

*USING AUDIO SCRIPT FADING AND MULTIPLE-EXEMPLAR
TRAINING TO INCREASE VOCAL INTERACTIONS IN CHILDREN
WITH AUTISM*

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Script-fading procedures have been shown to be effective for teaching children with autism to initiate and participate in social interactions without vocal prompts from adults. In previous script and script-fading research, however, there has been no demonstration of a generalized repertoire of vocal interactions under the control of naturally occurring relevant stimuli. In this study, 4 boys with autism were taught to initiate a conversation in the presence of toys through the use of a script and script-fading procedure. Training with multiple categories and exemplars of toys was used to increase the likelihood of generalization of vocal interactions across novel toys. A multiple-probe design across participants was used to assess the effects of these procedures. The intervention successfully brought interactions by children with autism under the control of relevant stimuli in the environment. Future research pertaining to the specific implementation of these procedures (e.g., fading, script placement, participant characteristics) is discussed.

Key words: autism, multiple-exemplar training, scripts, script fading, spontaneous language

Many children with autism have difficulties initiating vocal interactions or engaging in spontaneous speech (American Psychiatric Association, 2000). *Spontaneous speech* is defined as a verbal response in the presence of nonverbal discriminative stimuli and in the absence of verbal discriminative stimuli (Charlop, Schreibman, & Thibodeau, 1985). The degree to which language is spontaneous can be viewed along a

continuum, with the least spontaneous language prompted by a teacher and the most spontaneous language under discriminative control of naturally occurring environmental stimuli (Brown, Krantz, McClannahan, & Poulson, 2008). Appropriate spontaneous language is valuable in that it naturalizes children's speech, permits social interactions, and allows children to obtain information, objects, food, and attention (Charlop & Trasowech, 1991). Unfortunately, even children with autism who have received intensive language intervention often lack spontaneous language (E. G. Carr & Kologinsky, 1983). Although children may learn to answer questions and make requests, they are unlikely to initiate or pursue conversation with others (Stevenson, Krantz, & McClannahan, 2000).

Although behavior-analytic interventions have been used to teach a variety of language skills to children with autism (Brown et al., 2008), these strategies frequently focus on increasing responses cued by the speech of the instructor

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(Matson, Sevin, Fridley, & Love, 1990). For example, incidental teaching may promote generalized and spontaneous language use (e.g., McGee, Krantz, Mason, & McClannahan, 1983). However, the frequency of a child's initiations may limit the number of learning opportunities, and initiations may be absent when prepotent reinforcers are not visible or immediately available. Further, because incidental-teaching episodes evolve into discrete-trial training if the teacher requests too many elaborations, it may be difficult to achieve the give-and-take of ordinary conversation during these interactions (Stevenson *et al.*, 2000). Teaching strategies that emphasize adult prompting and reinforcement are likely (a) to produce atypical peer social exchanges marked by brief interaction episodes, (b) to require the ongoing presence of an adult, and (c) to decrease social interactions when adult prompts are reduced or withdrawn (Krantz & McClannahan, 1993). Most important, teaching strategies that rely on vocal prompts by an adult to initiate language interactions may inadvertently lead to prompt dependence.

In contrast, script and script-fading procedures can reduce reliance on adult prompting. Script fading provides models of contextually appropriate language through written or auditory scripts that serve as prompts for learners to engage in vocal interactions. The use of scripts can enhance the quantity and quality of social interactions between children with autism and others and help children initiate and engage in reciprocal and turn-taking responses that pertain to a shared topic (Cowan & Allen, 2007; Stevenson *et al.*, 2000). The use of scripts and script fading across settings, people, activities, and stimuli may also facilitate generalization and spontaneity of language.

In their seminal study on script fading, Krantz and McClannahan (1993) taught students with autism to talk to their peers about activities without vocal prompts from teachers or their peers. Written scripts, which served as prompts for the participants to interact with their peers, were systematically faded from end to beginning

until only a single quotation mark remained. Generalized responding was observed across new settings, teachers, and activities at the final script level (i.e., quotation marks).

To make children's vocal interactions less dependent on adult prompts, researchers have examined the use of script-fading technology within activity schedules (e.g., Krantz & McClannahan, 1998; Stevenson *et al.*, 2000). By incorporating scripts into activity schedules, stimulus control may be shifted from teacher prompts to schedule-based prompts that can be manipulated by the children themselves (Brown *et al.*, 2008).

Other script-fading researchers have focused on bringing interactions under the control of more natural environmental stimuli rather than teacher-controlled stimuli or activity schedules. In a study by Sarokoff, Taylor, and Poulson (2001), scripts were placed on stimuli (e.g., packages of snack items) that contained text that was part of the script. Children were taught to engage in scripted conversations by referencing the script attached to the items. Scripts were faded to just the text that was naturally embedded on the stimuli (e.g., a word on the snack package). Contrived discriminative stimuli, however, may have controlled verbal performances, such as vocal instruction to engage with the items. In addition, the researchers did not systematically assess responding in the absence of embedded text on the items.

Brown *et al.* (2008) further evaluated whether script-fading procedures could be used to teach individuals with autism to initiate and sustain vocal interactions under natural environmental cues. Initially, written scripts were placed directly on actual objects in a "mock store" classroom to prompt vocal statements. As the scripts were faded, unscripted statements also increased. In addition, conversation skills generalized to untrained stimuli and during community shopping trips.

Script and script-fading procedures have been used with a variety of learners, including nonreaders,

beginning readers, and advanced readers (Krantz & McClannahan, 1993, 1998; Stevenson et al., 2000). Both audio and text scripts are portable and can be mounted on a variety of objects. One advantage of using auditory scripts is that nonreaders are able to use this technology to learn to initiate conversations. Auditory scripts also provide models that allow learners to imitate the prosody and articulation in the recorded script. In another study, MacDuff, Ledo, McClannahan, and Krantz (2007) used this technology to teach learners with autism to make bids for joint attention by fading one-word audio scripts attached to toys or photographs. After the scripts were faded, bids for joint attention maintained and generalized to untrained materials and to nontraining settings.

Previous script-fading studies identified whether children with autism would use scripted interactions in the absence of the scripts themselves. For example, Krantz and McClannahan (1993) evaluated whether learners would produce variations of the scripted statements. After the scripts were faded, however, interactions, even if they were identical to the scripted statements previously presented, were still scored as unscripted interactions. Data regarding whether the participants were combining elements of the scripted statements or emitting novel interactions were not collected. Such an analysis would help identify the type of interactions emitted by learners when scripts are faded.

Collectively, script and script-fading research has produced a technology for helping learners with autism engage in meaningful social exchanges with others. Despite these advances, investigators of script and script-fading procedures have yet to teach learners with autism to engage in vocal interactions with novel stimuli from categories not used during teaching and in the absence of reinforcement. Bringing vocal interactions under the control of a variety of stimuli to produce a generalized repertoire of vocal interactions may be achieved with multiple-exemplar training. In multiple-exemplar training, generalization to untrained stimulus conditions

and to untrained responses is programmed by teaching sufficient exemplars of relevant stimuli to each of those stimulus conditions or responses (Osnes & Lieblein, 2003; Stokes & Baer, 1977).

