phase, and maintenance of correct responding was observed.

Following Daily Probe 13, treatment for BE14 was initiated. Michael's responding met mastery criteria for all target responses by Daily Probe 16. Thus, training tact function (BE14) was sufficient to produce the emergence of the listener by function response (CB14) and intraverbals (i.e., AE14 and CD14). Correct responding maintained in the posttreatment phase. Results were similar for the remaining targets. Thus, for four of the five targets, training only the tact function (BE) response resulted in the emergence of the listener by function (CB) and the intraverbal (AE and CD) responses. For all targets, responding maintained when treatment was discontinued.

Discussion

Michael was selected for participation in this sequence of experiments because prior tact and listener training provided in clinical services had failed to yield emergence of untrained intraverbals. Prior to Experiment 1, the tact (BD), listener (AB), tact function (BE), and listener by function (CB) responses for 12 target stimuli were trained to mastery, yet he did not demonstrate any related intraverbals (AE and CD). The interspersal treatment procedure used in Experiment 1 led to the emergence of these untrained intraverbals, despite being applied to only two of the pairs. We wondered if exposure to interspersal treatment in Experiment 1 would have a permanent effect on Michael's repertoire. Specifically, we wanted to see if his previous history with interspersal treatment would have an impact on the emergence of untrained responses following only tact function or listener by functioning training without additional interspersal treatment. Findings from Experiment 2 support this hypothesis, on a preliminary basis, as Michael demonstrated the emergence of all untrained intraverbals (AE and CD) following tact function training alone for four out of five new targets. However, this outcome was not replicated across participants, and the overall effects of sequencing the studies cannot be isolated in this experimental preparation. Discussion of the clinical implications of these results and the possible mechanisms underlying emergence are included next.

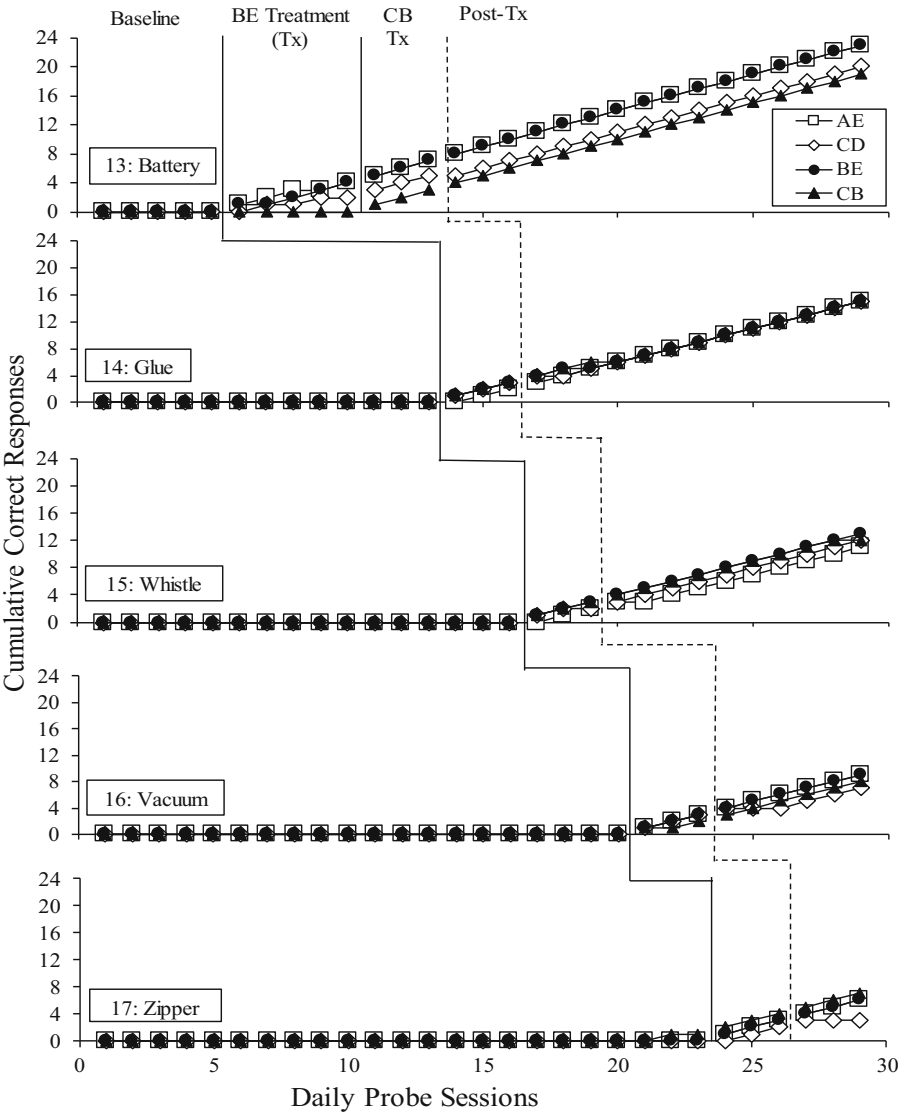

Fig. 3. Results of daily probe sessions across conditions are shown for Michael. Open squares represent item-function intraverbals (AE), open diamonds represent function-item intraverbals (CD), closed circles represent tact function responses (BE), and closed triangles represent listener by function responses (CB)

