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Using script fading to promote natural environment stimulus control of verbal interactions among youths with autism

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Abstract

Script fading was used to teach three youths with autism to initiate and sustain verbal interactions under stimulus control consistent with the natural environment. The youths learned to engage in verbal interactions during simulated shopping trips and during visits to community stores. The effectiveness of script fading was examined using a multiple-baseline-across-settings experimental design. During pre-test trips to community stores and during baseline sessions, all three youths demonstrated near zero rates of verbal interactions. With the introduction of the script-fading procedure, all three youths successfully learned to use the scripted statements in conversations during a series of simulated shopping trips. As the scripts were faded, from last word to first word, rates of unscripted statements systematically increased. All three participants also demonstrated generalization of their newly acquired conversation skills to untrained stimuli. In addition, all three youths demonstrated generalization of their conversation skills during community shopping trips to local retail stores. These results suggest that the script-fading procedure brought verbal interactions under the stimulus control of environmental, as opposed to teacher-controlled stimuli.
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Behavior analytic intervention strategies have proven effective in teaching a variety of language skills to individuals with autism. Language skills such as generalized verbal imitation (Young, Krantz, McClannahan, & Poulson, 1994), labeling (Lovaas, 1977), using adjectives (Rousseau, Krantz, Poulson, Kitson, & McClannahan, 1994), making social initiations (Krantz & McClannahan, 1998), and engaging in conversation (Sarokoff, Taylor, & Poulson, 2001; Stevenson, Krantz, & McClannahan, 2000) have successfully been taught using behavior analytic technology.

The focus of other behavior analytic language studies has shifted from the acquisition of basic language skills to instruction that promotes the use of language skills across a variety of environments (Krantz & McClannahan, 1993). These studies represent a shift in focus from skill acquisition to stimulus control. A number of studies have examined the generalization of language skills from teaching environments to more naturalistic environments (e.g., Koegel, Camarata, Valdez-Menchaca, & Koegel, 1998; Krantz & McClannahan, 1998; Matson, Sevin, Fridley, & Love, 1990). Many of these authors use the term "spontaneous" to describe language performances that occur in natural environments. Spontaneity is often viewed as behavior that has its cause within the individual emitting the behavior. In fact, the lack of spontaneity is sometimes seen as a result of behavior analytic teaching procedures (Zanolli, 1997).

Sigafoos and Reichle (1993) provide a more behavior analytic conceptualization of "spontaneity" that is directly applicable to language use in natural settings. They suggest that language that is considered spontaneous refers to linguistic responses that occur in the absence of an explicit prompt such as a model to be imitated or a question asked by a teacher. They argue that spontaneous performances are those performances under the control of discriminative stimuli that occur in the natural environment as opposed to discriminative stimuli presented or controlled by a teacher. Accordingly, spontaneous language can be viewed as a continuum with the least spontaneous language being prompted by a teacher and the most spontaneous performances being under the discriminative control of naturally occurring environmental stimuli. By defining spontaneity in stimulus control terms "spontaneous language" is well within the realm of behavior analytic investigation.

Individuals with autism, even those who have received intensive language intervention, are often viewed as lacking spontaneous language (Carr & Kologinsky, 1983; Halle, 1982). Several naturalistic observation studies have suggested that there are severe deficits in spontaneous language among individuals with autism (Hauck, Fein, Waterhouse, & Feinstein, 1995; Stone & Caro-Martinez, 1990). Given that there are spontaneous language deficiencies among individuals with autism, how, then, does one help an individual who has learned some basic language skills using discrete-trial teaching to develop the more complex and distal stimulus control that will promote spontaneous language?

Script fading is a strategy that has been used to increase spontaneous language among individuals with autism. Script fading consists of teaching learners to use written scripts or audio recordings that provide models of appropriate language. As the learners begin to use the scripted language in their interactions, the scripted phrase or sentence is systematically faded from end to beginning. For example, if a script said "Watch me jump!" it would be faded, in four steps, to (a) "Watch me," to (b) "Watch," to (c) a blank script, and finally to (d) no script.

Krantz and McClannahan (1998) embedded scripts in activity schedules to increase the social initiations of three preschoolers with autism. The activity schedules used in this study contained pictures of 16 activities that the learners could perform without the assistance of a teacher. The

participants were taught to use their activity schedules to independently retrieve the necessary materials, complete the activity, and return the materials to their storage locations (MacDuff, Krantz, & McClannahan, 1993; McClannahan & Krantz, 1997, 1999). In addition, when a written script appeared in the schedule, the students were taught to approach a conversation partner and repeat the script. After acquiring this social initiation skill, the scripts were systematically faded from end to beginning. Upon completion of the teaching procedure, all three participants showed high levels of social initiations, although no scripts remained in their activity schedules. In addition, all three participants showed increased use of initiations that were not scripted and initiations during new activities when they were added to the schedules. Of particular note in this study is the shift in stimulus control from teacher prompts to schedule-based prompts manipulated by the students themselves. This represents a crucial step toward environmental control of language.

In another script-fading study, Krantz and McClannahan (1993) taught youngsters with autism to initiate social interactions to their peers. Students were presented with written lists of scripts that they could use to initiate conversation with their peers during typical classroom activities. The youths were taught to use the written scripts to talk to their peers and then to place a checkmark next to each script that they used. As soon as the youths were correctly using the scripts, fading began. The scripts were systematically faded from end to beginning until only a single quotation mark remained. After the fading sequence was completed, all four participants maintained high levels of social interactions. All four youths also showed increased use of unscripted language. Here again, individuals with autism were able to maintain conversational performances in the absence of scripts and prompts from instructional staff. Only the presence of their peers and their script pages with single quotation marks were needed to support their newly developed conversational skills.

Sarokoff et al. (2001) taught two students with autism to engage in conversation about snacks and video games. They used scripts that always began with text that was present on the packaging of the video game or snack. For example, if the conversation stimulus was a bag of Skittles®, scripts could have been "Skittles are fun to eat." Initially, these scripts were written on paper and the corresponding stimulus was placed on top of the paper. Eventually, the sheets of paper were faded which resulted in only the name of the product on the packaging remaining. After teaching, only the teacher's presentation of a conversation stimulus was required to maintain their social interaction.