The purpose of the current study was to teach young children with autism to initiate and engage in vocal interactions in the presence of multiple stimuli, using audio scripts on toys and systematically fading those scripts. We expanded the script-fading literature by assessing whether interactions would generalize from trained to novel stimuli after instruction with different teaching categories of multiple toy exemplars. Participants were taught scripts that identified, described, and provided a function of the toys to facilitate the emergence of a range of vocal interactions. To extend previous script-fading research, multiple types of different interactions emitted by the participants were identified. Additional dependent measures assessed whether the participants also used language modeled by the conversation partner in their interactions.

METHOD

Participants

The participants were four boys, Dan, Justin, James, and Adam, who attended an all-day private school for children with autism. The boys met the criteria for autistic disorder (American Psychiatric Association, 2000) and had been diagnosed by an outside agency before enrollment in the school. Prior to participation, each participant was evaluated with the Preschool Language Scale (3rd ed.; Zimmerman, Steiner, & Pond, 1992).

All participants required continuous one-on-one supervision and ongoing intervention at school. A token-based system was used throughout the day. Although all participants communicated using spoken language, their teachers identified the boys as having difficulty initiating vocal initiations and sustaining vocal interactions. Before the study, all four participants could imitate words presented on audio recorders and

Table 1
Toy Categories, Sample Toy Exemplars, and Sample Scripts

Category	Sample toy	Script 1	Script 2	Script 3
Vehicles	Car	Check out this car!	Look, it's red!	Cars go beep.
Instruments	Piano	I can play piano.	It's black.	Watch me hit the keys!
Balls	Soccer ball	I have the soccer ball!	It's black and white.	Let's kick it!
Action figures	Spiderman	Spiderman is so cool!	He has a web.	Watch how he climbs!
Building materials	Lego tractor	These Legos are awesome!	It's a tractor!	You can attach them.
Animals	Cow	Cool, it's a cow!	It goes to a farm.	Cows say moo

Note. Each category consisted of four toy exemplars with three scripts assigned to each. The table depicts one exemplar toy from each category along with its scripts for illustration purposes.

vocally tact all stimuli used in the study. All participants had minimal experience with the use of script-fading procedures. Only Justin had any prior experience with scripts and script-fading procedures with the experimenter.

Dan was 4 years 11 months old at the start of the study, and had been enrolled in the school for 1 year. He emitted low levels of stereotypy. He scored an age equivalent of 5 years 1 month on the Preschool Language Scale. Justin was 5 years old at the start of the study, and had been enrolled in the school for 2.5 years. He also emitted low levels of stereotypy. He scored an age equivalent of 3 years 1 month on the Preschool Language Scale. James was 6 years old at the start of the study, and had been enrolled in the school for 4 years. He emitted low to moderate levels of stereotypy. He scored an age equivalent of 3 years 3 months on the Preschool Language Scale. Adam was 6 years old at the start of the study, and had been enrolled in the school for 1.5 years. He emitted moderate levels of stereotypy. He scored an age equivalent of 2 years 4 months on the Preschool Language Scale.

Settings and Materials

Sessions were conducted in an unoccupied room in the school that contained bookcases with toys, a camera on a tripod, and the experimenter's study materials (i.e., timer, conversation partner responses, and snacks). Pre- and postintervention probe sessions were conducted in a smaller version of a general education preschool class-

room that contained a variety of toys from the experimental categories, bulletin boards, chairs, tables, and shelves. The toys were selected based on those found in a typical preschool setting and were not selected based on individual participant preferences. Attached to each toy was a small round audio recorder, the Go Talk Button, that played up to a 10-s statement when pressed.

The six categories of toys used in the study were (a) vehicles, (b) instruments, (c) balls, (d) action figures, (e) building materials, and (f) animals (see Table 1). Each participant, however, was assigned to only four of the six possible toy categories. For each participant, three categories were used for teaching. From each teaching category, three toys were used during teaching trials and one toy was used during a within-category generalization probe trial. In addition, one of four possible toys from a category not used during teaching was used during an across-category generalization probe trial. Assignment of categories was partially counterbalanced across participants, such that each category was used for teaching for two of the four participants. Dan's teaching categories were balls, animals, and building materials; Justin's were instruments, balls, and vehicles; James's were vehicles, animals, and action figures; and Adam's were building materials, instruments, and action figures. Each participant was assigned a different category to assess across-category generalization. For Dan, Justin, James, and Adam, these were instruments, action figures, balls, and vehicles, respectively.

Experimenter and Assistants

The experimenter and one of three assistants conducted each session. All had worked at the school for a minimum of 2 years and were experienced with script-fading procedures, prompting strategies, and data collection. Throughout the study, the first author (i.e., the experimenter) always served as the conversation partner, prompted the participant to turn off the timer, and delivered edible items into the cup. The assistants initially positioned themselves approximately 0.3 to 0.6 m away from a participant and manually prompted him to press the button on the audio recorder, conducted error-correction procedures, and delivered tokens to Adam during his sessions. After scripts were faded, the assistants stayed outside the room and reentered if prompting was necessary. Video recordings were made of all sessions and were used for scoring after each session.

Stimuli and Scripted Statements

To identify age-appropriate phrases or statements for the scripts related to the toys used in the present study, preschool and kindergarten children of typical development were observed in their classrooms while they played with similar categories of toys, and their vocal interactions were recorded. Scripts were then adapted from these vocal interactions. Three types of scripts were created per category of toys. For each toy presented, one of three possible scripts could be presented. Each script either (a) identified the toy (e.g., "Look at my car!"), (b) provided a description of the toy (e.g., "It's red"), or (c) described a function of the toy (e.g., "They go really fast"). For a script to be used, each participant was required to pronounce the words in the script. To assess this, prior to the study, all of the participants were provided with a vocal model of each script on an audio recorder, preceded by the instruction "say."

Design and Dependent Variables

A concurrent multiple-probe design across participants was used to assess the effects of script fading on vocal interactions made by the participants. *Interactions* were defined as vocal

responses emitted by the participant that were directed to the conversation partner by using the partner's name or orienting to the partner (Brown et al., 2008). Interactions included both initiations (i.e., vocal responses directed to the conversation partner before the partner engaged in the conversation) and elaborations (i.e., vocal responses directed to the conversation partner after the partner engaged in the conversation). Although interactions were not required to be grammatically correct, they had to contain at least a noun and a verb. *Noninteractions* were defined as repetitions of the immediately prior response of the participant or the conversation partner (i.e., a participant repeated his statement verbatim or altered it only by adding the recipient's name), echolalia, single words (e.g., "toys"), greetings or good-byes (e.g., "hi Elena"), polite statements (e.g., "thank you"), responses to questions or instructions (e.g., "okay"), and requests (e.g., "tickle me").

