Using Instructive Feedback to Increase Response Variability During Intraverbal Training for Children with Autism Spectrum Disorder

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Abstract We evaluated the effects of instructive feedback on the variability of intraverbal responses for two children with autism spectrum disorder. Specifically, we used an adapted alternating treatments design to compare participants' novel responses and response combinations during an intraverbal category program across conditions with and without instructive feedback. During instructive feedback, secondary targets were presented during the consequence event of the learning trial and consisted of a therapist's model of response variability. The results showed that participants engaged in more novel response combinations during instructive feedback conditions. We discussed the clinical implications of these results as well as areas for future research.

Keywords Autism spectrum disorder · Discrete-trial instruction · Instructive feedback · Response variability · Verbal behavior

Children with ASD may have difficulty responding appropriately to the language of others (e.g., reciprocal conversation and question answering), which can interfere with the development of meaningful social relationships (American Psychiatric Association 2013). Skinner (1957) used the term intraverbal relation to refer to verbal behavior such as certain conversational language, question-answering, or reciprocal language interactions. An intraverbal is a verbal response that is evoked by a verbal antecedent stimulus that lacks point-to-point correspondence with the response. For example, a child might respond, "I am fine," following the verbal antecedent stimulus, "How are you?" The maintaining consequence is a generalized social reinforcer, and the

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reinforcement history and temporal contiguity of the stimuli are important to the stimulus control for the intraverbal. Due to the prevalence of intraverbal behavior during social interactions, teaching intraverbal responses to children with ASD is an important treatment goal (Sundberg and Michael 2001).

A number of recent studies identified effective strategies to teach intraverbal responses to children with ASD (e.g., Ingvarsson and Hollobaugh 2011; Ingvarsson and Le 2011; Kodak et al. 2012). Intraverbal training may be conducted within the format of discrete-trial instruction (DTI; Smith 2001) to provide repeated practice opportunities. For example, a target intraverbal response is prompted and reinforced. As independent responses increase, prompts are gradually faded. A commonly cited disadvantage of using DTI to teach intraverbal responses is that the drill-like nature of the teaching procedure may generate rote responding, and children with ASD may fail to acquire spontaneous language because of the tight stimulus control established with the teaching procedure (Sundberg and Partington 1999). It is possible that repeated trials of prompting and reinforcement may strengthen one target response despite the availability of several, different appropriate responses. For example, during initial acquisition trials for listing members of a category (e.g., “Tell me three animals”), the learner may provide a variety of correct and incorrect responses. However, after repeated exposure to prompts for incorrect responses and reinforcement for correct responses, the learner may engage in fewer varied responses and emit the same three responses needed to gain access to reinforcement (e.g., the learner may say, “cat, dog, pig” on every trial, which consistently produces reinforcement).

Despite the availability of effective procedures for teaching intraverbal responses to children with ASD, few studies have evaluated methods to overcome the potential disadvantages of DTI by promoting variability in newly acquired intraverbal responses. Some recent studies have found that differential reinforcement procedures led to increased variability in verbal responses for children with ASD and other intellectual disabilities (Esch et al. 2009; Heldt and Schlinger 2012; Lee et al. 2002; Lee and Sturme 2006; Susa and Schlinger 2012). For example, Lee et al. used a lag reinforcement schedule to increase variability in vocal responses to social questions for children with autism. The experimenter provided reinforcement for appropriate vocal responses to social questions (e.g., “What do you like to do?”) if the participants’ vocal response varied from their previous response (i.e., lag 1). For 2 of the 3 participants, the lag schedule increased the percentage of trials with varied responses to a social question; however, varied responding did not maintain once the lag schedule was discontinued.

Heldt and Schlinger (2012) used a lag schedule of reinforcement to increase variability in tacts for two children with intellectual disabilities. During sessions with the lag schedule, participants earned praise and access to a preferred item if they emitted a tact that varied from their previous three responses (i.e., lag 3). Both participants’ frequency of varied tacts increased when the lag schedule was introduced, and variable tacts maintained after the lag schedule was withdrawn. However, this study was one of few studies that demonstrated maintenance of varied responding following the removal of the lag schedule. Also, previous studies have typically used lag schedules of reinforcement to increase response variability for responses already in an individual’s repertoire (i.e., following the initial acquisition of a skill). It is possible that promoting response variability during the initial acquisition of skills may prevent patterns of repetitive responses from developing and may facilitate the maintenance of

varied responding. Thus, additional research is needed to identify methods to increase variability in verbal responses for children with ASD.

Instructive feedback is one potential procedure that could be used to increase response variability. Instructive feedback is a procedure that has been shown to increase the efficiency of effective instructional procedures like DTI (Reichow and Wolery 2011; Werts et al. 1993; Wolery et al. 1993a). Instructive feedback involves providing secondary targets (i.e., extra, non-target stimuli) in the consequent event of an instructional trial. Participants are not required to respond to the secondary targets, and the therapist does not provide any programmed reinforcement if the participant does respond to the secondary target. For example, during a trial with instructive feedback, the therapist would present the antecedent verbal stimulus, “What do you eat?” and provide praise and a preferred item if the learner’s response specifies a food item (e.g., “An apple”). While the therapist is delivering the preferred item, she would say, “An apple is a fruit.” In this example, asking “What do you eat?” is the primary target, and the therapist’s statement, “An apple is a fruit,” is the secondary target.