Each of the above mentioned script-fading studies demonstrated the acquisition of new verbal performances. In each case, however, non-natural discriminative stimuli remain in the environment and may control verbal performances. For example, in the Krantz and McClannahan (1993) study sheets of paper with single quotation marks are present during the terminal performances. In the Krantz and McClannahan (1998) study, activity schedules that indicated which activities to complete were present. In the Sarokoff et al. (2001) study the experimenters specifically placed stimuli on a table between pairs of participants and verbally instructed the participants to engage with the stimuli.

None of these studies evaluated whether or not learners' newly acquired conversation skills would have occurred in an environment that did not contain these prompts. The current study was designed to evaluate the extent to which script fading can be used to teach individuals with autism to initiate and sustain conversational speech in typical environments without non-natural stimuli.

Behavior analytic language instruction is capable of teaching basic language skills and then shifting the stimulus control of those performances toward stimuli occurring in

the natural environment. Among the most important linguistic skills is engaging in a conversation with another person. What, then, are the stimulus conditions that should set the occasion for engaging in conversation with another person? For the purposes of the current study, we assumed that two stimulus components are sufficient to set the occasion for initiating and sustaining a conversation. Specifically, we used an environment that contained both a conversation partner and an object that served as a topic of conversation. Thus, terminal performances should occur in the absence of non-natural prompting stimuli.

The current study examined the extent to which script fading can be used to teach individuals with autism to initiate and sustain conversational speech under stimulus control consistent with the typical environment. Script fading was selected as an instructional technique because in prior studies it has been effectively used to teach conversational speech. In addition, it requires minimal teacher prompts. It is believed that by using fading techniques it will be possible to shift control of conversational speech from scripts to the objects that serve as conversation topics. It is predicted that the introduction of a script-fading intervention will lead to increased conversational skills. In addition, the increases in conversational speech will be maintained in the absence of scripts and other prompting stimuli after fading.

1. Method

1.1. Participants

Three youths with autism participated in the experiment. Each of the children was independently diagnosed with autism by a qualified professional from an independent agency. All three youths met the criteria for autism defined in the Diagnostic and Statistical Manual of Mental Disorders, 4th ed., text revision (American Psychiatric Association, 2000). Each of the participants could communicate using spoken language. All three youths, however, had difficulty making verbal initiations to others.

Rand was 13 years old at the start of the study. He had received 10 years of educational services. Rand scored an age equivalent of 4 years 10 months on the Peabody Picture Vocabulary Test (Dunn & Dunn, 1997) and his Vineland Adaptive Behavior Scale (Sparrow, Balla, & Cicchetti, 1984) composite score age equivalent was 4 years 0 month. Pete was 9 years old at the start of the study. He has been receiving educational services for 6 years prior to the start of the study. Pete scored an age equivalent of 4 years 9 months on the Peabody Picture Vocabulary Test (Dunn & Dunn, 1997). Pete's adaptive behavior composite score on the Vineland Adaptive Behavior Scales (Sparrow et al., 1984) was an age equivalent of 5 years 5 months. Sean was 7 years old at the start of the study. Prior to the start of the study, he had received 4 years of educational services. Sean's adaptive behavior composite score on the Vineland Adaptive Behavior Scales was an age equivalent of 1 year 8 months and his Peabody Picture Vocabulary Test score was an age equivalent of 2 years 11 months.

All of the children had extensive experience with behavior analytic teaching procedures including lengthy experience with language instruction using script-fading technologies. All three children had relatively low levels of stereotypic responses such as tensing, finger play, and non-contextual laughter. All three boys typically received instruction with a two-to-one student-to-teacher ratio throughout the school day. Additionally, they were able to respond to typical

classroom instructions without assistance. All of the children also used token-based motivational systems extensively.

1.2. Setting

1.2.1. Materials and equipment

All teaching and generalization sessions were conducted in a 3 m × 5 m classroom with a carpeted floor. Prior to entering the classroom, an Audio-Technica® Pro 88W/R wireless microphone transmitter and an Audio-Technica® MT830MW omni-directional microphone were clipped to the participant's clothing. The wireless receiver was connected to a Sony® model CCD-TR930 videocassette camera/recorder. All teaching and generalization sessions were videotaped and scored after each session. In addition, a single-bank mechanical counter, used to record points earned, was clipped to the participant's clothing before entering each session. The mechanical counter was a metal cylinder that was 4.5 cm in diameter and 3 cm tall. It had a button that when pressed incremented a mechanical counter inside the device. Each press of the button caused the numeral displayed on the mechanical counter to be increased by one.

1.2.2. Pre-teaching classroom

During the stimulus and reading pre-teaching phases, the classroom contained a table and two typical desk chairs. The table was placed in the center of the room with one chair on either side of the table facing one another. In addition, a large, opaque, plastic box was placed on the teacher's side of the desk. The box contained the stimulus materials that were presented during stimulus pre-teaching. During pre-teaching a token-based motivational system was placed on the desk between the participant and the teacher.

1.2.3. Mock stores

During the response-contingent modeling and script-fading phases, the classroom was reconfigured to create three mock stores. The table and chairs were removed and replaced with shelves. During videotape-rental-store sessions, videotapes were arranged on the shelves so that the participant could easily see and handle the videotapes. The mock sporting goods store was created by displaying a variety of sporting goods such as balls, helmets, and golf clubs during sporting goods sessions. During mock convenience-store sessions, snack foods were arranged to resemble a typical convenience-store snack food display. In each of the three mock stores, the stimulus materials were arranged so that the participants could obtain and manipulate them without assistance. During each session, only the stimuli associated with a single mock store were present.

1.2.4. Community stores

Three retail stores were used as the community settings for the pre- and post-tests. The community setting for the videotape-rental-store condition was the family section of a local-video-rental store. The sporting goods section of a local discount store was used as the community setting for the sporting goods condition. Community pre- and post-test sessions for the convenience-store setting were conducted in the snack food section of a local delicatessen. Before conducting each session, each community store was visited to verify that all stimulus items were available on the shelves. If participants attempted to leave the specific section of a community store during data collection activities, manual guidance was used to direct them back to the appropriate section of the store.

1.3. Dependent measures

The dependent measures included frequencies of scripted and unscripted interactions for the teaching stimuli and unscripted interactions for the generalization stimuli. Data from all sessions were scored from video recordings made during each session in the mock stores. Data were scored from audio recordings made during the community pre- and post-test sessions.

