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A Comparison of Video Modeling with In Vivo Modeling for Teaching Children with Autism

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The present study was designed to compare the effectiveness of video modeling with in vivo modeling for teaching developmental skills to children with autism. A multiple baseline design across five children and within child across the two modeling conditions (video and in vivo) and across tasks was used. Each child was presented two similar tasks from his or her curriculum; one task was used for the video condition, while the other was used for the in vivo condition. Video modeling consisted of each child watching a videotape of models performing the target behavior, whereas in vivo modeling consisted of the children observing live models perform the target behavior. After the observations, children were tested for acquisition and generalization of target behaviors. Results suggest that video modeling led to faster acquisition of tasks than in vivo modeling and was effective in promoting generalization. Results are discussed in terms of video modeling's motivating and attention maintaining qualities.

KEY WORDS: Comparison of video and in vivo modeling; autism.

INTRODUCTION

The challenges in treating children with autism are many, and researchers must continually explore a variety of teaching procedures. One procedure that has received much attention in the literature is modeling (Buffington, Krantz, McClannahan, & Poulson, 1998; Charlop, Schreibman, & Tryon, 1983; Egel, Richman, & Koegel, 1981). This method generally involves the child observing another person engage in a target behavior. Indeed, studies have found that typically developing children learn easily through modeling (e.g., Bandura, Ross, & Ross, 1961; Hosford, 1980; Meltzoff, 1996). Learning through observation is also important for children with autism if they are to be mainstreamed into classrooms with typical children, where much of learning comes naturally through watching and imitating models. However, the use of modeling for children with autism has been less clear. Although early research was not supportive of the use of modeling for children with autism (e.g., Varni, Lovaas, Koegel, & Everett, 1979), later research demonstrated the efficacy of modeling for children with autism (e.g., Charlop *et al.*, 1983; Egel *et al.*, 1981; Tryon & Keane, 1986).

Egel *et al.* (1981) taught children with autism various discrimination tasks (e.g., color, shape, on/under, and yes/no discrimination) by having them observe typical children correctly performing such tasks. Charlop *et al.* (1983) also demonstrated that modeling was effective in that it enhanced generalization and maintenance. Tryon and Keane (1986) promoted imitative, independent play for children with autism using modeling.

Evolving from this modeling literature came video modeling, which typically involves the child observing a videotape of a model engaging in a target behavior and subsequently imitating. Dowrick (1999) was among the first to demonstrate the effectiveness of video modeling. Dowrick found video self-modeling to be

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effective in a variety of settings with a variety of populations, including children with spina bifida, hyperactivity, and developmental disabilities (e.g., Dowrick, 1991; Dowrick & Dove, 1980; Dowrick & Raeburn, 1977; Dowrick & Raeburn, 1995). Video modeling has also been used to treat a variety of behaviors that include completing workshop assemblies, walking performance, communication skills, and selective mutism (Dowrick, 1986; Dowrick, 1999: Dowrick & Hood, 1981).

Given the effectiveness of video modeling with these populations, researchers tested this technique with children and adults with autism. Haring, Kennedy, Adams, and Pitts-Conway (1987) demonstrated that, through the use of video modeling, the purchasing skills of young adults with autism generalized across different community settings. Charlop and Milstein (1989) used video modeling procedures to teach conversational speech skills to children with autism. Their results showed that all children rapidly acquired conversational speech skills after observing the modeling procedure, and generalization across children and settings was maintained at 15-month follow-up. Additionally, a concomitant increase in question asking and response generalization was also seen. Social/recreational behaviors for children with autism such as independent play, cooperative play, and pretend play have also been shown to improve through the use of video modeling (Charlop-Christy, 1993, 1994).

Research has shown that both in vivo modeling and video modeling are effective not only in teaching new behaviors to children with autism but also in promoting generalization and maintenance of these behaviors. Thelen, Fry, Fehrenbach, and Frautschi (1979) discussed the advantages of video modeling over in vivo modeling. First, videotape can produce a variety of naturalistic settings that would be difficult to create in vivo in the clinic or classroom. Second, with video modeling, the therapist/teacher has greater control over the modeling procedure than with in vivo modeling, because the videotape can be recreated until the desired scene is obtained. Third, there is the convenience of repeated observations of the same model, because the model does not have to be present for each presentation of the videotape. Finally, videotapes can be reused with other people, meaning more clients can be treated. With these advantages, video modeling may be a more worthwhile procedure to use than in vivo modeling.

However, no studies to date have directly and systematically compared these two procedures. Additionally, the use of in vivo and video modeling with children with autism who have a variety of functioning levels has not been addressed. In the present study, we compared the effectiveness of in vivo and video modeling in increasing target behaviors of children with autism by assessing (a) the effects of in vivo and video modeling across different tasks, (b) generalization of the acquired skills across stimuli, children, and settings, and (c) time and cost efficiency of both modeling techniques.

METHOD

Participants

Five children ages 7–11 years attending biweekly sessions at an after-school behavior therapy program for children with autism participated in this study. All children were diagnosed with autism by two independent agencies according to the criteria of the American Psychiatric Association (APA, 1994), as presented in the DSM-IV. All children were reported by their parents to watch television or videos for at least 30–60 minutes a day. This finding was consistent with television viewing behavior of typical children of similar age (Truglio, Murphy, Oppenheimer, Huston, & Wright, 1996). Children were chosen to participate in the study so that a range in level of functioning would be represented. All children had nonverbal imitation repertoires.

At the time of the study, Erin was 8 years 1 month old with a mental age of 4 years 7 months as derived from the Leiter International Performance Scale (Levine, 1986). Overall functioning on the Vineland Adaptive Behavior Scales (Sparrow, Ball, & Cicchetti, 1984) reflected ability in the 11–18 month range. While she receptively labeled many objects and pictures, including body parts, she had difficulty with expressive labeling. As judged by parents, therapists, and teachers, her pronunciation was poor and rarely did she speak spontaneously. She avoided social interactions with peers, and her eye contact was short in duration. Erin had behavior problems of self-injurious behavior (picking and biting fingertips), stereotypy (staring at hands), pica, and aggression (hitting teachers and staff).