Table 2 depicts the three major categories of dependent variables assessed: initiations, elaborations, and generalized interactions. Five possible types of initiations were scored: scripted, unscripted, novel, in vivo scripted, and in vivo unscripted. Six types of elaborations were scored: scripted, unscripted, novel, in vivo scripted, in vivo unscripted, and acknowledgments. Two types of generalized interactions were measured: within category and across category. The toys used to assess generalization of interactions were presented on the bookcase alongside the training toys but were never associated with the teaching procedures. The number of each type of interaction emitted by each participant in the presence of the teaching and probe stimuli was recorded during each session. Criterion was defined as emitting an independent vocal interaction for any of the five types of initiations during at least 89% (eight of nine) of teaching trials for two consecutive sessions.

Preference Assessment

A multiple-stimulus-without-replacement preference assessment (based on J. E. Carr, Nicolson, &

Table 2
Names and Definitions of Three Categories of Dependent Measures

Category of interaction	Type	Definition
Initiations (vocal responses directed to the conversation partner before the partner engages in the conversation)	Scripted	Vocal response was exact match to any of the three possible scripts for that toy or category or differed only in conjunctions, articles, prepositions, or pronouns, regardless of whether scripts were full, partial, or faded.
	Unscripted	Vocal response did not match scripts presented in current session from each category (i.e., partial or full scripts) and differed from the script by more than conjunctions, articles, prepositions, or pronouns.
	Novel	Vocal response did not contain any words from the original scripts besides conjunctions, articles, prepositions, pronouns, or the toy's name.
	In vivo scripted	Vocal response that matched any statements modeled by conversation partner in prior trials, with addition that conjunctions, articles, prepositions, pronouns, or changes in verb tense were altered.
	In vivo unscripted	Vocal response similar to any statements modeled by conversation partner in prior trials and differed from model by more than conjunctions, articles, prepositions, pronouns, verb tense, or the toy's name.
Elaborations (vocal responses directed to the conversation partner after the partner engaged in the conversation)	Scripted, unscripted, novel, in vivo scripted, in vivo unscripted	Definitions are the same as those above except the vocal response occurred after the conversation partner engaged in the conversation.
	Acknowledgments	Positive verbal productions (e.g., "yeah," "okay," "yes," "sure" "cool") emitted after conversation partner made a statement.
Generalized interactions	Within category	Any interaction type that occurred in presence of novel toy drawn from teaching categories of toys.
	Across category	Any interaction type that occurred in presence of novel toy drawn from novel category of toys.

Higbee, 2000) was conducted before implementation of the intervention to identify the top three edible items for each participant. These were used as putative reinforcers during teaching sessions for independent vocal interactions during teaching trials.

Conversation Partners

During each session, the experimenter served as a conversation partner and sat approximately 1 m away from the participant and bookcase. The conversation partner provided vocal statements drawn from a written list to the statements or initiations made by the participant. Responses were not made following noninteractions or mands, but were made following every interaction statement made by the participant. For each toy, the conversation partner could emit one of

three possible responses. These statements provided models of vocal interactions for the participants in addition to the scripts on the audio recorders. Some of the conversation partner statements were more generic (e.g., "I love playing with that!") and some were specific to a particular toy (e.g., "It has lights" for a toy car) or to a toy category (e.g., "I love building things!" for building materials). For each toy, the statements to be used by the conversation partner were randomly selected before the session.

Procedure

General format. During all conditions, 13 stimuli were arranged across three bookcases. These consisted of three toys from each of the three teaching categories (totaling nine teaching trials), one within-category generalization toy

from each of the three teaching categories, and one across-category generalization toy from the category not used during teaching (for a total of four probe trials). Apart from the across-category generalization toy, which was randomly assigned to a bookcase, each bookcase held toys from one teaching category. For example, one bookcase held four toys from the vehicles category and one toy from a different, untaught category (e.g., animals). During sessions, only one bookcase that held the specific category of toys was available.

A session began when the participant was brought into the classroom by the assistant with the designated toys arranged on the bookcase shelves. As they walked in, the conversation partner emitted an instruction to play (e.g., "Play with your toys," "Have fun playing," "Let's play."). The participant could interact with any toy on the bookcase. If, after picking up a toy, a participant emitted a vocal interaction, the conversation partner, who was sitting on the floor or standing (depending on which the participant was doing at the time) 0.3 m away from the participant, responded with an appropriate statement and prompted the participant to set a timer. The timer was set for 30 s to indicate the duration the participant could play with the toy. After the participant had manipulated all the toys on the bookcase, the participant and conversation partner left the room. The same procedures were repeated for each bookcase (i.e., category) of toys.

Baseline. No prompts, reinforcement, or scripts were provided during baseline sessions, but toys were presented on the shelf as described above, and snacks were provided at the end of the sessions, regardless of performance. In addition, if a participant emitted a vocal interaction, the conversation partner responded with an appropriate statement. Sessions lasted approximately 10 min (i.e., 3 min per toy category plus an additional 1 min for transitions). Because Adam displayed moderate levels of stereotypy, an individualized token motivational system was developed for him in which tokens were delivered

contingent on the absence of motor stereotypy but never after a vocal interaction.

Script and script-fading intervention. Audio recorders that contained audio scripts were attached to the toys. When the participant entered the room, he could interact with any toy on the bookshelf. The assistant, positioned behind the participant, waited 10 s for the participant to pick up the toy. If the participant did not respond within 10 s or made an error (e.g., not emitting an interaction in response to the recorder, not repeating the script appropriately when full scripts were presented, or not orienting towards the conversation partner within 10 s of being presented with the stimulus), the assistant manually prompted the participant from behind to press the device and to orient by positioning his body to face the conversation partner. After the scripts were faded, if the participant did not emit a response or repeated only the faded portion of the script, the assistant replaced the faded script with the full script and prompted the participant to press the recorder. When the participant repeated the full script, the faded script was immediately reintroduced according to the current fading step. Prompts continued until the participant responded correctly in the presence of that toy. No vocal prompts were provided.

When the participant picked up the toy and emitted an appropriate vocal interaction (e.g., "I like to play soccer"), the conversation partner responded with one of the three statements randomly chosen from a predetermined list of statements (e.g., "Soccer is my favorite"), then dropped an edible item into a cup. After the statement, the conversation partner paused briefly to provide an opportunity for the participant to elaborate. She then prompted the participant, using hand-over-hand guidance, to start the timer located on the top shelf of the bookcase, and if necessary, blocked access to the remaining toys on the bookcase by manually redirecting the participant to the selected toy. The participant was given 30 s of access to manipulate each toy. During this time, the conversation

partner could engage with the participant. When the timer went off, he was prompted by the conversation partner to turn it off, leave the toy on the floor, and pick up another toy. After he interacted with a toy, it was removed for the remainder of the session. After the participant had manipulated all the toys on the bookcase, the conversation partner delivered the cup of preferred snacks, the participant left the room, and he was able to consume the snacks. The same procedures were repeated for each bookcase (i.e., category) of toys.