1.3.1. Interactions

Interactions were defined as verbal responses made by the participant that were directed to the conversation partner by using the partner's name, orienting to the partner, or using a gesture to gain the partner's attention. Interactions did not need to be grammatically correct. To be scored as an interaction, verbal responses had to contain a noun and a verb and be separated from the participant's prior verbal response by a change in topic or a verbal response from the conversation partner. Verbal responses that were verbally or gesturally prompted, verbal responses that were repetitions of the immediately prior response of the participant or the conversation partner, and verbal responses made in response to questions asked by the conversation partner were not scored as interactions (Krantz & McClannahan, 1998).

1.3.2. Scripted interactions

Those interactions that matched scripts that were present in the current session were scored as scripted interactions. Interactions that differed only in conjunctions, articles, prepositions, and/or pronouns were also scored as scripted interactions. When partial scripts were presented, interactions that included the partial script along with any additional words were scored as scripted if they met the interaction criteria described above. Interactions that differed in any other respect from the script were not scored as scripted interactions (Stevenson et al., 2000).

1.3.3. Unscripted interactions

Interactions that did not match any of the scripts presented in the current session were scored as unscripted interactions. If there were no scripts present during a session, all interactions in that session were scored as unscripted interactions. Consequently there could be no scripted interactions during the response-contingent modeling phase or after fading level 6 in the script-fading phase. If a participant constructed an interaction that was similar to the content of a script, it was scored as an unscripted interaction if it differed from the script by more than conjunctions, articles, prepositions, or pronouns. For example, if a participant said "I like green M and M's," which is similar to the script "I like the red M and M's," it was scored as an unscripted interaction because the adjective was changed. If, on the other hand, the participant had said "You like the red M and M's." the interaction would have been scored as a scripted interaction because the only difference was that the participant changed the pronoun "I" to "you."

1.3.4. Generalization interactions

Any interaction that met the definition of an interaction and referred to one of the generalization stimuli was scored as a generalization interaction.

1.4. Stimulus materials

Nine teaching stimuli and nine generalization stimuli were used in each mock store. Examples of generalization stimuli, teaching stimuli and associated scripts are listed in Table 1.

Table 1
Sample teaching and generalization stimuli used in the mock stores

Mock store	Stimulus type	Stimulus	Script
Convenience	Teaching	Almond Joy® Candy Bar Kit Kat® Candy Bar Lay's® Potato Chips	"Coconut is chewy." "Chocolate tastes yummy." "Potato chips are salty."
	Generalization	Nutter Butter® Cookies Reese Sticks® Candy Bar Wrigley's® Chewing Gum	N/A N/A N/A
Sporting goods	Teaching	Baseball Glove Football Frisbee® Flying Disk	"I love to play catch." "Passing the ball is easy." "It's hard to throw it."
	Generalization	Bicycle Helmet Skateboard Soccer Ball	N/A N/A N/A
Video	Teaching	Black Beauty Videotape Hercules Videotape Rugrats in Paris Videotape	"That horse is big." "She is wearing purple." "Cartoons are funny."
	Generalization	A Bug's Life Free Willy The Aristocrats	N/A N/A N/A

1.5. Procedure

1.5.1. Mechanical counter pre-teaching

Given that portions of this study were to take place in the community, an unobtrusive reinforcement system was designed. The use of a mechanical counter was designed to create a reinforcement system so that the participant would attend to every point earned while minimizing the likelihood that others in the community setting would notice the delivery of points. To insure the participants' successful use of the reinforcement system, pre-teaching was conducted. This pre-teaching was completed prior to stimulus and reading pre-teaching. Mechanical counter pre-teaching was conducted during a discrete-trial picture-labeling task. After each correct answer, the teacher pressed the button on a mechanical counter in his possession. If the participant pressed the button on his mechanical counter, the teacher delivered a token on the participant's token board. If he did not press the button on his mechanical counter, the teacher manually guided the participant to press the button on his mechanical counter. When the participant earned 10 tokens on his token board, he exchanged them for a preferred snack. Mechanical counter pre-teaching continued until the participant correctly incremented his counter each time the teacher pressed the button on his counter during a single session.

1.5.2. Stimulus pre-teaching

Stimulus pre-teaching sessions were conducted prior to the community pre-tests. Stimulus pre-teaching was conducted to insure that the participants could identify all of the stimuli that were used in the study. During stimulus pre-teaching sessions, the participant and teacher were seated in the classroom on opposite sides of the table. The 54 stimuli were presented to the participant one at a time and the teacher asked: "What is this?" If the participant correctly labeled the object, the teacher delivered a token and descriptive praise. If the participant did not

correctly label the object the teacher provided the correct answer and no token was delivered. Stimulus pre-teaching continued until all of the objects were correctly labeled in a single session. If the participant gave a non-specific answer such as "ball" when presented with one of the balls, the teacher asked a follow-up question. The follow-up questions used the following form: "What kind of _____ is it?" Correct answers to either the primary or the follow-up question were scored as correct for that item.

1.5.3. Reading pre-teaching

Prior to the community pre-tests, the participants were taught to read each of the 93 words that were used in the scripts. During reading pre-teaching sessions, flash cards with a single word on each card were presented to the participant and the participant was asked to read the word. If the participant correctly read a word, the teacher delivered a token and descriptive praise. Typical descriptive praise statements included "Good, you read cookies." and "Great, that was helmet." If the learner did not correctly read a word, the teacher stated the correct answer and no token was delivered. Reading pre-teaching continued until all of the words were read without prompts in a single session.

1.5.4. Community store pre-tests

Prior to the first response-contingent modeling session, the participants' conversation performances were measured in the three community stores. During the community pre-test sessions audio recordings were made and scored after the session by the teacher and an additional scorer. Each community pre-test session began when the participant was in the specified section of the community store. During the pre-test sessions the participant was free to browse in the specified section of the store. The conversation partner remained within 1.5 m of the participant at all times. Community pre-test sessions lasted for 5 min in each of the three stores. During community pre-test sessions, no programmed consequences were delivered.