Jerry was 7 years 10 months old with a mental age of 4 years 11 months as derived from the Leiter International Performance Scale. He displayed echolalia and occurrences of inappropriate laughter and meaningless sounds. As tested on the Leiter, Jerry demonstrated sight recognition of several words, matched items by shape and color, but did not put items in categories (i.e., foods, animals). Jerry's behavior problems included frequent stereotypy such as gazing and tapping. Also, he moved toy pieces in a stereotypic manner and colored in a highly perseverative way (e.g., he repeatedly drew the same picture, usually simple geometric shapes such as circles or triangles).

Jeff was 10 years 9 months old with an age equivalence of 5 years 4 months as derived from the Leiter International Performance Scale. He had an age equivalence of 4 years 10 months as measured by the Peabody Picture Vocabulary Test—Revised, Form M for receptive labeling (Dunn & Dunn, 1981). His expressive language problems included difficulties with pronunciation and immediate echolalia. In addition, he failed to correctly answer questions that started with "Wh" words (e.g., "What did the boy do?" or "Where did the boy go?"). Jeff's behavior problems, which interfered with his learning, included inappropriate verbalizations (e.g., "I'm going to cut you up"). In addition, Jeff perseverated on certain toys and topics such as fires, earthquakes, and tornadoes.

Greg was 11 years 3 months with a mental age of 4 years 4 months as derived from the Southern California Ordinal Scales of Development (SCOSOD), an unpublished assessment. His adaptive scores on the Vineland Adaptive Behavior Scales were in the "low" level for every domain (communication, daily living skills, socialization, and adaptive behavior composite). He lacked spontaneous speech and seldom engaged in appropriate cooperative play. His play consisted mainly of solitary, repetitive use of video and computer games. In the area of academics, reading was at the first-grade level, and mathematical skills were at a beginning second-grade level, as reported by his teacher. Greg would write three-to-four-word sentences and verbally answer questions in three-word phrases. Greg's main behavior problems included frequent episodes of severe aggression. His aggressive behavior and his stereotypy (e.g., licking his fingers and moving his body in circles) all interfered with learning new tasks through traditional procedures.

Tony was 7 years 2 months with an age equivalence of 6 years 9 months as derived from the Verbal Language Developmental Scale (Mecham, 1971). On the Peabody Picture Vocabulary Test, he placed at 6 years 7 months. In the area of communication, Tony had an age equivalence of 5 years 4 months on the Vineland and could answer questions using four-to-five word sentences. Based upon the Woodcock-Johnson Psycho-Educational Battery-Revised (Woodcock & Johnson, 1989) his reading and mathematics were both at a second-grade level. For socialization, according to the Vineland, he had an age equivalence of 4 years 4 months. It was also noted that he did not play with other children in any social games, always engaging in solitary play. Tony's behavior problems included frequent use of ritual acts and insistence upon sameness (e.g., he would take a bath only if the water was at an exact level in the tub, or he became upset if an object was moved from the place that he left it). He was not independent in performing daily living skills, having an age equivalence of 3 years 6 months on the Vineland Scales. Thus, he relied heavily upon his parents for daily living (self-help) skills such as brushing his teeth or washing his face.

Tasks, Materials, and Models

Tasks were chosen according to the specific needs of each child as determined by assessments performed as a part of each child's curriculum. Because children did not acquire these tasks as part of their regular behavior treatment, the children's psychologist, primary therapists, parents, and teachers agreed that these specific tasks should be addressed. Therefore, these specific tasks were targeted for use in the in vivo modeling and video modeling treatment conditions. Task difficulty was held as constant as possible so that a more difficult task would not be assigned to one particular condition. A psychologist trained therapists naive to the purpose of the study, and 15 college students, also naive to the study; all agreed that the tasks presented in the in vivo and video conditions for each child were of similar difficulty level. Additionally, baselines of each child's performance for the task used for in vivo modeling and the task used for video modeling were comparable.

Each task was randomly assigned to either the video modeling condition or the in vivo modeling condition by drawing the names of tasks from a covered container. Table I lists the target behaviors and tasks for each child. A detailed description of the procedures for each target behavior appears in the Procedure section below. It is important to emphasize that exactly the same procedures were used for both the video modeling and the in vivo modeling conditions except for the difference in the medium of how the models were presented (video vs. in vivo).

The models for both the in vivo and video modeling conditions were familiar adults who worked as therapists at the after-school program. Peers were not used as models because previous research (e.g., Ihrig & Wolchik, 1988) suggested that children with autism learned equally well from peer and adult models. The therapists in this study were all trained in the modeling procedures, and the experimenter (L.L.) made sure

Table I. Children's Target Behaviors and Tasks

Child	Target behavior 1	Target behavior 2
Erin	Expressive labeling of emotions 1. Happy versus Sad In vivo modeling 2. Tired versus Afraid Video modeling	
Jerry	Independent play 1. Car Wash Game Video modeling 2. Coloring In vivo modeling	
Jeff	Spontaneous greetings 1. "Hello. How are you?" Video modeling 2. "Good-bye. See you later." In vivo modeling	Oral comprehension 1. When/Why Questions In vivo modeling 2. What/Where Questions Video modeling
Greg	Conversational Speech 1. Scripted Conversation 1 In vivo modeling 2. Scripted Conversation 2 Video modeling	Cooperative play 1. Card game "War" Video modeling 2. Card game "10" In vivo modeling
Tony	Self-help Skills 1. Brushing teeth Video modeling 2. Washing Face In vivo modeling	Social play 1. "Red Rover" In vivo modeling 2. "Number Tag" Video Modeling

that each therapist performed the target behavior correctly before demonstrating it later to the child. Additionally, procedural reliability was measured.