Previous studies show that most participants acquire some or all of the secondary targets in the absence of direct reinforcement; thus, incorporating secondary targets into learning trials provides learners with the opportunity to acquire substantially more skills. This effect has been demonstrated with typically developing children (e.g., Werts et al. 1996), children with intellectual disabilities (e.g., Wolery et al. 1991), students labeled as needing emotional support (e.g., Werts et al. 1993), and, more recently, children with ASD (Loughrey et al. 2014; Reichow and Wolery 2011; Vladescu and Kodak 2013).

Reichow and Wolery (2011) compared the acquisition of target responses for children with ASD who were taught with a progressive prompt-delay (PPD) procedure with and without instructive feedback. The experimenters found that participants acquired the target skills taught with both the PPD procedure with and without instructive feedback. However, participants acquired twice the number of targets in the PPD procedure with instructive feedback compared to the PPD procedure alone. Thus, the addition of instructive feedback increased the efficiency of the PPD procedure.

Vladescu and Kodak (2013) extended Reichow and Wolery (2011) by comparing the efficiency of presenting secondary targets in the antecedent and consequence portions of a learning trial for four children with ASD. The experimenters also examined acquisition of secondary targets when they were presented outside of a learning trial (i.e., in the absence of teaching primary targets). The results showed that three of the four participants acquired the secondary targets in the absence of any direct prompting and reinforcement. For the participants who acquired the secondary targets, acquisition was similar when the secondary targets were presented in the antecedent portion of the trial, the consequence portion of the trial, or when secondary targets were presented in the absence of training for primary targets.

Instructive feedback could be used to increase variability in intraverbal responses for children with ASD. That is, varied intraverbal responses could be presented as secondary targets. For example, a therapist could present the antecedent verbal stimulus “Tell me three vehicles” and wait for a response. If the child says, “Car, truck, bus,” then the therapist could say, “Yay; that’s right! Boat, plane, and tractor are also vehicles.” In this example, “Car, truck, and bus” are the primary targets and “Boat, plane, and tractor” are

the secondary targets. If the presentation of secondary targets in this example is as successful as previous studies that included secondary targets in training, the learner may show increased variability in responses emitted during subsequent response opportunities. In the previous example, the therapist presented the secondary targets “Boat, plane, and tractor” in close temporal proximity to the word “vehicles,” which had previously been paired with reinforcement for emitting the primary target responses, “Car, truck, bus.” Thus, it is possible that the learner may emit one or more of the secondary targets the next time the therapist presents the instruction, “Tell me three vehicles,” despite the fact that the therapist did not provide direct reinforcement if the learner responded to the secondary targets when they were presented in the consequence portion of the learning trial.

We were unable to identify any prior studies that evaluated the use of instructive feedback to increase the variability of verbal responses for children with ASD. The purpose of the present investigation was to evaluate the effects of secondary targets presented in the consequence portion of the learning trial on the variability of intraverbal responses for children diagnosed with ASD. In addition, we compared the differential effects of presenting secondary targets on response variability for tasks the participants had already mastered and demonstrated patterns of rote responding, and for novel tasks for which the participants had no previous training.

General Method

Participants, Setting, and Materials

Two children with ASD, who received early intensive behavioral intervention services from a hospital-based clinic, participated. Shane was a 5-year–3-month-old male who communicated using full sentences. We conducted the Peabody Picture Vocabulary Test-4 (PPVT-4; Dunn and Dunn 2007) with Shane when he was 4 years and 10 months, and his age equivalent was 2.6 years. At the start of the study, Shane was receiving instruction on early literacy skills and had acquired over 150 intraverbal responses including answering questions related to personal information, features of items, functions of items, opposites, and what, where, and when questions. Porter was a 5-year–4-month-old male who communicated using four-to-six word phrases. We conducted the PPVT-4 with Porter when he was 5 years and 2 months, and his age equivalent was 4.2 years. Prior to the start of the study, Porter had acquired over 50 intraverbal responses including answering questions related to personal information, animal sounds, opposites, features of items, and functions of items.

Both participants also previously learned intraverbal categories (e.g., when asked, “What is a circle?” the child said “a shape”) and to provide at least three members of a category when asked “Tell me three (category name).” Both children were identified to participate in the current study because they had a history of rote responding during an intraverbal categories program. That is, when asked to name three items in a category, the participants almost always provided the same three responses in the exact same order.

We identified and included four intraverbal categories that had already been acquired (i.e., mastered tasks) and four intraverbal categories for which the participant had not

received any previous instruction on listing members of those categories (i.e., acquisition tasks). These eight intraverbal categories were semi-randomly assigned to each condition (2 categories per condition; see Table 1). For each category, we assigned four primary targets; for conditions with instructive feedback, we also assigned four secondary targets. Prior to training, we ensured that participants could tact pictures of each of the primary and secondary targets. We conducted all sessions in a private session room that contained a table, two chairs, and the materials necessary to conduct the session (e.g., data sheets, preferred items, and timer).