1.5.5. Response-contingent modeling

After the conclusion of the community store pre-test sessions, data collection began in the response-contingent modeling phase in all three settings for each participant. Response-contingent modeling sessions were conducted in the appropriate mock store. Upon entering the "store," the session was started. Throughout each session the conversation partner remained facing and with 1.5 m of the participant. The participants were free to browse through the items in the mock stores and were allowed to handle the items if they chose. If a participant emitted an interaction, the conversation partner responded with an appropriate conversational response. Response-contingent modeling sessions for Pete and Sean were 3 min long. Because of his more advanced language, Rand's sessions were 5 min long. No points were delivered for interactions during response-contingent modeling sessions. The conversation partner, however, modeled an appropriate conversational statement after each interaction emitted by the participant.

1.5.6. Script fading

After the response-contingent modeling data stabilized, the script-fading intervention was started in the first setting of the multiple-baseline design for each youth. As in the community pre-test sessions and the response-contingent modeling sessions, the conversation partner remained within 1.5 m of the participant at all times.

During script fading, printed scripts were attached to each stimulus. The scripts were set in an 18-point Times New Roman font on clear self-adhesive labels. The labels were 1-cm tall and the

Table 2
Fading levels used during script fading

Fading level	Remaining script content
Level 0	Full script
Level 1	Last word removed
Level 2	Last two words removed
Level 3	All but the first word removed
Level 4	All but the first word removed on six stimuli and no script on three stimuli
Level 5	All but the first word removed on three stimuli and no script on six stimuli
Level 6	All but the first word removed on one stimulus and no script on eight stimuli
Level 7	No scripts

length of each label was trimmed so that the script words just fit on the label with no extra label remaining. These labels were attached to each teaching stimulus in an unprinted area of the stimulus. Correct placement of the scripts was verified prior to each session. In addition, the location of the label on the stimulus was moved after each change in fading level.

During the initial script-fading sessions, if a participant did not say any of the scripts to the conversation partner within 30 s of entering the mock store or within 30 s of the last interaction they were manually guided to point to a script. Manual guidance was sufficient to prompt the participant to use the script to initiate an interaction with the conversation partner. Independent use of the scripts was reinforced by delivering points for scripts that were recited without prompts. The teacher operated a separate mechanical counter to cue the participant to self-deliver points on the mechanical counter attached to the participant's clothing. Both unscripted interactions and scripted interactions that referred to teaching stimuli were reinforced with points. These points were exchanged for a preferred snack after each session.

As soon as a participant emitted at least 10 interactions without any script-reading prompts in a single session, no additional prompts to read scripts or initiate interactions were delivered during the remainder of the study. In addition, when the participant met this criterion, the script-fading procedure began. The fading levels that were used are shown in Table 2.

During the first three fading steps the scripts were reduced from full scripts to only the first word of the script. To enhance the probability of transfer of stimulus control from the scripts to the teaching items the first word was faded from the scripts using a strategy that gradually removed the script from an increasing proportion of the teaching items. This was accomplished during the next three fading levels. In addition, as the number of items with scripts was reduced, the scripts appeared on different items during each successive session. The scripts were removed from three of the nine teaching stimuli at fading level 4. During sessions at fading level 5 the scripts were removed from six teaching items and remained on three teaching items. For fading level 6 the first word of a script remained on only a single teaching item. Finally, during fading level 7 no scripts were present. When a participant used each script present during a session at least once, without prompts, he was moved to the next fading level for the next session. Fading continued until participants completed fading level 7. After stable responding was observed in all three mock-store settings, the community post-test sessions were conducted.

1.5.7. Generalization measures

Throughout the response-contingent modeling and script-fading phases three generalization stimuli, in addition to the nine teaching stimuli, were displayed during each session. The generalization stimuli were block randomized such that over three sessions each of the

generalization stimuli would have been present in each mock store for a single session. By combining the data from each group of three successive sessions a measure of the complete set of generalization stimuli was obtained. No points were delivered for interactions referring to generalization stimuli. The conversation partner, however, did make an appropriate conversational statement in response to each generalization interaction. At no time were any scripts placed on the generalization stimuli.

1.5.8. Community store post-tests

After the completion of script fading in all three mock-store settings, interactions were examined in the community stores. The community store post-test sessions were identical to the community store pre-test sessions.

1.6. Experimental design

A multiple-baseline-across-settings experimental design was used to evaluate the effects of the intervention package (Baer, Wolf, & Risley, 1968). The intervention strategy included the use of scripts, a script-fading procedure, and reinforcement for engaging in conversational interactions (Krantz & McClannahan, 1993, 1998; Stevenson et al., 2000). The intervention package was introduced serially in each setting. Generalization of conversational skills to the generalization stimulus items was measured throughout the study. In addition, the participants' performances were evaluated in community settings prior to the intervention and after the completion of intervention.

1.7. Data analysis

The data from each session were summarized by reviewing the session video or audio recording and scoring each interaction as a scripted interaction, an unscripted interaction, or a generalization interaction. The data were then summarized as the number of scripted interactions and the number of unscripted interactions per minute. In addition, after every third session the number of generalization interactions in that session and the previous two sessions were combined to yield the rate of generalization interactions that referred to the total set of nine generalization stimuli thus allowing a comparison to the teaching data. During scoring, each observer was allowed a maximum of five replays for each segment of tape.

1.7.1. Interobserver agreement

Two independent observers scored a sample of the videotaped sessions. For the purposes of collecting interobserver agreement data, each videotape contained a time track that indicated the running time within the session. For each interaction each observer recorded the time that the interaction began to the nearest second and the type of interaction. Interobserver agreement was assessed on a point-by-point basis. To be scored as an agreement both observers had to score an interaction as the same type of interaction and code the time within 1 s of the other observer. Interactions that were coded with different interaction types or that were not coded as occurring within 1 s of the other observer's time were scored as disagreements. The interobserver agreement percentage was calculated by dividing the number of agreements by the number of agreements plus the number of disagreements and multiplying by 100.

During response-contingent modeling, interobserver agreement on Rand's unscripted interactions was 100%. During the script-fading phase agreement had a range of 93–98%.

Data were obtained for 44% of Rand's sessions (21 of 48 sessions). Interobserver agreement data were collected on 33% of Pete's sessions (20 of 60 sessions). During the response-contingent modeling sessions, in which interobserver data were collected, both observers scored Pete as not having emitted any interactions. During the script-fading phase interobserver agreement had a range of 90–97%. During 23 of Sean's 69 sessions (33%) interobserver agreement data were collected. During the response-contingent modeling phase interobserver agreement was 100%. During the script-fading phase interobserver agreement percentages were between 82 and 93%, inclusive. During the community pre-test sessions none of the three participants emitted any interactions and neither observer recorded any interactions. Interobserver agreement during the community post-test sessions had a range of 89–100%.