General Discussion

These findings support the use of the interspersal treatment as an alternative to transfer of stimulus control procedures for establishing intraverbals. Though the acquisition of the targeted intraverbals represents a positive outcome, the most compelling finding was the emergence of untrained intraverbals. Following the introduction of interspersal treatment, effects on untrained intraverbals were observed for both participants. The emergence and maintenance of these responses under extinction conditions suggest that

interspersal treatment may be an efficient means of establishing intraverbals when prerequisite responses (i.e., tact, listener, tact function, listener by function) are already in the repertoire. Finally, results from Experiment 2 suggest that interspersal treatment may produce overall improvements in emergent responding. Replications of these findings are needed, as well as a direct comparison to transfer of stimulus control procedures to determine which approach is most efficient in terms of rapidity of learning, maintenance of skills, number of emergent skills, and effects on subsequent learning opportunities (Wolery, Ault, & Doyle, 1992). Specifically, researches might apply a parallel-treatments design (Delfs et al., 2014; Gast & Wolery, 1988), with one condition consisting of transfer of stimulus control procedures to teach intraverbals and the other consisting of the interspersal treatment, to directly compare the approaches.

As the procedures in the current study are a synthesis of a variety of research lines, there are many ways these findings can be interpreted. These procedures are similar to the task interspersal literature (e.g., Mace et al., 1988; Neef, Iwata, & Page, 1980; Rowan & Pear, 1985); thus, occasioning the emission of verbal responses on the tact and tact function responses during interspersal treatment may have functioned to increase the overall likelihood of the emission of these same verbal responses on the subsequent intraverbal probes. Behavioral momentum (Nevin et al., 1983) suggests that once a response occurs, it is more likely to occur again as it grows in strength. Thus, the strengthening of the "item" and "item-function" verbal responses could have led to an increased chance of contacting reinforcement on the intraverbal probe trials during interspersal treatment. Finally, once the response contacted differential reinforcement during interspersal treatment, it could be brought under appropriate verbal conditional control. However, the order of presentation of the mastered, related tasks varied prior to each intraverbal probe trial, creating only a 25% chance that the response topography emitted immediately before the intraverbal probe would be correct (i.e., if the tact function trial preceded an item-function trial, or if a tact trial preceded a function-item trial). Alternatively, on 75% of trials, the most recently emitted response would have been incorrect on the intraverbal probe. If this were the only mechanism responsible for emergence, more trial-and-error response patterns would have been observed in the interspersal treatment sessions, requiring more sessions to mastery (see Table 3). Furthermore, this would not account for the untrained intraverbals, which were never exposed to the mastered, related responses and differential reinforcement components of the interspersal treatment package.

The emergence of untrained intraverbals may be due to the development of relational frames of coordination, established through the multiple-exemplar training incorporated into the procedures (Hayes, Barnes-Holmes, & Roche, 2001; Stewart, 2018). Across the tact function (BE), listener by function (CB), and intraverbals (AE and CD), the phrases do with and use to could be considered contextual cues for coordination, related to the purpose of items (e.g., "What do you do with [item]?" "What do you use to [function]?"). Interspersal treatment may have functioned to establish these contextual cues once the participants emitted the correct intraverbals and contacted reinforcement. As this history of reinforcement was established for responding in accordance with the relational frame of coordination, derived relational responding might account for the emergence of correct responses within untreated classes. Michael's performance in Experiment 2 could be explained as a product of the strengthening of his derived relational responding repertoire, such that now mutual and

combinatorial entailment occurs in accordance with the relational frame of coordination without remedial training.

The effectiveness of the interspersal treatment may be a product of what Skinner (1957) referred to as "contiguous usage" (p. 75). Skinner described a process by which tacts might transfer to intraverbals based on the "nonverbal circumstances under which they are emitted occuring together" (p. 75). It is this proposed mechanism that underlies the logic of multiple tact-training procedures (e.g., Miguel, Petursdottir, & Carr, 2005). To draw an example from the current study, during interspersal treatment, the participants were required to emit both the item tact and the function tact (e.g., "oven" and "cook") in the presence of the nonverbal stimulus (i.e., a picture) in rapid succession. These prior responses and the reinforcement provided for them may have strengthened the emission of the intraverbal (e.g., "What do you do with an oven?" "cook"). Miguel et al. (2005) proposed a similar process during receptive discrimination-training procedures, which they referred to as "covert contiguous usage" (p. 39). To draw another example from the current study, when the participants were presented with the mastered, related tasks during interspersal treatment, the participants were reported to intermittently emit tacts of the pictures as they selected them by function. To clarify, when presented with an array of pictures and asked, "What do you use to cook?" the participant selected the oven and emitted the tact "oven." The reinforcement provided following the selection response and the tact in the presence of the nonverbal stimulus (i.e., picture) may have been sufficient to establish the intraverbal (e.g., "What do you use to cook?" and the participant said, "oven"). However, it is important to note that these proposed mechanisms would only likely be effective if the participants were simultaneously behaving as speakers and listeners (Horne & Lowe, 1996), consistent with bidirectional naming (BiN; Miguel, 2016).