When a participant repeated the scripts independently (i.e., in the absence of prompts) during at least eight of nine teaching trials for two consecutive sessions, a six-step script-fading procedure began in which scripts were faded from end to beginning (see Table 3). For each fading step, the participant was required to independently emit each script presented during a session or emit an unscripted or novel interaction, without prompts for two sessions before moving to the next fading level. This continued until participants completed Fading Level 6 at which the recorder was completely removed from the toy.

The script-fading procedure was completed for Dan, Justin, and James (i.e., audio recorder completely removed). When the recorder was removed for Adam, however, independent initiations decreased. Therefore, an additional fading level was used, during which prompts were delivered by holding the recorder out of view behind him and pressing it to play the script (see Table 3).

When a participant interacted independently in the absence of scripts, the schedule of reinforcement was thinned to a fixed-ratio (FR) 2 schedule. After two sessions of responding independently during at least eight of nine of teaching trials, reinforcement was further thinned to an FR 4 schedule. After two additional sessions of at least eight of nine independent responses during teaching trials, reinforcement was then provided only at the end of a session (i.e., only one piece of a snack).

Table 3
Fading Levels Used During Script Fading

Fading level	Script content
0	Full script
1	Last word removed
2	Last two words removed
3	All but the first word removed
4	All but the first word removed on three stimuli and no script on six stimuli
5	All words removed from audio recorder
6	No scripts (i.e., recorder removed)
7 ^a	No scripts (assistant presses recorder during prompts)

^aLevel 7 was used only for Adam.

Assessment of Generalization of Vocal Interactions

Within- and across-category generalization of interactions was assessed during three trials and one trial, respectively, during each session. Generalization probe toys did not have audio recorders attached to them, nor were they associated with any other aspects of the teaching procedure. To assess generalization of interactions from trained to untrained toys in each teaching category (i.e., within-category generalization), three generalization probes were presented during each session, randomly interspersed among trials with teaching toys. Generalization of vocal interactions to a toy category not used during teaching (across-category generalization) was assessed by presenting a toy from an additional category.

Throughout all sessions, the participants were manually guided by the assistant to pick up and interact with every toy on the shelf, including toys used to assess generalization (i.e., those without scripts). After the participant emitted an interaction in the presence of a toy or 10 s elapsed without an interaction being emitted, the conversation partner prompted him to start the timer, and he was given 30 s of access to the toy. Although a participant's vocal interactions were followed by responses from the conversation partner, they were never followed by delivery of edible items during generalization probe trials.

Follow-Up Sessions

To assess each participant's maintenance of vocal interactions, data were collected in the same room used for experimental sessions approximately 2 weeks and then 2 months after intervention concluded. These sessions were identical to those conducted during baseline.

Pre- and Postintervention Probe Sessions

Although generalization of vocal interactions across settings and people was not specifically programmed for in the present study, we assessed whether multiple-exemplar training across materials would be sufficient to facilitate generalized responding in an untrained setting and with an untrained conversation partner (i.e., a peer). To accomplish this, vocal interactions were measured during two preintervention and two postintervention probe sessions conducted in the smaller version of a general education preschool classroom at the participants' school. One preintervention and one postintervention session were conducted with a peer, and the remaining sessions were conducted with only the instructor present. In each session, 15 toys drawn from all six possible categories were presented on a variety of shelves in the room. These consisted of two toys from each of the three categories used during training, three from the category used to assess across-category generalization, and three each from the two categories not used during the ongoing experimental sessions for that participant. The toys used from training and across-category generalization, however, were not identical to those used during the baseline and intervention sessions but were similar. For example, if a black-and-white soccer ball was used during the baseline and intervention sessions, a blue-and-white ball would be used for the pre- and postintervention probe sessions. Because six of the toys came from categories never used during typical experimental sessions and the remaining nine toys were similar to those used during ongoing sessions, generalization of interactions could also be assessed in the presence of

novel toys and categories. Each session lasted approximately 10 min. No scripts, reinforcement, or prompts were provided.

Social Validity

One social validity measure determined whether the participants were rated as engaging in more appropriate language after the intervention. Video clips from baseline and maintenance sessions were presented to 14 college students who served as raters. For each participant, 3 min of video from a baseline session and 3 min from a maintenance session were shown to the raters. The order of presentation of baseline and maintenance session video clips was fully counterbalanced. After watching each pair of video clips for each participant, the observer was asked, "In which of the two video clips (1 or 2) did the child use more appropriate language?"

A second social validity measure was adapted from the Treatment Acceptability Rating Form—Revised (Reimers & Wacker, 1988). Assistants from the present study and other school instructors were asked to rate their satisfaction with the procedures, outcomes, and ease of use of the intervention on a 7-point Likert scale.

Interobserver Agreement

The experimenter collected primary data, and assistants collected interobserver agreement data. Before the study, assistants were given all response definitions and practiced collecting data on several videos of the experimenter and nonparticipant learners role-playing sample experimental sessions until consistency in scoring was obtained.

Throughout all phases of the study, sessions were videotaped. Interobserver agreement was calculated by observers who recorded the participants' statements verbatim and then identified the type of interaction that characterized each statement. An agreement was defined as both observers identifying each statement as the same type of interaction. Interobserver agreement was obtained for 33% of baseline, treatment, and

maintenance sessions and 50% of the pre- and postintervention probe sessions. Agreement was calculated by dividing the total number of agreements by the total number of agreements plus disagreements and converting the result to a percentage.

During baseline and pre- and postintervention sessions, only novel vocal interactions were possible due to the absence of teaching scripts. Interobserver agreement on each participant's novel interactions during these conditions was 100%. During intervention, interobserver agreement on all vocal interactions was a mean of 88% (range, 64% to 100%) across all participants.

Treatment Integrity

Treatment integrity was assessed during 33% of all sessions for accurate delivery of the instructor's manual prompts, the conversation partner's implementation of language modeling, and the accuracy of the presentation of toys and other materials (e.g., whether the predetermined sequence of session trials was followed correctly). The treatment components were implemented correctly for 97% of opportunities (range, 92% to 100%). Interobserver agreement on treatment integrity was also collected during all treatment integrity sessions with 100% agreement.

RESULTS

Initiations

Scripted and unscripted initiations. Figure 1 displays the number of scripted and unscripted initiations emitted by the participants. None of the participants emitted any initiations during baseline. With the introduction of the script-fading intervention, Dan's number of scripted initiations increased to a mean of 4.1 (range, 2 to 9) initiations per session; unscripted initiations averaged 3.8 (range, 0 to 6) initiations per session throughout intervention. Dan's number of scripted initiations systematically dropped as script fading progressed. After scripts had been completely faded, the number of scripted initiations averaged 2.7 (range,

2 to 3) per session for the remainder of the study. With the introduction of the script-fading intervention, unscripted initiations increased. Unscripted initiations averaged 4.2 (range, 0 to 6) per session throughout intervention. After scripts had been completely faded in Session 19, the number of unscripted initiations averaged 4.9 (range, 2 to 6) per session for the remainder of the study.