2. Results

2.1. Pre-teaching

Rand completed mechanical counter pre-training in five sessions. Pete successfully completed mechanical counter pre-teaching in two sessions. Sean successfully learned to press the button on his mechanical counter in six pre-teaching sessions. Rand only required two pre-teaching sessions to learn to read each of the 93 words correctly. Pete completed reading pre-teaching in 12 sessions. Sean reached the criterion of 100% accuracy in reading the script words in 18 sessions. During the initial stimulus pre-training session Rand, Pete, and Sean could correctly label 80, 39, and 19% of the stimuli, respectively. Rand required 10 sessions to complete stimulus pre-teaching. Pete finished the stimulus pre-teaching in 14 sessions. Sean required 24 sessions to complete stimulus pre-teaching.

2.2. Interactions

Fig. 1 shows Rand's data across the multiple-baseline experimental design. Sessions are shown on the abscissa. The number of interactions per minute is shown on the ordinate. The line between sessions 6 and 7 in the top panel indicates the condition change from response-contingent modeling to script fading. Fading levels are indicated by numbered arrows along the top of each panel. Unscripted interactions are indicated by the filled circles. The open squares represent generalization interactions and the open circles indicate scripted interactions. The three panels of the figure show data from the convenience store on top, the video store in the middle, and the sporting goods store in the bottom panel.

As seen in the top panel of Fig. 1, during the response-contingent modeling phase, Rand did not emit any unscripted interactions (filled circles) in the convenience-store setting. With the introduction of the script-fading intervention, during session 7, Rand's scripted interactions (open circles) increased to 13 interactions per minute over 2 sessions. Script fading, in the convenience-store setting, began during session 8. Rand's rate of scripted interactions systematically dropped as the fading level increased. Between sessions 9 and 13 the number of scripted interactions per minute dropped to near zero levels and remained low until the final script was removed at session 16.

As shown in the top panel of Fig. 1, with the introduction of the script-fading intervention, unscripted interactions (filled circles) increased to 12 interactions per minute over the first 9 script-fading sessions. During the remaining 27 sessions the rate of unscripted interactions had a range of 11–15 interactions per minute in the convenience-store setting.
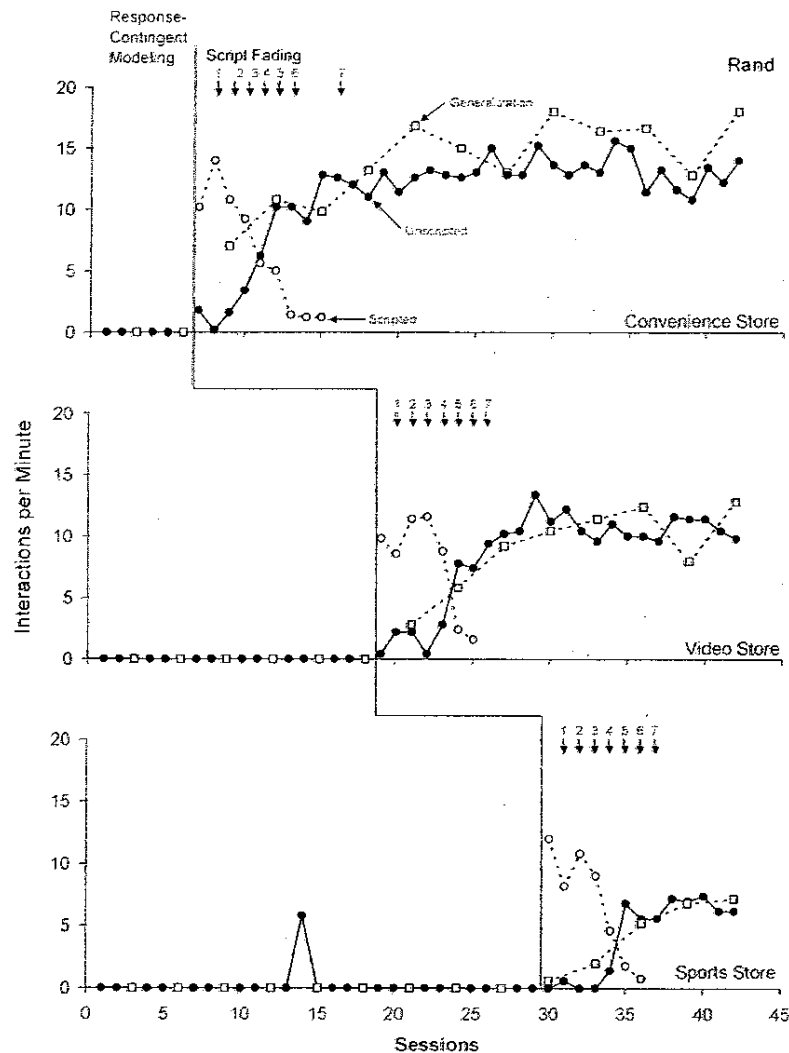
Fig. 1. Data for Rand: the number of scripted, unscripted, and generalization interactions across the three mock stores are shown. Fading levels are indicated by numbered arrows.

During the response-contingent modeling phase no generalization interactions (open squares) were emitted. With the introduction of the script-fading intervention Rand's rate of generalization interactions increased to 17 interactions per minute over the first 15 sessions of script fading. His rate of generalization interactions had a range of 13–18 interactions per minute during the remaining sessions in the convenience-store condition.

The middle panel of Fig. 1 shows Rand's interaction data in the video-store setting. Rand's performance in the video-store setting closely paralleled his performance in the convenience-store setting. During the response-contingent modeling phase he did not make any unscripted interactions. During the first session of the script-fading phase, scripted interactions increased to 10 interactions per minute. Scripted interactions remained between 10 and 12 interactions per

minute through fading level 3. Between fading level 3 and fading level 6 the rate of scripted interactions dropped to 2 interactions per minute over 3 sessions.