Dependent Variables and Data Collection

We collected data on participant responses, including (a) correct responses, defined as the participant providing three or more members of a target category following the presentation of the antecedent verbal stimulus (e.g., when presented with, “Tell me some animals,” the participant said, “cat, pig, dog”); (b) prompted responses, defined as a correct response within 5 s of a therapist’s vocal model of three members of a target category; (c) incorrect responses, defined as the participant providing one or more

Table 1 Target responses for each participant by condition

Participant	Task	Condition	Category	Target stimuli
Shane	Mastered	PD IF	Occupations	Primary: fireman, astronaut, cook, farmer Secondary: cop, teacher, vet, doctor
			Food	Primary: pizza, popcorn, cherries, apple Secondary: cake, fries, pear, chips
		PD	Furniture	Primary: chest, bed, chair, couch
			Actions	Primary: hiding, jumping, swinging, drawing
	Acquisition	PD IF	Vehicles	Primary: train, bike, camper, bus Secondary: car, boat, tank, airplane
			Accessories	Primary: ring, necklace, purse, tie Secondary: belt, watch, gloves, earring
		PD	Emotions	Primary: cold, happy, surprised, mad
			Pets	Primary: lizard, dog, fish, bird
Porter	Mastered	PD IF	Shapes	Primary: octagon, star, diamond, rectangle Secondary: heart, square, cross, arrow
			Numbers	Primary: 5, 6, 7, 8 Secondary: 4, 9, 10, 11
		PD	Letters	Primary: D, P, M, T
			Colors	Primary: purple, blue, green, brown
	Acquisition	PD IF	Emotions	Primary: sad, mad, cold, happy Secondary: surprised, hurt, tired, itchy
			Accessories	Primary: ring, necklace, purse, tie Secondary: belt, watch, gloves, earring
		PD	Furniture	Primary: chair, table, pillow, bed
			Vehicles	Primary: car, subway, tractor, van

PD prompt delay, *PD IF* prompt delay with instructive feedback

responses that were not members of a target category; and (d) no responses, defined as the participant not providing a vocal responses or saying “I don’t know” within the specified prompt delay. During sessions with instructive feedback, we collected data on participant echoic responses, defined as the participant emitting a response with point-to-point correspondence to one or more of the secondary targets within 5 s of the therapist’s vocal model of the secondary targets. We converted each dependent measure to a percentage of trials by dividing the number of trials with an occurrence of a participant response by the total number of trials in a session and multiplying by 100.

To evaluate the role of instructive feedback on response variability, we measured the cumulative frequency of participants’ correct novel responses and novel response combinations. We counted a novel response only when the participant emitted a member of a target category for the first time in the study. For example, the child’s response “cat, dog, pig,” to the therapist’s presentation of the antecedent verbal stimulus “Tell me some animals” on the first trial would be counted as three novel responses. The response “cat, dog, horse” on the next trial would be counted as one additional novel response for “horse”, for a total of four novel responses in that session. Novel responses could include primary targets, secondary targets in the prompt-delay with instructive feedback conditions, or other responses that were not targeted (i.e., non-target responses). We counted a novel combination only when the participant emitted three members of a target category in a specific order for the first time in the study. For example, the response “car, bus, plane” to the therapist’s presentation of the antecedent verbal stimulus “Tell me some vehicles” would be counted as one novel combination. If the child’s response on the second trial was “plane, bus, car,” then this would be counted as another novel combination for a total of two novel combinations in that session. If the child said “car, bus, plane” on the third trial, this would not be scored as a novel combination because the child had already provided those three responses in the same order on a previous trial. Novel combinations could include three primary targets, a combination of primary targets and non-target responses, or three non-target responses. During the prompt-delay with instructive feedback conditions, participants could emit novel response combinations consisting of three secondary targets, a combination of primary and secondary targets, or a combination of secondary targets and non-target responses.

Interobserver Agreement and Procedural Integrity

A secondary observer independently collected data during an average of 46 % (range, 39 to 62 %) of sessions across conditions for participants’ correct, incorrect, no responses, prompted responses, and echoic responses. In addition, for every correct participant response, the secondary observer also recorded the three responses provided by the participant. We compared the primary and secondary observers’ data on a trial-by-trial basis and calculated interobserver agreement (IOA) for participants’ responses by taking the number of trials with exact agreements in a session, dividing it by the number of agreements plus disagreements, and converting the result to a percentage. We scored an agreement if both observers recorded the same participant response on a specific trial (e.g., both observers scored the participant’s response as correct). We scored a disagreement if both observers scored a different participant response on a trial (e.g., the primary observer scored the response as a no response, and the secondary

observer scored the response as an error). Mean IOA was 99 % (range, 88 to 100 %) for Shane and 96 % (range, 81 to 100 %) for Porter.

A secondary observer collected treatment integrity data on specific therapist responses during an average of 46 % (range, 39 to 62 %) of sessions across conditions for each participant. Therapist responses included (a) presenting a controlling prompt, defined as providing a vocal model within 2 s of the scheduled prompt delay following incorrect or no responses; (b) delivering a reinforcer, defined as providing verbal praise and brief access to a high-preference tangible or edible item (determined by a daily preference assessment) within 2 s of a correct or prompted response; and (c) presenting secondary targets during the instructive feedback conditions, defined as providing three of the four secondary targets immediately following the delivery of praise and a high-preference item, and withholding reinforcement if the participant echoed the secondary targets (i.e., the therapist did not provide praise or a change in facial expression following a correct echo). Observers scored the implementation of each trial as correct (100 % accuracy) or incorrect (less than 100 % accuracy). We calculated treatment integrity for each session by taking the number of trials implemented correctly, dividing it by the number of trials in a session, and converting the result to a percentage. Mean treatment integrity was 100 % for Shane and 99 % (range, 80 to 100 %) for Porter.