A videotape of the model(s) displaying the target behavior was made for each behavior to be taught through video modeling. Different models were used for each video to ensure that specific model characteristics did not influence the effects of this condition. In all the videos, the models displayed the target behavior at an exaggeratedly slow pace, as suggested by previous research (e.g., Charlop & Milstein, 1989).

Settings

Baseline and training sessions for oral comprehension, conversational speech, and cooperative play were conducted in the therapy room (2.4 × 2.6 m) at the children's after-school program. Generalization probes for these target behaviors were conducted in the program's free-play room (2.6 × 4.4 m). Both rooms had several chairs, a table, and bins full of toys. One-way mirrors were in place for unobtrusive viewing. Generalization opportunities for play tasks were conducted outside the clinic in an open, grassy area. Baseline and training sessions for self-help skills were performed in the clinic's kitchen, which contained a sink. Generalization probes for daily living skills were assessed in a public bathroom near the clinic. Baseline and training sessions for spontaneous greetings were conducted 3 feet inside the front door of the clinic. Generalization probes for spontaneous greetings were carried out either at the front door of a local restaurant or at the student store.

Design

A multiple baseline design across children was used. Additionally, a multiple baseline design within child across the two modeling conditions and within each modeling condition across the two tasks was used. Thus, each child had a longer baseline. Also, for each child, baseline was longer for each succeeding condition and for each task in each condition as an additional control.

Erin and Jerry were presented with one target behavior each (e.g., identifying emotions) broken down into two tasks (e.g., happy/sad task and tired/afraid task). One task was presented in the in vivo modeling condition while the other task was presented in the video modeling condition. Jeff, Greg, and Tony were presented with two target behaviors. As above, each target behavior was broken down into two tasks for the in vivo and video modeling conditions. The additional target behaviors for three out of the five children, as well as the variety of target behaviors used in this study were presented for two reasons. The first reason was to create a robust study so that we could compare in vivo versus video modeling across a wide variety of target behaviors, in addition to across children with different levels of functioning. Second, we wanted to choose target behaviors that were specifically pertinent to each child.

Procedure

The second author served as experimenter. The third author and another trained therapist, both naive to the experimental hypotheses, also carried out baseline and modeling sessions with children. Other therapists, all naive to which modeling condition had been presented, served as experimenters in the generalization probes.

Note that procedures for the in vivo modeling conditions and the video modeling conditions were conducted in an identical manner. That is, in both conditions, models performed at a slow, exaggerated pace and children were reminded to pay attention or to respond whenever necessary (Charlop & Milstein, 1989). Prompting and reinforcement were used for correct responses only in baseline and they were removed once the modeling conditions were presented (see Baseline below). During the modeling conditions, prompts were for on-task behavior only, such as "Pay attention," and verbal praise was given for attending to the model or television screen. No prompting or intended reinforcement was used during the generalization probes.

Target Behavior for Erin

Expressive Labeling of Emotions. For the first task, Erin was to expressively discriminate (verbally name) the two pictures depicting the emotions of happy and sad (in vivo modeling). The second task involved expressively labeling the emotions of tired and afraid (video modeling). For both tasks, the experimenter held up a picture drawn for the task and asked, "What is it?" The experimenter then allowed the child 10 seconds to respond. The pictures for both tasks were presented in random order. Criterion for the expressive labeling task was at least 80% correct on two consecutive blocks of ten trials (Charlop *et al.*, 1983; Schreibman & Charlop, 1981). Generalization probes involved expressively labeling emotions displayed by a different pictured person.

Target Behavior for Jerry

Independent Play. Two car-wash games were used for the first task to assess the child's independent play skills. One car set was used for training, while the other was used as a stimulus during generalization probes (video modeling). For the second task, two coloring material sets, one for training and one for generalization probes, were used to assess independent play (in vivo modeling). Jerry was allowed to play with these materials and was videotaped for 5-minute sessions in the playroom. A cassette tape was played during the play sessions to signal each 10-second interval. Using a 10-second partial interval scoring method, an observer watched the videotapes and recorded a mark at each interval where one or more incidents of independent play occurred. Independent play was scored if the child was using toys or crayons in the manner in which they were modeled or in any appropriate manner (e.g., moving crayon back and forth on paper). Criterion was met when Jerry was playing independently on two consecutive sessions at double his baseline level (the reader is referred to the first author for a complete description of all tasks).

Target Behaviors for Jeff

Spontaneous Greetings. For the first task, Jeff was to spontaneously say, "Hello. How are you?" to the experimenter as he walked through the doorway upon arriving at the clinic (video modeling). The experimenter stood 3 feet away from the door, looked directly at the child, and did not use any facial expressions. If Jeff greeted the experimenter, the experimenter reciprocated the greeting. For the second task, Jeff was to spontaneously say, "Good-bye. See you later" to the experimenter as he walked out the door on his way home (in vivo modeling). The experimenter stood in the same location as in the first task and provided eye contact. Criterion for saying spontaneous greetings was 100% on two consecutive sessions. Generalization was tested with different people at different, untrained locations (e.g., a local restaurant and the student store).

Oral Comprehension. The experimenter sat directly across from Jeff and read short stories, consisting of three sentences each. For the first task, the experimenter read a story and then asked two comprehension questions that began with "when" and "why" (in vivo modeling). For the second task, the same stories were used as in the first task. However, this time the two comprehension questions began with "what" and "where" (video modeling). Jeff's performance met criterion for oral comprehension when answers were 100% correct for two consecutive sessions. Generalization probes consisted of questions after a new story was read by a new reader.

Target Behaviors for Greg

Conversational speech. Four scripted conversations were used for this target behavior. Two conversations were used for training stimuli and two for generalization stimuli. Conversation 1 was taught by in vivo modeling, while Conversation 2 was taught by video modeling. After the experimenter presented the first line of the conversation, which was always a question, he waited 10 seconds for a response. Greg had to answer the question and provide an appropriate question of his own. A response was considered correct if it followed the predetermined line in the scripted conversation or if it consisted of a contextually appropriate statement and question. If Greg did not respond to the question within the allotted time, the experimenter continued by presenting the next line of the conversation until criterion (100% of appropriate lines spoken for two out of three consecutive sessions) was met.