With the introduction of the script-fading procedure in the video-store setting Rand's rate of unscripted interactions increased from zero during baseline to 10 interactions per minute across 10 sessions. The rate of unscripted interactions remained between 9 and 13 interactions per minute for the rest of the study. During the response-contingent modeling phase Rand did not emit any interactions in the video-store setting. With the introduction of the script-fading procedure generalization interactions increased to 9 per minute between sessions 19 and 27. Generalization interactions had a range of 8–13 interactions per minute throughout the rest of the experiment.
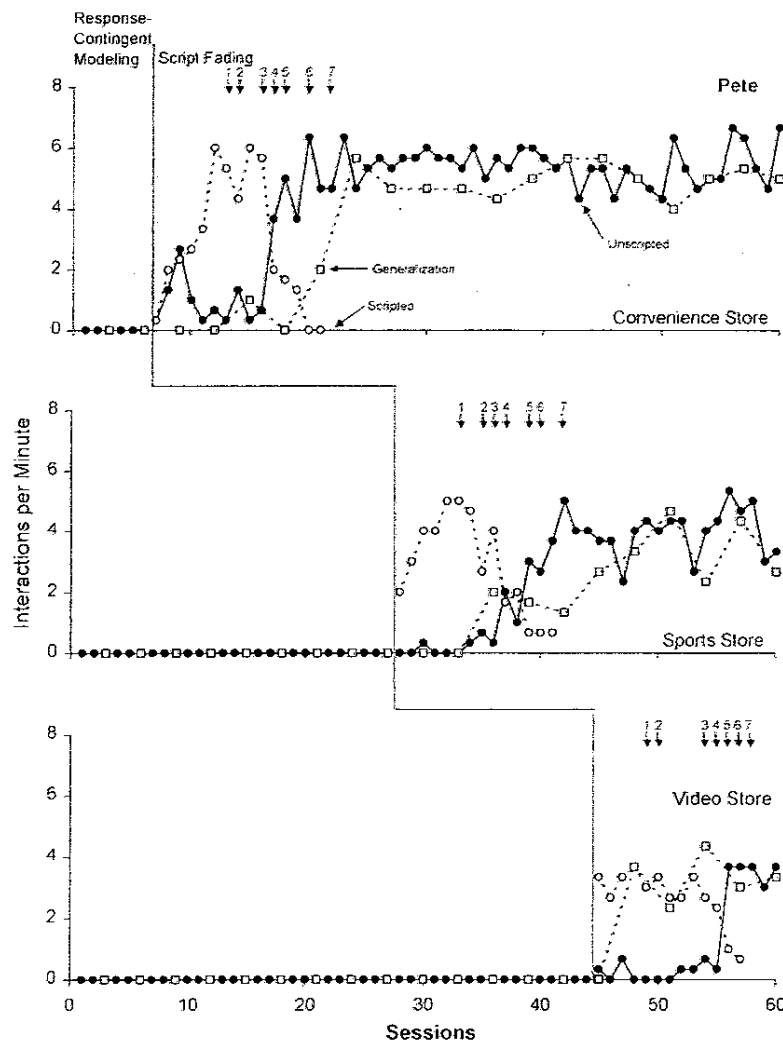

Fig. 2. Data for Pete: the number of scripted, unscripted, and generalization interactions across the response-contingent modeling and script-fading phases are shown for the three mock stores. Fading levels are indicated by numbered arrows.

Rand's performance in the sports-store setting was similar to the convenience and video stores. There was, however, a session in the response-contingent modeling phase that reached almost 6 unscripted interactions per minute. All other sessions during the response-contingent modeling phase showed zero rates of unscripted interactions. In the script-fading phase Rand's scripted interaction performance was similar to his performance in the convenience and video stores. He made 12 scripted interactions per minute during the first intervention session. His rate of scripted interactions systematically dropped to 1 interaction per minute across the first 6 fading levels in sessions 31–36.

In the sports store, Rand's rate of unscripted interactions remained low during the first four sessions in the script-fading phase. Between sessions 34 and 35 the rate of unscripted interactions
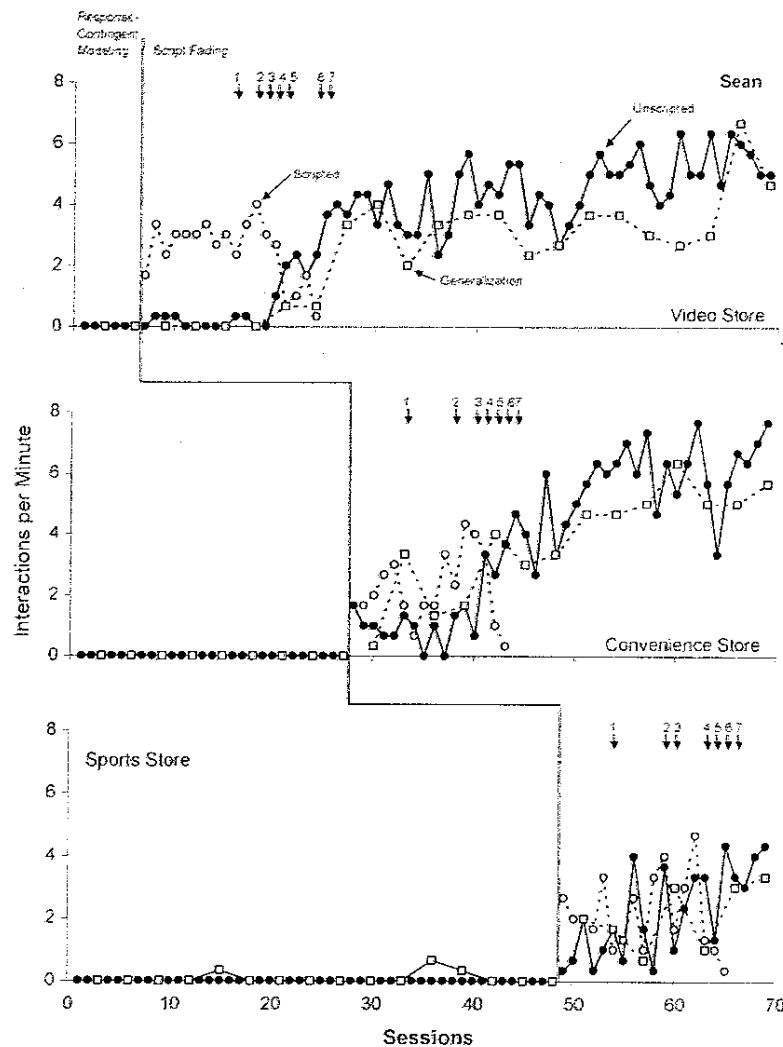

Fig. 3. Data for Sean: the number of scripted, unscripted, and generalization interactions across the response-contingent modeling and script-fading phases are shown for the three mock stores. Fading levels are indicated by numbered arrows.

increased from near zero levels to 7 interactions per minute. Unscripted interactions had a range of 5–8 interactions per minute until the end of the study. Between sessions 30 and 36 Rand's rate of generalization interactions increased from less than 1 to more than 5 interactions per minute. The final 2 generalization data points were 6 and 7 interactions per minute.