The BiN account has been experimentally evaluated across a number of studies, consistently demonstrating the emergence of listener behavior following speaker training and vice versa (e.g., Delfs et al., 2014; Frampton et al. 2017; Kobari-Wright & Miguel, 2014; Lee, Miguel, Darcey, & Jennings, 2015; Miguel & Kobari-Wright, 2013; Miguel, Petursdottir, Carr, & Michael, 2008). We hypothesize that interspersal treatment functioned to strengthen BiN for Cody and Michael in Experiment 1. Prior to interspersal treatment, Michael and Cody may have failed to behave as speakers while engaging in listener responding and vice versa. Explicitly requiring the participants to behave as both speakers and listeners in close temporal contiguity may have functioned to establish this capability. This hypothesis is supported by results from the interspersal treatment sessions themselves. During sessions for the first intraverbal pair, intraverbals were slower to emerge, and more sessions were required before mastery-level responding was observed (Table 3). However, intraverbals emerged more rapidly during sessions for subsequent targets. This pattern of responding suggests that a fundamental change in the participants' repertoires had taken place. Several studies examining MEI have reported similar findings regarding the emergence of speaker and listener behavior (Fiorile & Greer, 2007; Gilic & Greer, 2011; Greer, Stolfi, et al., 2005; Greer, Yuan, & Gautreaux, 2005).

The present study has several limitations that may offer fruitful avenues for future research. The current study included two participants of fairly similar ages and presentations. Additional replications of both Experiments 1 and 2 with learners of different ages and language skills would strengthen these results or potentially reveal the need

for even more intensive remedial strategies. Further, the inclusion of the retraining of the tact function (BE) and listener by function (CB) responses for Cody makes it difficult to discern if the emergence of the subsequent intraverbals was due solely to the interspersal treatment. However, the emergence of the majority of the untrained intraverbals was seen prior to the retraining phase, providing support for the effects of the intervention. Future researchers should include systematic maintenance procedures for the mastered responses to reduce the likelihood of deterioration over time. Examples can be seen in the equivalence literature where "baseline" or initially trained relations are mixed randomly with probes for the emergent relations (e.g., Arntzen & Hansen, 2011). However, as the mixing of the trained and untrained responses is likely a critical feature of the present study, rehearsal of these trained responses should occur during separate sessions.

These findings have implications for the design and implementation of clinical and educational services. The VB-MAPP Transition Assessment specifically identifies "Transfer Without Training" as a critical component of the determination of a learner's educational needs. Sundberg (2008) points out that transfer across operants increases "the child's probability of learning in a less restrictive education setting" (p. 140). Consider the difference in instructional time when a learner need only to be taught two responses (i.e., tact [BD] and tact function [BE]) in order to demonstrate the emergence of four untrained responses (i.e., listener [AB], listener by function [CB], item-function intraverbal [AE], function-item intraverbal [CD]), compared to the time needed to directly train all six relations. Not only is the reduction of direct training trials apparent, but there is also increased similarity with instructional practices used in educational settings (Morrow & Brittain, 2003). For example, during story time in preschool classrooms, picture books are read to the class, and students are asked questions corresponding to the spoken or pictorially depicted stimuli. Results from the educational literature suggest that this type of approach produces acquisition of vocabulary from the targeted storybook, as well as general gains in expressive vocabulary (Hargrave & Senechal, 2000). However, a student who requires extensive instruction on individual verbal operants may not benefit from this type of more flexible, varied instruction. Thus, initially investing the time to assess whether emergence of untrained responses occurs and taking remedial steps to ensure that they do could significantly alter where and how a student receives education.

Future research should replicate the procedures used in the current study with additional learners who fail to demonstrate emergent responses, in both applied and basic preparations. In the meantime, this study presents support for an approach that may lead to improved clinical outcomes for more individuals with disabilities. We hope this study is a step forward in the synthesis of methods from a variety of research lines aimed at promoting emergent responses under intraverbal control.

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Compliance with Ethical Standards

Conflict of Interest The authors have no declared financial conflicts of interest.

Ethical Approval All procedures performed in studies involving human participants were in accordance with the ethical standards of the institutional and/or national research committee and with the 1964 Helsinki declaration and its later amendments or comparable ethical standards.

Informed Consent Informed consent was obtained for all individuals in the study.

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