With the introduction of intervention, Justin's scripted initiations increased to a mean of 5.6 (range, 3 to 9) initiations per session. The mean number of unscripted interactions was 2.7 (range, 0 to 5) initiations per session throughout the entire intervention. After scripts had been completely faded in Session 36, the mean number of scripted initiations was 4.8 (range, 3 to 6) for the remainder of the study. The mean number of unscripted initiations after script fading had been completed was 3.4 (range, 2 to 5) per session.

With the introduction of intervention, James's mean number of scripted initiations increased to 6.4 (range, 4 to 9). The mean number of unscripted interactions increased to 2.4 (range, 0 to 4) initiations per session throughout the entire intervention. After scripts had been completely faded in Session 56, the number of scripted initiations averaged 5.5 (range, 5 to 6) per session for the remainder of the study. The number of unscripted initiations after script fading had been completed averaged 3.2 (range, 2 to 4) initiations per session.

With the introduction of the script-fading procedure, the mean number of Adam's scripted initiations was 3 (range, 0 to 9) initiations per session. Unscripted interactions averaged 5 (range, 0 to 9) initiations per session throughout the entire intervention. His scripted initiations systematically dropped during Fading Levels 1 to 6. At this point, however, between Sessions 79 and 84, independent interactions decreased until Fading Level 7 was implemented. After the scripts had been completely faded in Session 87, the number of scripted initiations averaged 2 (range, 0 to 4) initiations per session for the remainder of

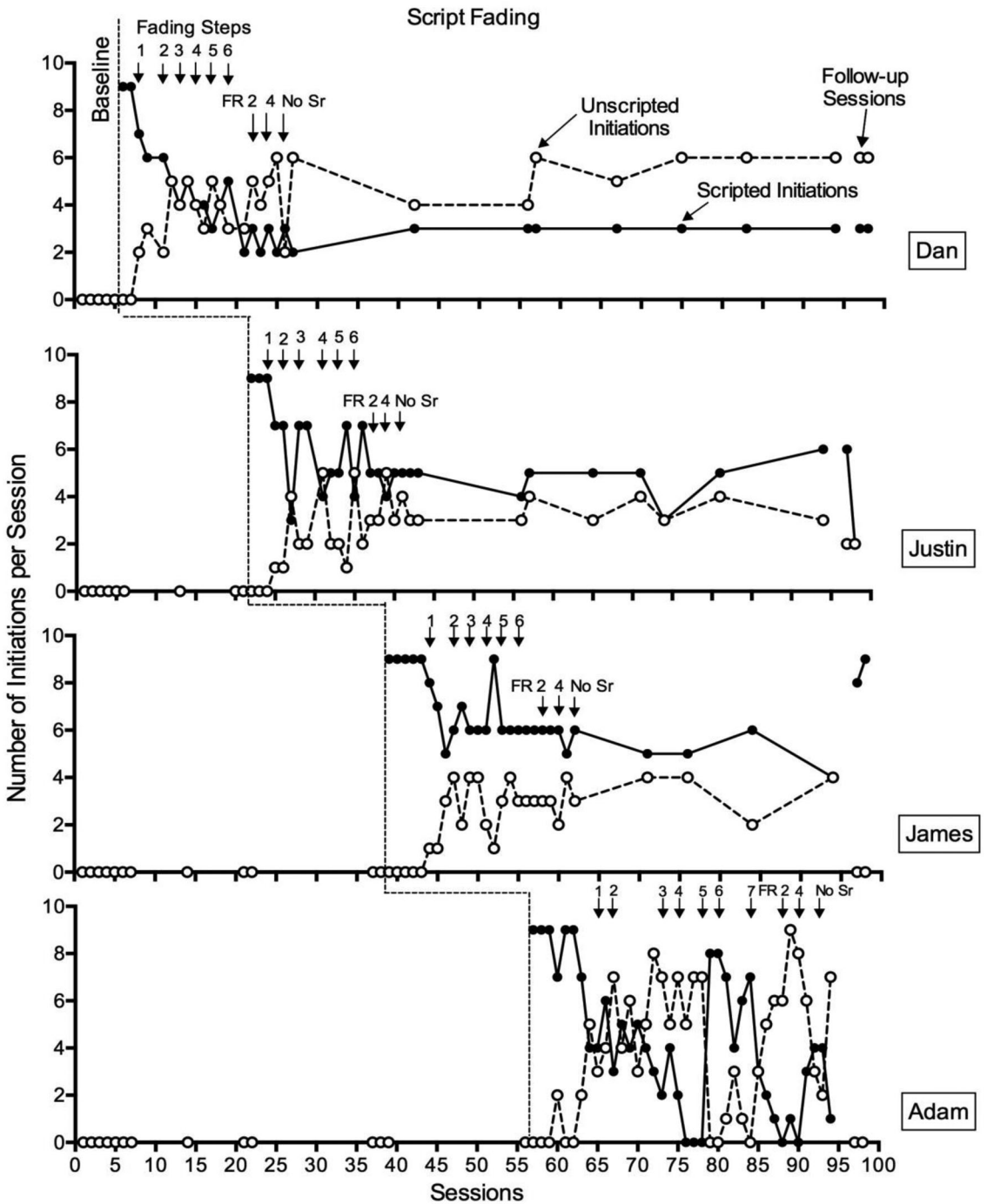


Figure 1. Number of scripted and unscripted initiations during baseline, interventions, and follow-up conditions across four participants. Numbered arrows along the top of each panel indicate script fading levels. The arrows labeled FR indicate the thinning of reinforcement (i.e., FR 2, FR 4); Sr = reinforcement.

the study. The number of unscripted initiations after completion of script fading averaged 6 (range, 2 to 9) initiations per session.

By the end of the intervention, scripts were completely faded and reinforcement was removed for all four participants. Complete script fading occurred for Dan in 15 sessions, with reinforcement completely thinned after 22 sessions of intervention. For Justin, all the scripts were faded in 15 sessions, and reinforcement was completely thinned after 21 sessions of intervention. All the scripts were faded in 18 sessions for James, and reinforcement was completely thinned after 24 sessions of intervention. For Adam, all the scripts were faded in 31 sessions, and reinforcement was completely thinned after 37 sessions of intervention.

Novel, in vivo scripted, and in vivo unscripted initiations. Figure 2 shows that few or no initiations were emitted by each participant during baseline. With the introduction of the script-fading intervention, the number of novel initiations by Dan increased to a mean of 8.4 (range, 0 to 23) initiations per session throughout the entire intervention. After scripts had been completely faded, the number of novel initiations averaged 8.7 (range, 2 to 23) per session for the remainder of the study. With the introduction of the script-fading intervention, both in vivo scripted and in vivo unscripted initiations remained stable. In vivo scripted initiations remained at 0 per session throughout the intervention. In vivo unscripted initiations averaged 0.1 (range, 0 to 2) per session throughout the intervention.