Cooperative Play. The first task was the card game “10” (video modeling) which was a modified version of the game “21” or “Blackjack.” To make the game easier for Greg, only numbers from 1 to 5 in the deck of cards were used, and a player had to reach only 10 instead of 21 to win the game. Both players sat at a table directly facing each other with a deck of cards between them. The experimenter began the game by saying, “Let’s play ten.” Greg and the experimenter had to take turns flipping over the cards and adding them up. The game ended when the sum of one of the players’ cards was ten or greater. The second task was the classic card game “War” (in vivo modeling). As above, Greg and the experimenter sat facing each other at a table with a deck of cards between them. Both players took turns flipping over the cards, and Greg had to decide whose card was larger. Criterion was met when Greg could respond 100% correctly for two consecutive sessions. Generalization probes for both card games involved playing with a different-colored deck of cards with a new person.

Target Behaviors for Tony

Daily Living Skills. For the first task, Tony had to brush his teeth (video modeling). A toothbrush, toothpaste, and a cup were all placed next to a sink for Tony to use. The experimenter began the session by bringing the child next to the sink and saying, “Brush your teeth.” Generalization conditions for brushing teeth included using a new toothbrush and new toothpaste in different bathrooms. For the second task, Tony had to wash his face (in vivo modeling). With everything else cleared away, a bar of soap and a towel were placed next to the sink for Tony to use. The experimenter began the session by bringing the child next to the sink and saying, “Wash your face.” Criterion for self-help skills was 100% correct performance for two consecutive sessions. Generalization probes for face washing involved using new soap and towels in different bathrooms.

Social Play. The first social game that Tony played was a modified version of “Red Rover” (in vivo modeling). In this outdoor game, Tony had to line up in a row with three other people and face the experimenter. Instead of calling people over by their names, in the traditional way, the experimenter called people over by the color of their clothing. For example, the experimenter said, “Red Rover, Red Rover, send orange over,” and anyone wearing orange was to run to a designated “safe” zone before being tagged by the person who was “it.” Generalization probes for “Red Rover” involved playing with other people, in a new location, and wearing different clothing. For the second game, Tony played “Number Tag” which was similar to “Red Rover” but numbers were used instead of color of clothing (video modeling). Each player was given four 3-× 5-inch index cards. Each card contained a number that ranged from 11–20. The experimenter began the game by holding up a number and calling it out. Each player then had to go through the four cards in hand. If a player had the number that was called out in his or her hand, then that player had to run over to the “safe” zone. Again, the first person tagged became “it.” Tony’s performance reached criterion when it was 100% correct for two consecutive sessions. Generalization probes for “Number Tag” involved playing with other people, in a new location, using different-colored index cards.

Baseline

During baseline, prompting and reinforcement were provided for correct responses in order to determine whether participants could learn the target behaviors through traditional procedures, which included prompts and correction trials. Prompted responses were scored as incorrect. Rewards (edibles, toys, praise, and “high-fives”) were provided for correct responses to training stimuli. No prompting and no rewards occurred in the generalization probes. A preference assessment was initially conducted to determine what items children enjoyed. This assessment consisted of giving the children a choice from an array of desired items, and noting which ones the child chose the most frequently during two work sessions.

Baselines were extended across children, across tasks, and across modeling conditions. Baselines were also extended to increase the number of sessions from the previous behavior, and treatment began once it was deemed that baseline responses had stabilized.

Video Modeling

No prompting and no tangible rewards for correct responses were provided during the modeling conditions for the target behavior. Prompting during the modeling conditions was limited to on-task behavior. That is, if the child was not looking at the model or the television, the experimenter said, “Pay attention.” Praise was provided if the child was looking at the television screen. Video modeling took place in the training setting. Following the procedure described by Charlop and Milstein (1989), the child was first instructed to sit quietly and watch the television monitor. The experimenter sat next to the child and observed the child to make sure that he or she was looking at the video.

After two initial presentations of the video, the experimenter began testing acquisition of the target behavior by saying, “Let’s do the same, just like on TV” and then started the task. Testing occurred over the course of weeks to months, depending upon the child’s schedule and how quickly he or she learned. After two test sessions in which the child’s performance did not meet criterion, the video was presented once and then testing for acquisition was repeated until criterion was met.

In-Vivo Modeling

In-vivo modeling also took place in the training setting and was conducted in exactly the same manner as video modeling. However, in this condition, the participants initially watched live models (familiar therapists) twice, and then the experimenter began acquisition testing by saying, “Let’s do the same, just like they did.” Again, as with video modeling, prompting and reinforcement were not provided for correct responses. However, prompting was provided to get the child to look at the model, and reinforcement in the form of praise was provided if the child was looking at the model. These procedures were repeated until performance criterion was met. As mentioned earlier, precautions were taken so that the only difference between the video modeling condition and the in vivo modeling condition was that in the in vivo condition the models were live and in the video condition the models appeared on the television screen.

Reliability of Independent Variable

To see whether the modeling procedures were done accurately and consistently in the in vivo condition, the modeling sessions were videotaped. A reliability rater scored the accuracy and consistency of the model’s responses. Scoring was carried out by obtaining the protocol for the modeling procedure and then marking off correct responses from a checklist. That is, the rater watched the actions of the model and marked off each correct response of the target behavior to make sure the model was following the correct procedures. Reliability of the independent variable for in vivo modeling was 99%.

Generalization

Generalization probes across different stimuli, persons, and settings were conducted during baseline and also 3 to 5 days after criterion performance was demonstrated in training. Each session tested generalization across all three dimensions at once. Neither prompting nor rewards occurred during generalization probes. In addition, no feedback was provided for correct or incorrect responses.