Procedures

We used an adapted-alternating treatments design (Sindelar et al. 1985) to compare the frequency of novel responses and novel response combinations across training conditions with and without instructive feedback for acquisition and mastered tasks. Each session consisted of 10 trials with each category presented in a random order 5 times per session. We conducted 1 to 2 sessions a day for each condition, 1 to 3 days a week. For acquisition tasks, we considered targets mastered once the participants' responded correctly during 90 % of trials for three consecutive sessions. For mastered tasks, we conducted a total of 10 sessions for targets in both the prompt-delay and prompt-delay with instructive feedback conditions.

Baseline During baseline, the participant had 5 s to respond to the therapist's presentation of the antecedent verbal stimulus (e.g., "Tell me three vehicles"). If the participant responded correctly, engaged in an error, or did not respond within 5 s of the antecedent verbal stimulus, the therapist did not provide differential consequences for correct or incorrect responses. However, following approximately every two trials, the therapist delivered praise and brief access to a preferred item contingent on appropriate session behavior (e.g., sitting appropriately, putting hands in lap, having a quiet voice). The therapist did not present instructive feedback during baseline. For acquisition tasks, the purpose of the baseline condition was to demonstrate that participants did not engage in any correct responses prior to implementing the prompt delay with and without instructive feedback. For the mastered tasks, the purpose of baseline was to demonstrate that participants' correct responding and response variability was stable and comparable across sets of targets prior to implementing the prompt delay with and without instructive feedback.

Prompt Delay The general teaching method used across all conditions was a constant prompt-delay procedure (Charlop et al. 1985). We created a list of 20 different combinations of three of the four primary targets, and the therapist rotated through the list of combinations each time she provided a model prompt. This was done to control for the number of different primary targets and target combinations presented by the therapist across the prompt-delay and prompt-delay with instructive feedback conditions. Training for acquisition tasks began with a 0-s prompt delay during which the therapist established ready behavior (i.e., ensured the child was oriented toward the therapist and was not engaging in disruptive movements of the limbs), presented the antecedent verbal stimulus, and immediately delivered a prompt (i.e., modeled three primary targets for a category). After two consecutive sessions during which the participant engaged in prompted responses on at least 90 % of trials, the delay from the presentation of the antecedent verbal stimulus to the prompt was increased to a constant 5 s. For mastered tasks, training began with a constant 5-s prompt delay.

Correct responses that occurred within 5 s of the presentation of the antecedent verbal stimulus resulted in immediate praise and brief access (i.e., 15 to 25 s) to a preferred edible or tangible item identified in daily brief multiple-stimulus-without-replacement preference assessments (Higbee et al. 2000). If the participant engaged in an incorrect response or did not respond within the prompt delay, then the therapist implemented an error-correction procedure which consisted of re-presenting the trial until the participant responded correctly to the initial antecedent verbal stimulus (Carroll et al. 2015). Immediately following an incorrect response or no response within the prompt delay, the therapist modeled three of the four primary targets in a random and varied order for the category and waited for the participant to echo the correct responses. Immediately after the participant echoed the therapist's model, the therapist re-presented the antecedent verbal stimulus and allowed the participant 5 s to respond independently. The therapist continued to re-present the trial until the participant responded correctly to the therapist's initial presentation of the antecedent verbal stimulus. If the therapist had to implement more than one error correction for the same trial, then the therapist always modeled the same three primary targets in the same order. If the participant responded correctly to the therapist's presentation of the antecedent verbal stimulus during error correction, the therapist provided immediate praise and brief access (i.e., 15 to 25 s) to a preferred edible or tangible item. For acquisition tasks, if participants did not master targets following 10 training sessions, then we provided praise only (i.e., no preferred item) for correct responses during error correction for the remainder of training. The purpose of this condition was to assess the cumulative frequency of novel responses and novel response combinations in the absence of instructive feedback for acquisition and mastered tasks.

Prompt Delay with Instructive Feedback This condition was identical to the prompt-delay condition described above, except that immediately following the delivery of reinforcement for a correct response to the initial instruction or error-correction procedure, the therapist presented three of the four secondary targets for that category. For example, following the antecedent verbal stimulus, "Tell me three shapes," and the participant's response, "Diamond, rectangle, octagon," the therapist provided praise (e.g., "That's right!"), delivered the preferred item, and said, "Heart, square, and arrow are shapes too." as the participant interacted with the preferred item. No differential

consequence was provided if the participant echoed one or more of the secondary targets (i.e., the therapist did not say anything, or change facial expression).

We created a list of 20 different combinations of 3 of the 4 secondary targets. Each time the therapist presented secondary targets, she rotated through the list providing 1 of the 20 combinations. This was done to control for the number of different secondary targets and target combinations presented by the therapist across sessions. If the participant's initial correct responses included more than one of the secondary targets, then the therapist provided one or more of the primary targets during instructive feedback. For acquisition tasks, if tangible reinforcement was removed for correct responses during error correction (i.e., the participant had not met mastery following 10 training sessions), then following a correct response on an error-correction trial, the therapist delivered praise, immediately presented three of the four secondary targets, and then presented the next trial following a brief inter-trial interval. The purpose of this condition was to assess the effects of instructive feedback on the cumulative frequency of novel responses and novel response combinations for acquisition and mastered tasks.