With the introduction of the script-fading intervention, Justin's number of novel initiations increased to a mean of 6 (range, 2 to 14) initiations per session throughout the entire intervention. After scripts had been completely faded, the number of novel initiations averaged 6.1 (range, 2 to 14) per session for the remainder of the study. With the introduction of the script-fading intervention, both in vivo scripted and in vivo unscripted initiations remained stable with no responding.

With the introduction of the script-fading intervention, the number of novel initiations by

James increased to a mean of 1.9 (range, 0 to 6) initiations per session throughout the entire intervention. After scripts had been completely faded, the mean number of novel initiations was 1.5 (range, 0 to 5) per session for the remainder of the study. With the introduction of the script-fading intervention, in vivo scripted initiations remained stable with no responding throughout the intervention. In vivo unscripted initiations averaged 0.04 (range, 0 to 1) initiations per session.

With the introduction of the script-fading intervention, Adam's number of novel initiations averaged 3 (range, 0 to 6) initiations per session throughout the entire intervention. After scripts had been completely faded, the number of novel initiations averaged 4 (range, 2 to 6) per session for the remainder of the study. In vivo scripted initiations remained at no responding throughout the intervention. In vivo unscripted initiations ranged from 0 to 1.

Within- and Across-Category Generalization

Figure 3 displays the percentage of probe trials (within and across categories) in which Dan, Justin, James, and Adam emitted interactions. During baseline, no participants emitted any interactions. With the implementation of the script-fading intervention, all four participants' within- and across-category generalization interactions increased. Dan's within-category generalization interactions averaged 98.7% (range, 67% to 100%). His across-category generalization interactions remained at 100% throughout the entire intervention. Justin's within-category generalization interactions averaged 64.3% (range, 0% to 100%) throughout intervention. His across-category interactions averaged 71.4% (range, 0% to 100%). James's within-category generalization interactions averaged 88% (range, 33% to 100%), and his across-category interactions averaged 92.9% (range, 0% to 100%) throughout intervention. Adam's within-category generalization interaction averaged 24% (range, 0% to 100%) per session, and his across-category

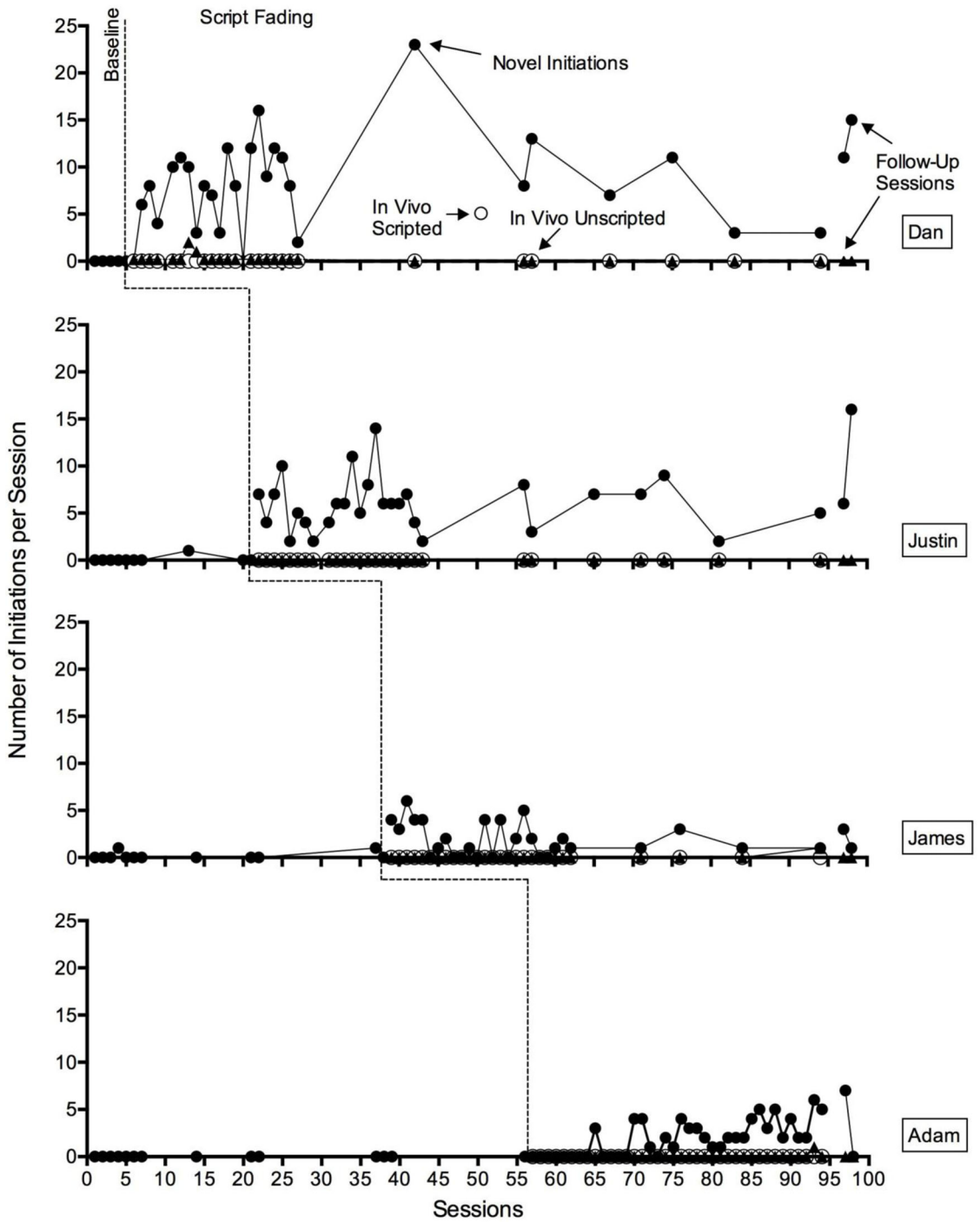


Figure 2. Number of novel, in vivo scripted, and in vivo unscripted initiations during baseline, intervention, and follow-up conditions across four participants.