Time and Cost Efficiency

Several measures were taken to assess the time and cost efficiency of in-vivo and video modeling. The amount of time it took to train all models for all conditions was recorded. The amount of time each model was used for the in-vivo condition was noted, as well as the amount of time it took to make each video. To measure cost efficiency, the amount of time each model was used was multiplied by the salary of a typical research assistant ($12/hr) to give a monetary basis for the efficiency comparison between the two modeling conditions. The cost of a videotape ($3.00) was also included for the video condition.

Interobserver Agreement

An observer recorded correct and incorrect responses by observing performance through a one-way mirror. Interobserver agreement was calculated by dividing the total number of agreements between the experimenter and the observer by the total number of agreements plus disagreements and multiplying by 100%. Reliability data were obtained for half of all tasks across all conditions for all children. Interobserver agreement ranged from 90% to 100% for all children.

RESULTS

Overall, video modeling led to quicker acquisition of skills than in vivo modeling. In addition, children's behaviors generalized after presentations of video modeling, but did not generalize after in-vivo modeling. Table II shows the number of modeling presentations needed for performances to reach criterion on respective tasks and whether or not generalization occurred for both video and in-vivo modeling conditions (see Table II). There was no difference in Jeff's speed of acquisition for either condition. The tasks were acquired after the two initial presentations for both modeling conditions. Erin, Greg, and Tony required approximately twice as many presentations for their performance to reach criterion in the in vivo condition as in the video condition. Finally, Jerry's performance showed the greatest contrast between modeling conditions. Only two initial presentations were required for his performance to reach criterion in the video condition, but eleven presentations were needed in the in vivo condition.

The data for Erin and Jerry can be seen in Fig. 1. Closed circles in the figure represent percentage of correct responses during sessions in which training stimuli were used. Open squares represent percentage of correct responses during generalization probes. Vertical arrows in the modeling treatment denote sessions where either in vivo modeling or video modeling was presented prior to testing (Figs. 1, 2, 3). During baseline, Erin's performance was near chance level (50%) for expressively labeling happy and sad. After six presentations of in-vivo modeling, Erin's performance met criterion (at least 80% correct for two consecutive sessions) for expressively labeling happy and sad. However, generalization probes across persons, settings, and stimuli showed that performance did not meet criterion. Expressively labeling tired and afraid was demonstrated with 50% accuracy during baseline. After four presentations of video modeling, Erin's performance reached criterion. Generalization probes across settings, persons and stimuli also showed criterion responding.

Jerry's average baseline level of independent play with the car-wash game was 29% of intervals for the training stimuli and 22% for the generalization stimuli. However, after only two presentations of video modeling, Jerry's performance met criterion (two consecutive sessions at double the baseline level). In addition, play behavior generalized across settings and stimuli, occurring at double the baseline level. For the appropriate coloring task, Jerry's independent play was recorded in only 30% of the intervals during baseline. Ten in vivo modeling sessions were needed before performance met criterion. Jerry's performance failed to meet criterion during generalization probes across setting and stimuli for the in vivo condition.

Data for behaviors 1 and 2 for Jeff and behavior 1 for Greg can be seen in Fig. 2. Jeff provided a spon-

Table II. Number of Modeling Presentations Needed to Reach Criterion for Each Condition and the Occurrence of Generalization

		In vivo modeling			Video modeling	
Child		No. of presentations	Generalization		No. of presentations	Generalization
Erin	Happy/Sad	6	No	Tired/Afraid	4	Yes
Jerry	Coloring	11	No	Car-wash game	2	Yes
Jeff	"Good-bye. See you later."	2	No	"Hello. How are you?"	2	Yes
	When/Why Questions	2	No	What/Where Questions	2	Yes
Greg	Scripted conversation 1	7	No	Scripted conversation 2	3	Yes
	Card game "10"	7	No	Card game "War"	3	Yes
Tony	Washing face	7	No	Brushing teeth	3	Yes
	"Red Rover" game	8	No	"Number Tag" game	4	Yes