Results

Figures 1 and 2 display the percentage of correct responses (top panel), cumulative frequency of novel response combinations (middle panel), and cumulative frequency of novel responses (bottom panel) across the mastered tasks and acquisition tasks for Shane and Porter, respectively. The three panels on the left of each figure show responding during mastered tasks and the three panels on the right show responding during acquisition tasks. Data for the 0-s prompt-delay sessions are not depicted in the figures.

For Shane, there was no difference in responding across the prompt-delay and prompt-delay with instructive feedback conditions for mastered tasks (Fig. 1; left panels). He consistently engaged in a high percentage of correct responses (top panel), and his frequency of novel response combinations (middle panel) and novel responses (bottom panel) did not change across sessions. For acquisition tasks (Fig. 1; right panels), Shane acquired targets from the prompt-delay with instructive feedback condition (10 sessions, 69 min) in fewer sessions and less training time than the prompt-delay condition (15 sessions, 81 min; top panel). During training of acquisition tasks, Shane engaged in more novel response combinations (middle panel) during the prompt-delay with instructive feedback condition (10 combinations) when compared to the prompt-delay condition (5 combinations). Shane engaged in a similar number of novel responses across the prompt-delay with instructive feedback (8 responses) and prompt-delay (7 responses) conditions (bottom panel). During sessions with instructive feedback, Shane never echoed the therapist's model of the secondary targets for mastered and acquisition tasks.

For mastered tasks (Fig. 1; left panels), Porter's percentage of correct responses was high across both the prompt-delay and prompt-delay with instructive feedback conditions (top panel). Porter engaged in more novel response combinations (middle panel) during the prompt-delay with instructive feedback condition (9 combinations) when compared to the prompt-delay condition (5 combinations). Porter engaged in a similar

Fig. 1 Percentage of correct responses (*top panel*), cumulative frequency of novel response combinations (*middle panel*), and cumulative frequency of novel responses (*bottom panel*) across the prompt-delay (PD) and prompt-delay with instructive feedback (PD IF) conditions for the mastered tasks (*three panels on the left*) and acquisition tasks (*three panels on the right*) for Shane

number of novel responses across conditions (bottom panel). For acquisition tasks (Fig. 1; right panels), Porter acquired the targets from the prompt-delay with instructive feedback condition (34 sessions; 207 min) in fewer sessions and less training time than the prompt-delay condition (41 sessions; 230 min; top panel). During training of acquisition tasks, Porter engaged in 10 novel response combinations in each condition (middle panel), and he engaged in a similar number of novel response across the prompt-delay with instructive feedback (10 responses) and prompt-delay (8 responses) conditions (bottom panel). During prompt-delay with instructive feedback sessions, Porter echoed the therapist's model of secondary targets during an average of 55 % of trials for mastered tasks and 58 % of trials for acquisition tasks.

Figure 3 provides a summary of the cumulative frequency of novel responses and novel combinations for each participant across conditions for mastered tasks (left panels) and acquisition tasks (right panels). For the mastered task during both the prompt-delay with and without instructive feedback conditions, Shane engaged in 6 novel primary responses and 2 novel response combinations each made up of 3 primary targets (top left panel). This represents the minimum number of responses and combinations a participant could engage in during a condition. Thus, for the mastered task,

Fig. 2 Percentage of correct responses (*top panel*), cumulative frequency of novel response combinations (*middle panel*), and cumulative frequency of novel responses (*bottom panel*) across the prompt-delay (PD) and prompt-delay with instructive feedback (PD IF) conditions for the mastered tasks (*three panels on the left*) and acquisition tasks (*three panels on the right*) for Porter

Shane emitted the same 3 primary targets in the same order on every trial. For the acquisition task (top right panel), Shane engaged in 7 primary novel responses and 1 non-target novel response during the prompt-delay with instructive feedback condition. During the prompt-delay condition, Shane engaged in 8 primary novel responses and 1 non-target novel response. Shane engaged 10 novel response combinations during the prompt-delay with instructive feedback condition, which included 9 combinations made up of 3 primary targets and 1 combination made up of 2 primary targets and 1 non-target response. He also engaged in 5 novel response combinations during the prompt-delay condition, which included 2 combinations made up of 3 primary targets and 3 combinations made up of 2 primary targets and 1 non-target response.

For the mastered task (bottom left panel), Porter engaged in 8 primary novel responses, 3 secondary novel responses, and 1 other non-target response during the prompt-delay with instructive feedback condition. During the prompt-delay condition, Porter engaged in 6 primary novel responses and 4 non-target responses. Porter engaged in 9 novel response combinations during the prompt-delay with instructive feedback condition, which included 5 combinations made up of 3 primary targets, 1 combination made up of primary and secondary targets, 2 combinations made up of 2 primary targets and 1 non-target response, and 1 combination made up of 2 secondary targets and 1 non-target response. He also engaged in 5 novel response combinations

Fig. 3 Summary of the frequency and type of novel responses and combinations during prompt-delay with instructive feedback (*PD IF*) and prompt-delay (*PD*) conditions with mastered tasks (*left panels*) and acquisition tasks (*right panels*) for Shane (*top panels*) and Porter (*bottom panels*)

during the prompt-delay condition, which included 1 combination made up of 3 primary targets, 3 combinations made up of 2 primary targets and 1 non-target response, and 1 combination made up of 3 non-target responses.