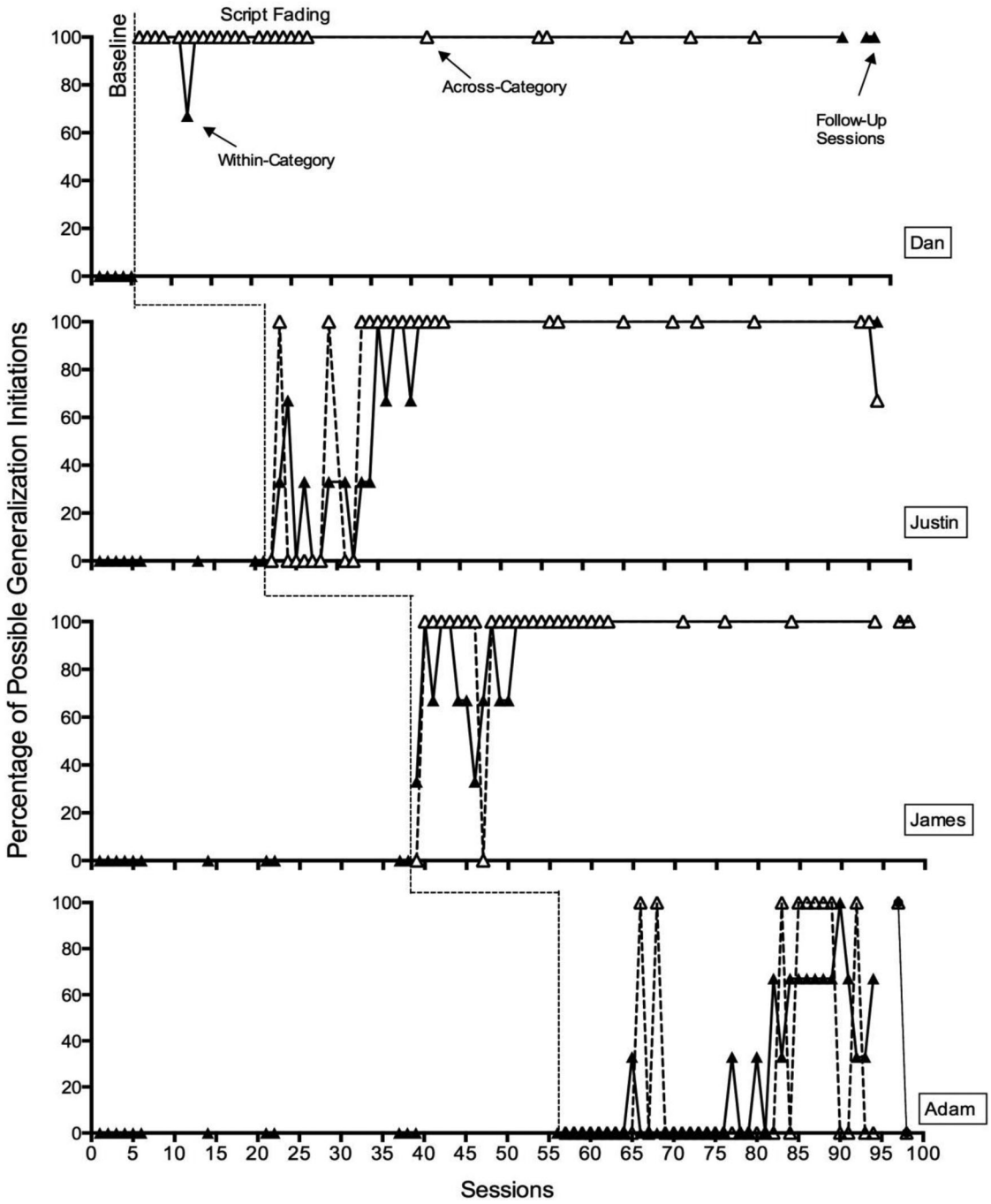


Figure 3. Percentage of trials in which interactions occurred during within- and across-category generalization probes during baseline, intervention, and follow-up conditions across four participants.

Table 4
Number of Interactions Emitted During Pre- and Postintervention Probe Sessions

Participant	With peer		With teacher	
	Preintervention	Postintervention	Preintervention	Postintervention
Dan	3	15	1	1
Justin	0	1	2	4
James	0	0	0	3
Adam	0	1	0	1
<i>M</i>	0.8	4.3	0.8	2.3
Range	0 to 3	0 to 15	0 to 2	1 to 4

generalization interactions averaged 24% (range, 0% to 100%) throughout intervention.

Elaborations

Acknowledgments and scripted and unscripted elaborations. Although data are not shown, Dan, Justin, James, and Adam did not emit any acknowledgments or scripted or unscripted elaborations during baseline. With the introduction of the script-fading intervention, however, there were only small increases in the number of acknowledgments and scripted and unscripted elaborations. Dan's number of acknowledgments ranged from 0 to 3, but he emitted no scripted or unscripted elaborations during the intervention. During intervention, Justin's acknowledgments and scripted and unscripted elaborations all ranged from 0 to 1. James's number of acknowledgments ranged from 0 to 2 per session, and his scripted and unscripted elaborations ranged from 0 to 1 per session. Adam's number of acknowledgments ranged from 0 to 2 during intervention. He emitted no scripted elaborations, and his unscripted elaborations ranged from 0 to 1.

Novel, in vivo scripted, and in vivo unscripted elaborations. Dan, Justin, James, and Adam did not emit any novel, in vivo scripted, or in vivo unscripted elaborations during baseline. Similar to the data for the other types of elaborations described above, there were only small increases in the number of novel, in vivo scripted, and in vivo unscripted elaborations with the introduction of the script-fading intervention. Dan's number of novel elaborations ranged from 0 to

3 per session, but he emitted no in vivo scripted or in vivo unscripted elaborations. Justin's novel elaborations ranged from 0 to 4, and his in vivo modeled elaborations and in vivo unscripted elaborations ranged from 0 to 2 per session. During intervention, James emitted no novel or in vivo elaborations but did emit 1 unscripted elaboration. Adam emitted no novel, in vivo scripted, or in vivo unscripted elaborations during intervention.

Pre- and Postintervention Probe Sessions

The number of interactions were scored during two pre- and two postintervention probe sessions in a classroom that was not associated with teaching, using novel toys similar to those used during teaching sessions. As shown in Table 4, no or few interactions were emitted during preintervention probe sessions with either a peer or a teacher. Only Dan's interactions increased during the postintervention sessions with a peer. For postintervention sessions with a teacher, small increases were seen only in the number of interactions emitted by Justin and James.

Follow-Up Measures

The results of the 2-week and 2-month follow-up measures are depicted in Figures 1 and 2. During Dan's 2-week follow-up, he emitted 3 scripted initiations, 6 unscripted initiations, and 11 novel initiations. During Justin's 2-week follow-up, he emitted 6 scripted initiations, 2 unscripted initiations, and 6 novel initiations.

James's 2-week follow-up produced 8 scripted initiations and 3 novel initiations. Adam's 2-week follow-up produced no scripted or unscripted initiations and 7 novel initiations.

Dan's 2-month follow-up resulted in 3 scripted initiations, 6 unscripted initiations, and 15 novel initiations. Justin's 2-month generalization follow-up resulted in 2 scripted initiations, 2 unscripted initiations, 16 novel initiations, 3 novel elaborations, and 1 *in vivo* unscripted elaboration. James's 2-month generalization follow-up resulted in 9 scripted initiations and 1 novel initiation. Adam's 2-month generalization follow-up measure resulted in no interactions.

Social Validity

After watching two video clips from before and after intervention for each participant, all 14 independent observers rated Justin and Adam as engaging in more appropriate language during the postintervention video clips. For Dan and James, 12 of the 14 observers (86%) rated them as engaging in more appropriate language during the postintervention video clips. These ratings indicated that the outcomes of the study were socially valid.