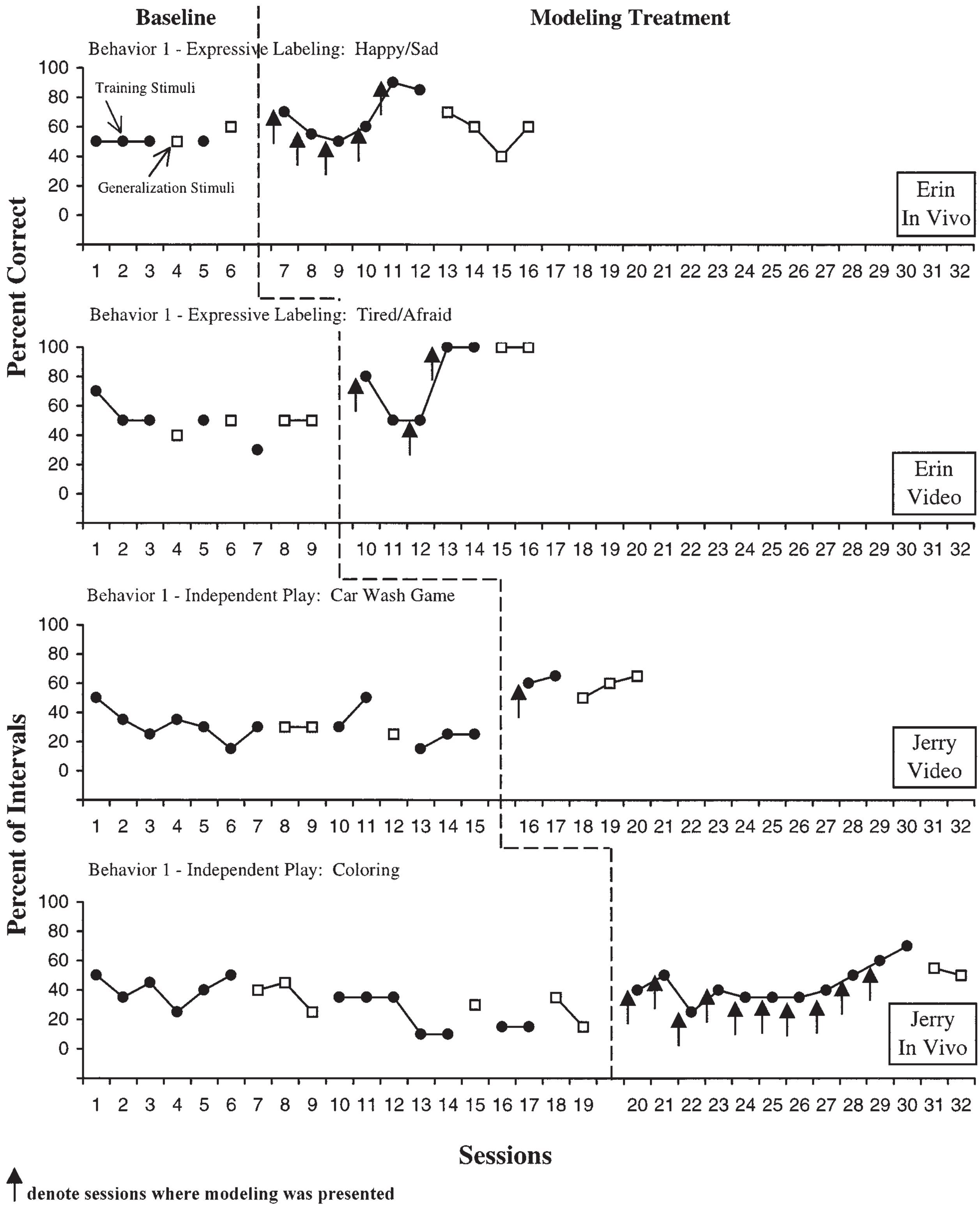

Fig. 1. Baselines, modeling treatment, and generalization probes for Erin and Jerry.

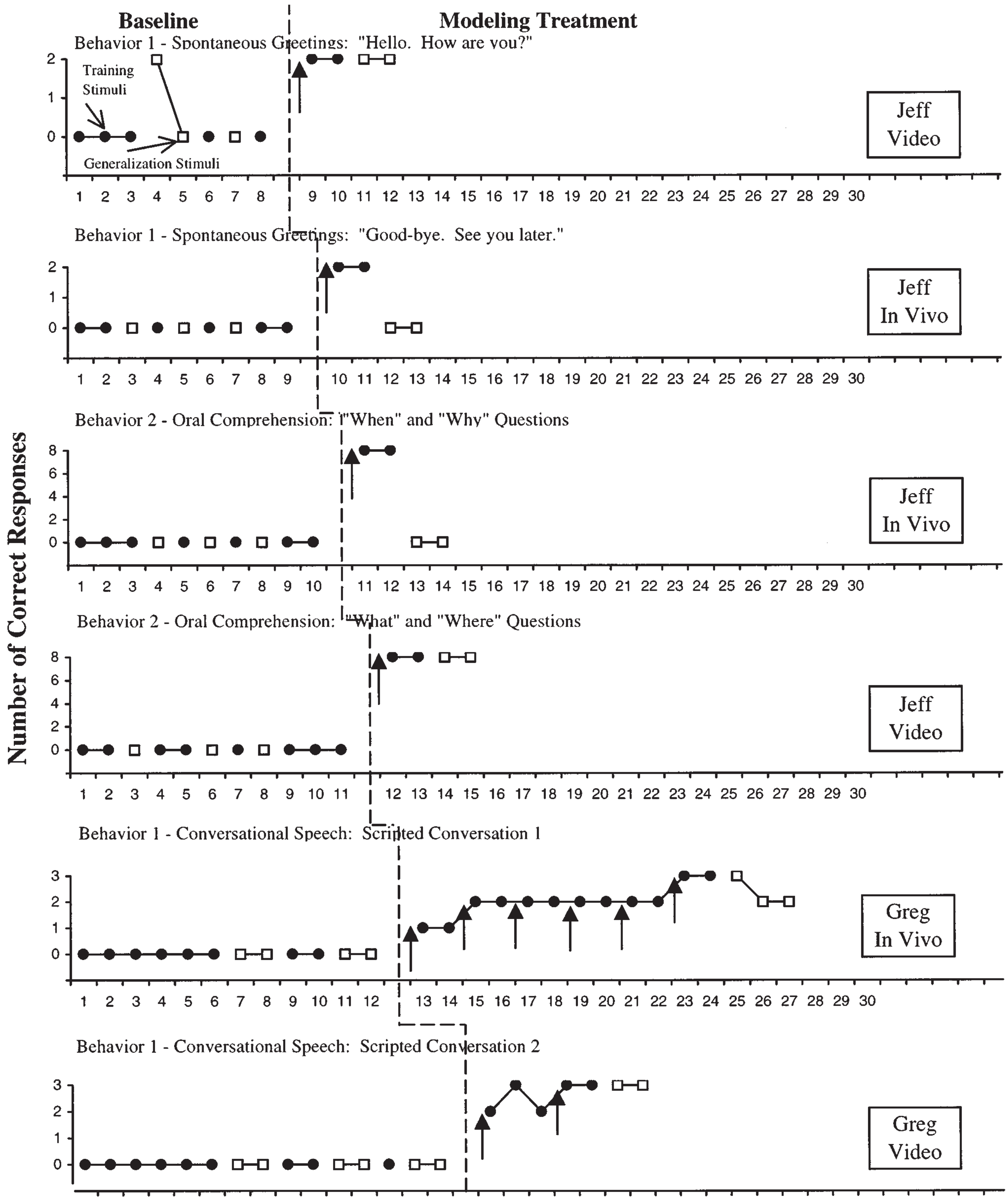

Fig. 2. Baselines, modeling treatment, and generalization probes for Jeff and Greg.

taneous greeting of "Hello. How are you?" in only one of eight sessions during baseline. However, once video modeling was implemented, his performance quickly reached criterion after only two video presentations. Jeff's performance also met criterion for generalization probes across persons and settings in the video modeling condition. During baseline, occurrences of spontaneous "Good-bye. See you later" were never recorded. However, performance quickly reached criterion after only two presentations of in vivo modeling. In contrast, no generalization occurred for the in vivo condition.