For the acquisition task (bottom right panel), Porter engaged in 7 primary novel responses and 3 secondary novel responses during the prompt-delay with instructive feedback condition. During the prompt-delay condition, Porter engaged in 8 primary novel responses. He also engaged in 10 novel response combinations during the prompt-delay with instructive feedback condition, which included 8 combinations made up of 3 primary targets, 1 combination made up of 3 secondary targets, and 1 combination made up of 2 primary and 1 secondary targets. During the prompt-delay condition, Porter engaged in 10 novel response combinations made up of 3 primary targets.

Discussion

In the present study, we evaluated the use of instructive feedback to increase response variability when teaching intraverbal categories to children with ASD. The results showed that participants engaged in more novel response combinations during the prompt-delay with instructive feedback condition when compared to the prompt-delay condition. For the acquisition task, Shane engaged in twice the number of novel response combinations during the prompt-delay with instructive feedback condition when compared to the prompt-delay condition. Similarly, for the mastered tasks, Porter engaged in almost twice the number of novel response combinations during the prompt-delay with instructive feedback condition when compared to the prompt-

delay condition. The current study extends previous research evaluating methods to increase variability in intraverbal responses for children with ASD. To our knowledge, this is the first study to evaluate the use of instructive feedback as a method to increase response variability. The results of the current study suggest that instructive feedback increased response variability for some of the tasks in the absence of direct reinforcement.

Although both participants engaged in more novel response combinations during one of the instructive feedback conditions, we did not replicate this effect across both task types. That is, Shane engaged in more novel response combinations during the prompt-delay with instructive feedback condition for the acquisition task; however, for mastered tasks, presenting secondary targets in the learning trial had no effect on response variability once a rote pattern of responding had been established. In comparison, Porter engaged in a higher frequency of novel response combinations in the prompt-delay with instructive feedback condition for the mastered task, and we did not observe a difference in response variability between conditions for the acquisition task. The results for Porter suggest that incorporating instructive feedback into training may sometimes promote variability in responding once rote patterns of responding have been established. However, the more reliable benefit of the procedure is observed when it is incorporated into acquisition programming. The current study should be replicated with additional participants to determine if instructive feedback is more likely to increase response variability when it is incorporated into the initial training of primary targets or into maintenance sessions following the acquisition of primary targets. This information could be used to help guide practitioners with incorporating this procedure in their clinical work.

The behavioral mechanism responsible for increased response variability during intervention sessions is not fully clear. It is possible that response variability increased through the process of observational learning (Wolery et al. 1993b). Specifically, the therapist modeled three of the four secondary targets in a different order during each presentation of instructive feedback; thus, the therapist modeled response variability in every trial. In addition, during the prompt-delay conditions, if the participants engaged in an incorrect response or did not respond within the allotted time period, the therapist modeled three of the four primary targets, and the three targets modeled during each trial varied. Thus, in the prompt-delay condition, the therapist also modeled variability on trials when a model prompt was provided. However, the results for Shane suggest that providing a model prompt alone, during which the therapist modeled three of the primary targets in a varied order, did not lead to an increase in novel combinations and responses during the prompt-delay condition. In comparison, we did observe an increase in Porter's response variability during both the prompt-delay with and without instructive feedback conditions for the acquisition task. Thus, it is possible that modeling different primary targets during the prompt-delay condition for acquisition tasks was sufficient to increase Porter's variability in responding. For the mastered task, Porter was not more likely to engage in variable responding during the prompt-delay condition. However, Porter's correct responding was almost always at 100 % during sessions for the mastered task; thus, the therapist rarely presented a model prompt of different primary targets. Therefore, it is possible that for Porter modeling variability at any time in the learning trial (i.e., as a model prompt or as instructive feedback) would be sufficient to increase response variability.

It is also possible that the observed increase in response variability was influenced by participants' generalized imitation repertoire (Baer et al. 1967). That is, both participants had an extensive history of reinforcement for echoing the therapist's model during the initial training of new targets (e.g., training sessions for primary targets); thus, it is possible that the contingencies of reinforcement for imitating primary and secondary targets were indiscriminable. Nevertheless, Shane never overtly echoed the secondary targets presented during prompt-delay with instructive feedback sessions. Porter echoed approximately 50 % of instructive feedback presentations. Despite this difference in echoic behavior, both participants had more novel combinations and novel responses during either acquisition or mastered tasks in the prompt-delay with instructive feedback conditions. It is possible that Shane engaged in covert echoic behavior, which we were unable to observe and measure. Future research that examines the impact of echoic behavior on acquisition may help elucidate the operant mechanisms responsible for the efficacy of instructive feedback.

Although the therapist did not provide immediate reinforcement if the participant echoed the secondary targets, it was possible for the participant to include one or more of the secondary targets as part of a correct response on a subsequent trial. In that case, the therapist would provide direct reinforcement for the participant's response. It is possible that the increased variability that occurred during prompt-delay with instructive feedback conditions was facilitated by opportunities to practice and receive direct reinforcement for responding with secondary targets during training trials. However, although some of the novel responses and response combinations emitted by participants during prompt-delay with instructive feedback conditions included secondary targets, participants were more likely to include one or more of the primary targets in their response. Additionally, novel response combinations were more likely to be different combinations of the primary targets. For example, Shane emitted 10 novel response combinations during the prompt-delay with instructive feedback condition for the acquisition task, and of those 10 combinations, 9 combinations included three of the primary targets. For Porter, 8 of the 10 novel combinations were made up of only primary targets for the acquisition task, and 5 of the 9 novel combinations were made up of only primary targets for the mastered task. Thus, the increased variability we observed during conditions with instructive feedback was not primarily due to participants including secondary targets in their responses.