Data from the consumer evaluations indicated that the procedures were appropriate and straightforward for use in the clinical setting. The consumers indicated that they understood the suggested procedures, the strategies were acceptable, they would be willing to implement the procedures, and the procedures were appropriate. They anticipated that it would not take too much effort to implement the strategies and that it would not be very disruptive to implement the strategies in their classrooms. They agreed that they liked the procedures and that the learners were likely to experience very little discomfort as a result of the procedures.

DISCUSSION

The present study identified whether script-fading procedures could be used to teach children

with autism to initiate conversations under the control of stimuli present in the natural environment. Before intervention, none of the participants emitted any interactions. During script fading and multiple-exemplar training, all four participants increased their scripted, unscripted, and novel initiations in the presence of teaching and untaught stimuli. Thus, the intervention was successful for teaching individuals with autism to initiate and sustain vocal interactions under the control of stimuli present in the environment, as opposed to teacher-controlled stimuli.

The study also contributed to the literature by evaluating the types of interactions participants made throughout the intervention and using multiple criteria to define different interaction types. For instance, a broader definition of scripted interactions was used than that from prior studies. Scripted interactions were those that exactly matched any of the three possible scripts for that toy, category, or both. Previous studies (e.g., Brown *et al.*, 2008) scored those types of interactions as unscripted. In previous studies (e.g., Brown *et al.*, 2008) scripted interactions decreased to zero levels, but scripted interactions in the current study did not. Previous studies had also not measured novel interactions, which were those interactions that did not contain any words from the original scripts besides conjunctions, articles, prepositions, pronouns, or the toy's name. The number of novel initiations during intervention increased.

The current study also assessed the extent to which these interactions generalized to both within- and across-category probe stimuli (Marzullo-Kerth, Reeve, Reeve, & Townsend, 2011; Reeve, Reeve, Townsend, & Poulson, 2007) after training with multiple exemplars of toys. To produce generalized responding to untaught examples, Stokes and Baer (1977) suggested that teaching should occur with response and stimulus exemplars that adequately reflect the diversity of the generalization being programmed. One way to determine relevant stimuli

is through the use of a general case analysis in which teaching examples that represent the full range of stimulus variations and response requirements in the generalization setting are selected (Engelmann & Carnine, 1982; Horner, Sprague, & Wilcox, 1982; Marzullo-Kerth et al., 2011; Reeve et al., 2007). In the present study, multiple-exemplar training with different categories of toys likely facilitated generalization of interactions because the exemplars used adequately represented the full range of stimulus variations and response requirements in the generalization setting (Engelmann & Carnine, 1982; Horner et al., 1982; Marzullo-Kerth et al., 2011; Osnes & Lieblein, 2003; Reeve et al., 2007; Stokes & Baer, 1977). Teaching with multiple exemplars of toys helped to produce generalized responding across untrained stimuli, but generalized responding of interactions did not occur across novel settings or people (i.e., peers). It is likely that if teaching sessions had been conducted across multiple settings and people, interactions would have also generalized across these stimulus dimensions.

Similar to other studies (e.g., MacDuff et al., 2007; Reagon & Higbee, 2009; Stevenson et al., 2000), auditory scripts were used in the present study rather than written ones to prompt learners to initiate vocal interactions. Although scripts were successfully faded with three of the participants, transfer of control of responding from the recorder to the toys did not occur for Adam. The addition of a fading level in which the recorder was played behind Adam, however, did result in transfer of control of interactions to the toys. Future studies should more systematically assess methods for successfully fading audio scripts.

In the present study, both in vivo scripted and in vivo unscripted interactions were assessed to identify whether the participants used any of the conversation partner's statements in their interactions and to provide information about the interactions being produced. Previously, these two types of interactions had not been evaluated in the script-fading literature. Although rein-

forcement was delivered following in vivo interactions during teaching trials, the participants were not prompted to use the language emitted by the conversation partner. Unfortunately, in vivo interactions were infrequently emitted by the participants. Future studies might include a separate teaching component to increase attending to the conversation partner's responses.

The present study also assessed both elaborations and acknowledgments, which had not been previously assessed in the script-fading literature. Interactions that occurred after the conversation partner's responses were scored as elaborations. Elaborations were scored in the same manner as initiations (i.e., scripted, unscripted, novel, in vivo scripted, and in vivo unscripted). These measures provided more detailed information about the type of language the participants produced. Results showed, however, that elaborations occurred much less frequently than did initiations. One reason for this may have been the fact that when participants emitted an initiation, they had access to the toy for 30 s. During toy play, interactions were less frequent. Another reason may be that participants were not explicitly prompted or scripted to emit elaborations.

Acknowledgments were vocal productions (e.g., "okay," "yes," "sure," "cool") that occurred after the conversation partner made a statement. In general, acknowledgments may signal to a conversation partner that attention is being directed to what he or she is saying. Simple words such as "yes" or "okay" may increase the probability that the conversation partner will continue his or her conversation and will converse with the person again in the future. Individuals who demonstrate this skill are more likely to gain and maintain access to more conversation partners in a typical environment. By measuring these interactions, data could be used to analyze whether participants who emit acknowledgments do indeed promote more elaborate conversations.

Although all four participants entered the study with varying skill levels and ages, all showed

systematic increases in interactions. The highest levels of novel interactions were observed for Dan and Justin, who entered the study with more expansive language repertoires than the other two participants. This likely contributed to Dan's and Justin's more varied and novel language production during intervention. In addition, Dan's high score on the Preschool Language Scale may have also increased the likelihood of his success with the intervention. James's and Adam's interactions consisted of more scripted and unscripted interactions than novel initiations or elaborations. Other prerequisite skills might have also influenced the outcomes. Although participants were required to identify the toys in the study and to imitate scripts on audio recorders, demonstrating prerequisite skills (e.g., describing the toys) might have helped to produce more novel language and more rapid skill acquisition. It may also have been beneficial if participants had been required to identify the functions of the toys.

Initiations taught through the script-fading intervention were maintained for three of the four participants. At the 2-week follow-up, all four participants' numbers of interactions were similar to their interactions in the last session of the intervention. In addition, three of the four participants had similar numbers of interactions during the 2-month follow-up. Only Adam displayed a large decrease in interactions during the 2-month follow-up. This decrease might have been a result of the novel setting. Another possibility, however, could be that because Adam was the fourth participant in the study, he did not receive the intervention for as many sessions as the other participants.

One limitation of the study is that each participant was exposed to specific toy categories that remained constant. We did note that the participants attended to the toys less as the intervention progressed. Future studies may benefit from changing toys more frequently, but still using toys that belong to the same category and for which the scripts would still be appropriate (e.g., different types of soccer balls).

Increasing the variety and novelty of the toys, while also varying the setting during the intervention sessions, might increase engagement, thus resulting in increases in interactions. In addition, more exemplars could increase the degree of generalized responding, thus increasing the utility of the interaction skills. Future researchers should also investigate whether preference for the toys used in the study might affect responding. It is possible that increased interactions would have been observed if the toys had been identified as highly preferred by the participants. Such studies should add to the body of effective strategies for teaching individuals with autism to initiate and sustain vocal interactions under the control of more natural environmental stimuli.

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