Fig. 2 shows Pete's performance across the convenience-, sports-, and video-store settings. With the introduction of the script-fading procedure Pete's rate of unscripted interactions systematically increased. Pete's performance essentially parallels Rand's performance with a few exceptions. Pete never emitted any unscripted or generalization interactions during the response-contingent modeling phase in any of the three settings. In both the convenience and sports stores Pete showed slower acquisition of scripted responding than Rand. Pete received the script-fading intervention in the convenience-store setting first. Pete's use of scripted interactions increased
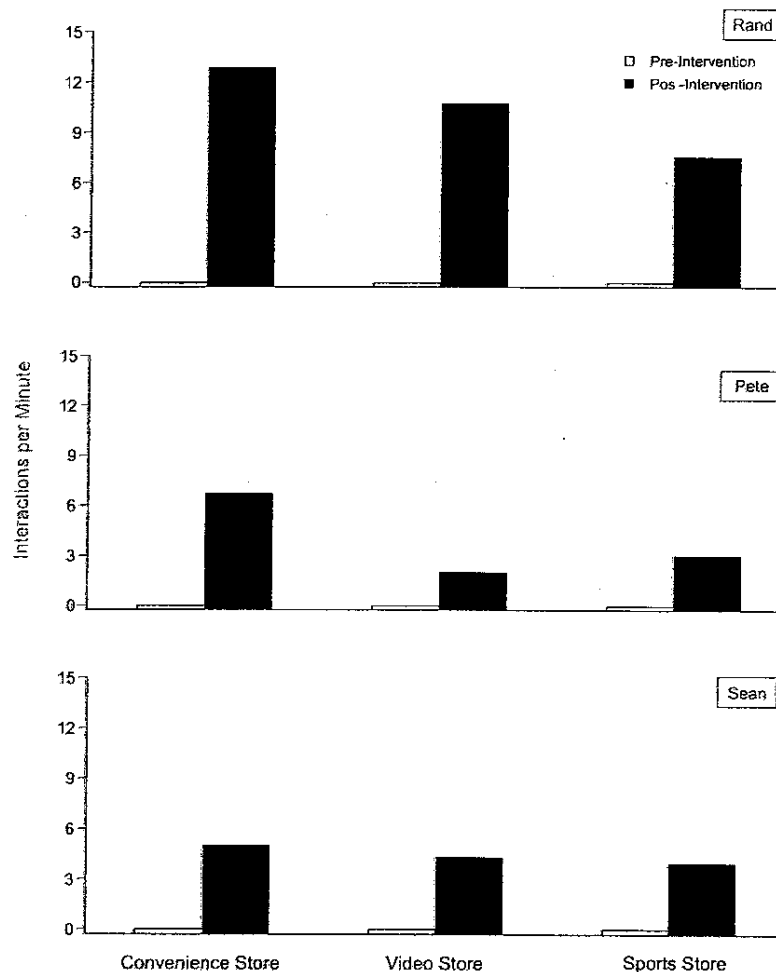

Fig. 4. Community pre- and post-test data: the number of interactions during the pre- and post-test sessions in community stores for all three participants is shown.

from less than 1 to 6 per minute during sessions 7–12. Pete's use of scripted interactions in the video-store setting was similar to Rand's typical pattern. In the video store Pete's scripted interactions increased to 3 interactions per minute during the first script-fading session. Then they systematically decreased as each successive fading level was reached. Although the acquisition of generalization interactions typically paralleled the acquisition of unscripted interactions, Pete showed an increase in his generalization interactions in the video-store setting that occurred prior to the increases in unscripted interactions.

Fig. 3 displays Sean's data across the video-, convenience-, and sports-store settings. Sean's performances are generally similar to Rand and Pete's performances. With the introduction of the script-fading procedure Sean's rate of unscripted interactions systematically increased. Sean never emitted any unscripted or generalization interactions during the response-contingent modeling phase in either the video store or the convenience store. He did, however, emit low rates of generalization interactions in three of the response-contingent modeling sessions in the sports-store condition. With the completion of the script-fading sequence both his unscripted interactions and his generalization interactions remained between 3 and 4 interactions per minute.

2.3. Community pre- and post-test data

Fig. 4 displays the data for the community pre- and post-test sessions. None of the three youths emitted any interactions in any of the stores during the community pre-test sessions. After the script-fading intervention all three boys showed increased interaction rates during the community post-test. Each of the youths showed increases in the rate of interactions in all three of the community stores during the post-test.

2.4. Response-contingent modeling

The conversation partner's implementation of language modeling was measured in four sessions for each youth. As described in the procedure section, response-contingent modeling required that the conversation partner model a conversational statement after each interaction made by the participant. The percentage of participant interactions that were followed by a response-contingent model from the conversation partner had a range of 90–100%.

3. Discussion

With the introduction of the script-fading package, all three boys showed systematic increases in the rate of unscripted interactions. Furthermore, all three boys also demonstrated systematic increases in the rate of generalization interactions after the introduction of the script-fading package. Because the changes for each youth occurred with the introduction of the script-fading package in each of the three mock-store settings, it can be concluded that the script-fading intervention caused the increases in conversational interactions.

Prior to intervention, during shopping trips in the community, all three boys failed to verbally interact with their conversation partner. After the intervention, during the community post-test sessions, each of the three boys demonstrated increased conversational interactions during shopping trips to the each of three community stores. It seems that, as programmed, during the community post-tests the presence of the conversation partner and a familiar item served as a compound stimulus that set the occasion for the youths' verbal interactions.