In the present study, both participants reached our mastery criterion in the prompt-delay with instructive feedback condition in fewer sessions than the prompt-delay condition. This finding suggests that instructive feedback may facilitate the acquisition of new skills. Reichow and Wolery (2011) also found that training with instructive feedback required fewer sessions to mastery than did training without instructive feedback for all three participants. Additional research is needed to evaluate whether the inclusion of instructive feedback leads to more rapid acquisition of primary targets and the behavioral mechanisms that may be responsible for these improvements in learning.

There are some potential limitations of the current study. We conducted a single comparison of the prompt-delay and prompt-delay with instructive feedback conditions

across acquisition and mastered tasks for each participant. Replicating our results with new sets of target stimuli would strengthen the findings of the study. Future research utilizing an adapted alternating treatment design to compare the effectiveness of different instructional strategies should conduct one or more replications with each participant to control for potential differences in the difficulty of target stimuli across conditions. Nevertheless, it is unlikely that the differences in response variability that we observed for mastered tasks during the instructive feedback condition were influenced by the specific targets included in each condition. That is, for the mastered tasks, participants had already acquired the targets prior to our comparison of prompt- delay with and without instructive feedback. Thus, differences in responding to these mastered tasks were likely due to the manipulation of the independent variable and not some other extraneous variable related to target selection.

We did not assess the maintenance of varied response combinations following the removal of the instructive feedback procedure. Although we observed an increase in the frequency of novel combinations when instructive feedback was used, it is possible that following the removal of instructive feedback varied that responding would not maintain. Researchers seeking to replicate our procedures with additional participants should measure maintenance to determine whether improvements in varied responding produced by instructive feedback maintain over time and under natural reinforcement contingencies.

The purpose of the present study was to evaluate the effect of instructive feedback on response variability in the absence of direct reinforcement for varied responses. Previous studies have demonstrated that direct reinforcement procedures, like lag schedules of reinforcement, can be used to increase variability in verbal behavior (e.g., Lee et al. 2002). Thus, there is evidence that both procedures can produce response variability, but there is no direct comparison of the effects of the two procedures. However, there may be some practical benefits to using instructive feedback over lag schedules. Specifically, instructive feedback can easily be incorporated into the consequence component of the learning trial. This procedure does not require participants to engage in additional responses, and it does not increase the overall duration of training. Additionally, instructive feedback does not require the therapist to closely monitor participants' responses on previous trials to determine if a response meets the criterion for reinforcement. Future research should evaluate the combined and separate effects of instructive feedback and lag schedules of reinforcement on response variability for children with ASD.

Previous research has demonstrated that instructive feedback is a useful procedure for increasing the efficiency of instruction (e.g., Reichow and Wolery 2011; Vladescu and Kodak 2013). The results of the current study suggest that instructive feedback may also be a useful procedure for increasing response variability. Future research should continue to evaluate novel applications of instructive feedback to educational programming for children with ASD to identify the myriad benefits of this procedure for enhancing outcomes for learners.