No correct responses to the "when" and "why" questions were recorded for Jeff during baseline (see Fig. 2). Once in vivo modeling was introduced, criterion was met after only two presentations. As with prior probes for across persons, settings, and stimuli for in vivo modeling, no generalization occurred. During baseline for oral comprehension of the "what" and "where" questions, Jeff's performance was at a zero level in all sessions for both training and generalization stimuli (he either echoed the questions or responded "Yes" to the questions). However, after only two video presentations, Jeff's performance quickly reached criterion. Probes for generalization across persons, settings, and stimuli also yielded criterion levels of responding.

For Conversation 1, no correct responses were recorded for Greg during baseline. After seven presentations of in vivo modeling, performance reached criterion (100% correct for two of three consecutive conversations) for Conversation 1. However, levels recorded during generalization probes were below criterion. No correct responses were recorded during baseline for Conversation 2. Once video modeling was implemented, responding reached criterion after only three presentations, and was demonstrated at criterion levels during generalization probes.

Figure 3 shows the data for Greg's second target behavior and both of Tony's target behaviors. For the card game "War," response accuracy averaged 50% (4/8) during baseline. Video modeling of the game "War" was introduced, and after only three video presentations, performance met criterion. Generalization across persons, settings, and stimuli was also demonstrated after video modeling procedures. During baseline for the card game "10," Greg's performance was about 50% accurate on training and generalization probes. Greg needed seven in vivo modeling presentations for his performance to reach criterion. Criterion was not met for generalization.

During baseline for brushing teeth, Tony's average response accuracy was about 50% for training and generalization stimuli. Once video modeling was introduced for brushing teeth, performance met criterion after only three modeling presentations. Criterion was also reached for generalization probes across different persons, settings, and stimuli. On the face-washing task, baseline performance was about 50% correct. After seven presentations of in vivo modeling, performance reached criterion. Generalization was not demonstrated, however.

For the social game "Red Rover," Tony's response accuracy was 50% for training and generalization stimuli during baseline, with performance leveling off at two correct responses (50%) per session. In vivo modeling was introduced for "Red Rover," and performance met criterion after eight presentations of the model. However, generalization was not demonstrated. During baseline for the social game "Number Tag," few correct responses were recorded. Performance met criterion after only four presentations of video modeling. Probes for generalization across persons and settings also demonstrated that criterion was met.

Time and Cost Efficiency Measures

As can be seen in Table III, the amount of time it took to train the models and to implement all the in vivo modeling sessions was greater than the amount of time needed for the video modeling conditions in every case except Jeff's (see Table III). The cumulative total time for in vivo modeling was 635 minutes versus 170 minutes for video modeling. The cost of in vivo modeling was greater than the cost of video modeling in every case, except for Jeff's. Total costs were $127 and $58 for in vivo modeling and video modeling, respectively.

DISCUSSION

The results of the present study suggest that video modeling is an effective and efficient technique for teaching children with autism a number of different behaviors (e.g., expressive labeling, independent play, spontaneous greetings, oral comprehension, conversational speech, cooperative and social play, and self-help skills). For four of the five children with autism, video modeling led to quicker acquisition of tasks than in vivo modeling. For one of the children (Jeff), criterion performance was demonstrated after only two presentations of both video and in vivo modeling. All five children acquired their specific tasks after exposure to video modeling rather rapidly. Importantly, video