A number of procedures identified by Stokes and Baer (1977) may have contributed to the successful generalization of verbal interactions from the teaching stimuli to the generalization stimuli. The conversation partner's responses may have served as a natural contingency of reinforcement sufficient to maintain conversational interactions about the generalization stimuli. Teaching conversational responses to nine stimuli in each store setting may have served to teach sufficient exemplars to promote generalization to the untaught stimuli. Placing the teaching stimuli on the mock-store shelves intermixed with the generalization stimuli might have helped the teaching stimuli to serve as common stimuli and therefore promote generalization. The use of a variable-ratio schedule of reinforcement for verbal interactions about the teaching items may have helped to create an indiscriminable contingency of reinforcement that promoted generalization.

The current experiment was designed to examine the extent to which script-fading procedures can help youths with autism learn to initiate and sustain verbal interactions under the control of stimuli present in the natural environment. All three participants, prior to the study, were able to engage in conversation when they were prompted to do so by an activity schedule or their teachers. In a typical community activity, shopping in this case, they did not initiate nor sustain verbal interactions. Thus, demonstrating that the presence of a conversation partner and a familiar item did not set the occasion for verbal interactions. The data from the current study indicate that script fading can be a successful technique for teaching individuals with autism to initiate and sustain verbal interactions under the control of stimuli present in a more naturalistic environment.

Teaching the youths to use scripts that were placed on familiar items was successful in promoting their initiation of conversation. Subsequent fading of the scripts allowed the combination of a familiar item and the conversation partner to gain stimulus control over the initiation of verbal interactions. These performances occurred without the presence of activity schedules, teacher presented stimuli, and partial scripts in the environment. The current study represents an important shift from teacher-mediated to natural-environment stimulus control of verbal interactions for individuals with autism.

Acknowledgments

References

American Psychiatric Association. (2000). *Diagnostic and statistical manual of mental disorders* (4th ed., text revision). Washington, DC: Author.

Baer, D. M., Wolf, M. M., & Risley, T. R. (1968). Some current dimensions of applied behavior analysis. *Journal of Applied Behavior Analysis, 1*, 91–97.

Carr, E. G., & Kologinsky, D. (1983). Acquisition of sign language by autistic children. II: Spontaneity and generalization effects. *Journal of Applied Behavior Analysis, 16*, 297–314.

Dunn, L. M., & Dunn, L. M. (1997). *Peabody Picture Vocabulary Test* (3rd ed.). Circle Pines, MN: American Guidance Service.

Halle, J. W. (1982). Teaching functional language to the handicapped: An integrative model of natural environment teaching techniques. *Journal of the Association for Persons with Severe Handicaps, 7*, 29–37.

Hauck, M., Fein, D., Waterhouse, L., & Feinstein, C. (1995). Social initiations by autistic children to adult and other children. *Journal of Autism and Developmental Disorders, 25*, 579–595.

Koegel, L. K., Camarata, S. M., Valdez-Menchaca, M., & Koegel, R. L. (1998). Setting generalization of question-asking by children with autism. *American Journal on Mental Retardation, 102*, 346–357.

Krantz, P. J., & McClannahan, L. E. (1993). Teaching children with autism to initiate to peers: Effects of a script-fading procedure. *Journal of Applied Behavior Analysis, 26*, 121–132.

Krantz, P. J., & McClannahan, L. E. (1998). Social interaction skills for children with autism: A script-fading procedure for beginning readers. *Journal of Applied Behavior Analysis, 31*, 191–202.

Lovaas, O. I. (1977). *The autistic child: Language development through behavior modification*. New York: John Wiley & Sons.

MacDuff, G. S., Krantz, P. J., & McClannahan, L. E. (1993). Teaching children with autism to use photographic activity schedules: Maintenance and generalization of complex response chains. *Journal of Applied Behavior Analysis, 1993*, 89–97.

Matson, J. L., Sevin, J. A., Fridley, D., & Love, S. R. (1990). Increasing spontaneous language in three autistic children. *Journal of Applied Behavior Analysis, 23*, 227–233.

McClannahan, L. E., & Krantz, P. J. (1997). In search of solutions to prompt dependence: Teaching children with autism to use photographic activity schedules. In D. M. Baer & E. M. Pinkston (Eds.), *Environment and behavior*. Boulder, CO: Westview.

McClannahan, L. E., & Krantz, P. J. (1999). *Activity schedules for children with autism: A guide for parents and professionals*. Bethesda, MD: Woodbine House.

Rousseau, M. K., Krantz, P. J., Poulson, C. L., Kitson, M. B., & McClannahan, L. E. (1994). Sentence combining as a technique for increasing adjective use in writing by students with autism. *Research in Developmental Disabilities, 15*, 19–37.

Sarokoff, R. A., Taylor, B. A., & Poulson, C. L. (2001). Teaching children with autism to engage in conversational exchanges: Script fading with embedded textual stimuli. *Journal of Applied Behavior Analysis, 34*, 81–84.

Sigafoos, J., & Reichle, J. (1993). Establishing spontaneous verbal behavior. In R. A. Gable & S. F. Warren (Eds.), *Strategies for teaching students with mild to severe mental retardation*. Baltimore, MD: Paul H. Brookes.

Sparrow, S. S., Balla, D. A., & Cicchetti, D. V. (1984). *Vineland Adaptive Behavior Scales*. Circle Pines, MN: American Guidance Service.

Stevenson, C. L., Krantz, P. J., & McClannahan, L. E. (2000). Social interaction skills for children with autism: A script-fading procedure for nonreaders. *Behavioral Interventions, 15*, 1–20.

Stokes, T. F., & Baer, D. M. (1977). An implicit technology of generalization. *Journal of Applied Behavior Analysis, 10*, 349–367.

Stone, W. L., & Caro-Martinez, L. M. (1990). Naturalistic observation of spontaneous communication in autistic children. *Journal of Autism and Developmental Disorders, 20*, 437–453.

Young, J. M., Krantz, P. J., McClannahan, L. E., & Poulson, C. L. (1994). Generalized imitation and response-class formation in children with autism. *Journal of Applied Behavior Analysis, 27*, 685–697.

Zanolli, K. (1997). The environmental antecedents of spontaneous social behavior. In D. M. Baer & E. M. Pinkston (Eds.), *Environment and behavior*. Boulder, CO: Westview.