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References

- American Psychiatric Association. (2013). *Diagnostic and statistical manual of mental disorders* (5th ed.). Arlington: American Psychiatric Publishing.
- Baer, D. M., Peterson, R. F., & Sherman, J. A. (1967). The development of imitation by reinforcing behavioral similarity to a model. *Journal of the Experimental Analysis of Behavior*, 10, 405–416. doi:[10.1901/jeab.1967.10-405](https://doi.org/10.1901/jeab.1967.10-405).
- Carroll, R. A., Joachim, B. T., St. Peter, C. C., & Robinson, N. (2015). A comparison of different error-correction procedures on skill acquisition during discrete-trial instruction. *Journal of Applied Behavior Analysis*, 48, 1–17. doi:[10.1002/jaba.205](https://doi.org/10.1002/jaba.205).
- Charlop, M. H., Schreibman, L., & Thibodeau, M. G. (1985). Increasing spontaneous verbal responding in autistic children using a time delay procedure. *Journal of Applied Behavior Analysis*, 18, 155–166. doi:[10.1901/jaba.1985.18-155](https://doi.org/10.1901/jaba.1985.18-155).
- Dunn, L. M., & Dunn, D. M. (2007). *Peabody picture vocabulary test manual* (4th ed.). Minneapolis: Pearson.
- Esch, J. W., Esch, B. E., & Love, J. R. (2009). Increasing vocal variability in children with autism using a lag schedule of reinforcement. *The Analysis of Verbal Behavior*, 25, 73–78.
- Heldt, J., & Schlinger, H. D. (2012). Increased variability in tacting under lag 3 schedule of reinforcement. *The Analysis of Verbal Behavior*, 28, 131–136.
- Higbee, T., Carr, J. E., & Harrison, C. D. (2000). Further evaluation of the multiple-stimulus preference assessment. *Research in Developmental Disabilities*, 21, 61–73. doi:[10.1016/S0891-4222\(99\)00030-X](https://doi.org/10.1016/S0891-4222(99)00030-X).
- Ingvarsson, E. T., & Hollobaugh, T. (2011). An evaluation of prompting tactics to establish intraverbals in children with autism. *Journal of Applied Behavior Analysis*, 44, 659–664. doi:[10.1901/jaba.2011.44-659](https://doi.org/10.1901/jaba.2011.44-659).
- Ingvarsson, E. T., & Le, D. D. (2011). Further evaluation of prompting tactics for establishing intraverbal responding in children with autism. *The Analysis of Verbal Behavior*, 27, 75–93.
- Kodak, T., Fuchtmann, R., & Paden, A. (2012). A comparison of intraverbal training procedures for children with autism. *Journal of Applied Behavior Analysis*, 45, 155–160. doi:[10.901/jaba.2012.45-155](https://doi.org/10.901/jaba.2012.45-155).
- Lee, R., & Sturmey, P. (2006). The effects of script-fading and a lag-1 schedule on varied social responding in children with autism. *Research in Autism Spectrum Disorders*, 8, 440–448. doi:[10.1016/j.rasd.2014.01.003](https://doi.org/10.1016/j.rasd.2014.01.003).
- Lee, R., McComas, J. J., & Jawor, J. (2002). The effects of differential and lag reinforcement schedules on varied verbal responding by individuals with autism. *Journal of Applied Behavior Analysis*, 35, 391–402. doi:[10.1901/jaba.2002.35-391](https://doi.org/10.1901/jaba.2002.35-391).
- Loughrey, T. O., Betz, A. M., Majdalany, L. M., & Nicholson, K. (2014). Using instructive feedback to teach category names to children with autism. *Journal of Applied Behavior Analysis*, 47, 425–430. doi:[10.1002/jaba.123](https://doi.org/10.1002/jaba.123).
- Reichow, B., & Wolery, M. (2011). Comparison of progressive prompt delay with and without instructive feedback. *Journal of Applied Behavior Analysis*, 44, 327–340. doi:[10.1901/jaba.2011.44-327](https://doi.org/10.1901/jaba.2011.44-327).
- Sindelar, P. T., Rosenberg, M. S., & Wilson, R. J. (1985). An adapted alternating treatments design for instructional research. *Education and Treatment of Children*, 8, 67–76.
- Skinner, B. F. (1957). *Verbal behavior*. Acton: Copley.
- Smith, T. (2001). Discrete trial training in the treatment of autism. *Focus on Autism and Other Developmental Disabilities*, 16, 86–92. doi:[10.1177/108835760101600204](https://doi.org/10.1177/108835760101600204).
- Sundberg, M. L., & Michael, J. (2001). The value of Skinner's analysis of verbal behavior for teaching children with autism. *Behavior Modification*, 25, 698–724. doi:[10.1177/0145445501255003](https://doi.org/10.1177/0145445501255003).
- Sundberg, M. L., & Partington, J. W. (1999). The need for both discrete trial training and natural environment language training for children with autism. In P. Ghezzi, W. L. Williams, & J. E. Carr (Eds.), *Autism: behavior analytic perspectives* (pp. 139–156). Reno: Context Press.
- Susa, C. L., & Schlinger, H. D. (2012). Using a lag schedule to increase variability of verbal responding in an individual with autism. *The Analysis of Verbal Behavior*, 28, 125–130.
- Vladescu, J. C., & Kodak, T. (2013). Increasing instructional efficiency by presenting additional stimuli in learning trials for children with autism spectrum disorders. *Journal of Applied Behavior Analysis*, 46, 805–816. doi:[10.1002/jaba.70](https://doi.org/10.1002/jaba.70).
- Werts, M. G., Wolery, M., Holcombe, A., & Frederick, C. (1993). Effects of instructive feedback related and unrelated to the target behaviors. *Exceptionality*, 4, 81–95. doi:[10.1207/s15327035ex0402_2](https://doi.org/10.1207/s15327035ex0402_2).
- Werts, M. G., Wolery, M., Venn, M. L., Demblowski, D., & Doren, H. (1996). Effects of transition-based teaching with instructive feedback on skill acquisition by children with and without disabilities. *Journal of Educational Research*, 90, 75–86. doi:[10.1080/00220671.1996.9944448](https://doi.org/10.1080/00220671.1996.9944448).

- Wolery, M., Doyle, P. M., Ault, M. J., Gast, D. L., Meyer, S., & Stinson, D. (1991). Effects of presenting incidental information in consequent events on future learning. *Journal of Behavioral Education, 1*, 79–104. doi:[10.1007/BF00956755](https://doi.org/10.1007/BF00956755).
- Wolery, M., Holcombe, A., Werts, M. G., & Cipolloni, R. M. (1993a). Effects of simultaneous prompting and instructive feedback. *Early Education and Development, 4*, 20–31. doi:[10.1207/s15566935eed0401_2](https://doi.org/10.1207/s15566935eed0401_2).
- Wolery, M., Werts, M. G., & Holcombe, A. (1993b). Reflections on “effects of instructive feedback related and unrelated to the target behaviors.” *Exceptionality, 4*, 117–123. doi:[10.1207/s15327035ex0402_5](https://doi.org/10.1207/s15327035ex0402_5).