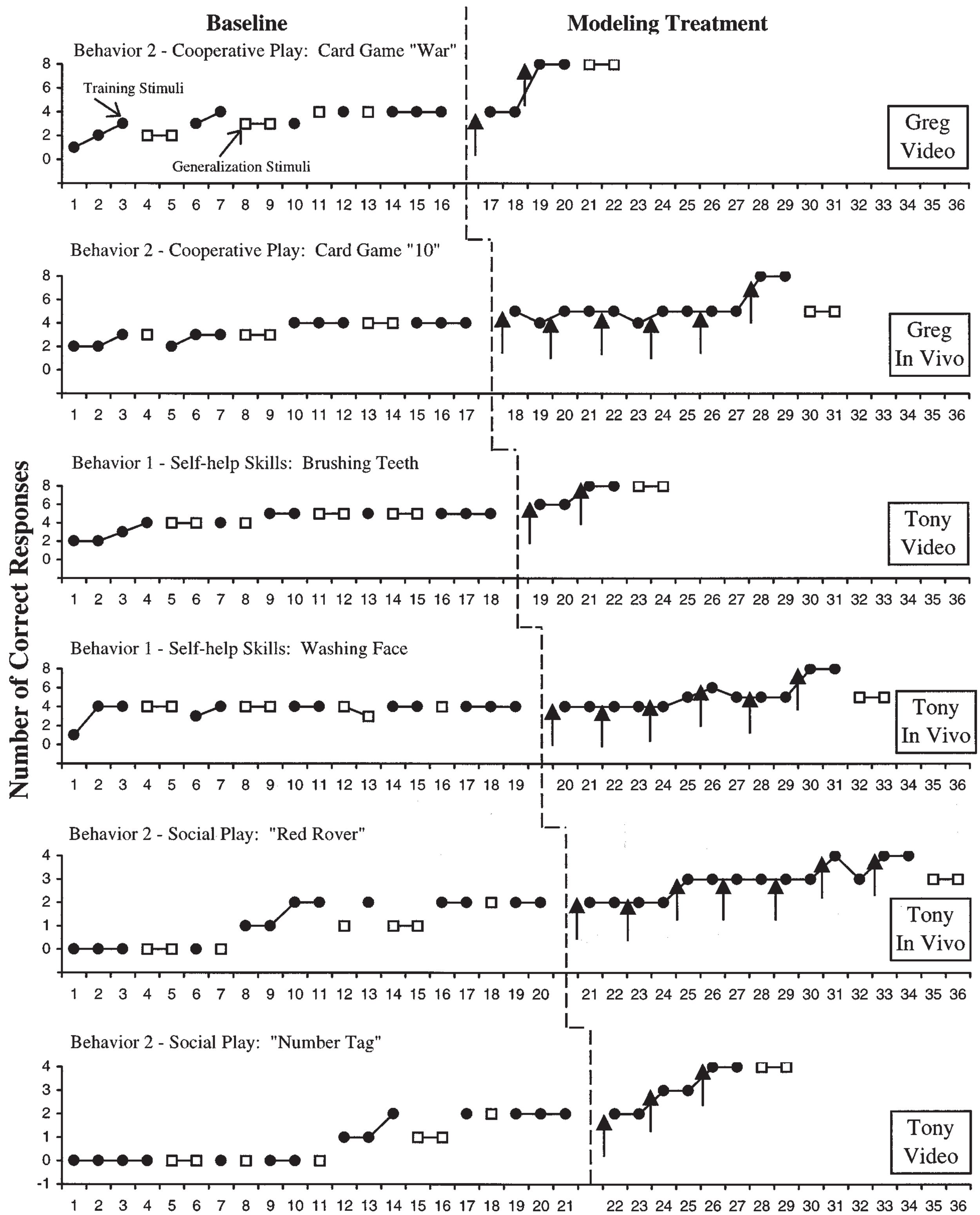

Fig. 3. Baselines, modeling treatment, and generalization probes for Greg and Tony.

Table III. Measure of Time and Cost for Each Condition

Child	Modeling	Total time (minutes)[a]	Cost
Erin	In vivo	105	$21.00
	Video	25	$8.00
Jerry	In vivo	180	$36.00
	Video	35	$10.00
Jeff	In vivo	35	$7.00
	Video	35	$13.00
Greg	In vivo	150	$30.00
	Video	30	$12.00
Tony	In vivo	165	$33.00
	Video	45	$15.00

[a] Total time represents amount of time needed to train all models plus amount of time each model was used for modeling and amount of time needed to make the video.

modeling promoted generalization of these tasks across different persons, settings, and stimuli, whereas in vivo modeling did not. This finding is notable in that the behavior of children with autism often does not generalize following training with traditional prompting and reinforcement procedures (Lovaas, Koegel, & Schreibman, 1979; McGee, Krantz, & McClannahan, 1985).

The results from the present study contribute to previous research in several ways. First, this research was a comprehensive study that included participants who were low functioning as well as high functioning. Many target behaviors were used, which included verbal and nonverbal tasks as well as social tasks, to ensure that the modeling was effective across a variety of skills and behaviors. Thus, the present study supports a robust finding for the efficacy of video modeling.

Although the most commonly used design in behavior analysis to compare treatments is the alternating treatments design, the use of a multiple baseline in the present study nevertheless demonstrated the effectiveness of video modeling (Hersen, 1990). Because of the strong replication of results that occurred within the participants as well as across four of the participants, the multiple baseline design showed that video modeling was more effective than in vivo modeling. Another concern in the present study with the multiple baseline design may be the short lag between implementation of treatment in one tier and the onset of treatment on the next tier in Figs. 2 and 3. However, this short lag was due to children reaching criterion right away in many instances. Furthermore, treatment began once baseline responses had stabilized as per criteria for ending baseline and starting intervention (Hersen, 1990).

As to why video modeling was more effective than in vivo modeling for teaching new behaviors, a number of hypotheses may be proposed. One is that video modeling may compensate for children's stimulus overselectivity. That is, children with autism may have difficulty responding to multiple cues in their environment (Lovaas *et al.*, 1979). For example, when learning to discriminate between male and female dolls, some children with autism were found to have distinguished between the two figures on the basis of the figures' shoes, and did not respond to cues such as the figures' heads (Schreibman & Lovaas, 1973). With in vivo modeling, then, the child may focus on a miscellaneous cue, such as the model's clothes, instead of attending to relevant cues such as the actual target behavior. Video modeling, on the other hand, attempts to compensate for the child's stimulus overselectivity by having the camera zoom in closely on the relevant cues to learn the behaviors. The hope is that if overselectivity is occurring, the child is "overselecting" to relevant cues, not irrelevant ones. Previous research has suggested that teaching the child to "overselect" to relevant cues may be achieved (e.g., Schreibman, 1975; Schreibman & Charlop, 1981; Schreibman, Charlop, & Koegel, 1982). By zooming in on relevant cues, the camera allows the child to follow along with the model's relevant actions better than he or she does without the video (Dowrick, 1991).

A second possible explanation for why video modeling may have generated rapid acquisition of the target behavior is because it improves motivation. In the present study, children were never given any type of external reinforcer while they were watching the video, yet they still watched and learned these new behaviors. Some modeling stimuli can gain high saliency because they are intrinsically reinforcing (Puca & Schmalt, 1999). Bandura (1965) attributed the attention-getting qualities of symbolic models, such as television, to this factor of intrinsic motivation. Indeed, children with autism frequently echo phrases heard on television, videos, and commercials, retell dialogue from videos, watch the same videos, or certain parts of videos, over and over again and become "preoccupied" with certain videos or television shows (Charlop-Christy, Schreibman, Pierce, & Kurtz, 1998; Schreibman, 1988). These all contribute to the likelihood that watching videos/television may be automatically reinforcing for some children with autism.

Video modeling has also been described as more stimulating than in vivo procedures and that it provides a change from the usual work environment (Dowrick, 1986). Dowrick, a leader in the area of video modeling, suggests that it is so effective because it is motivating and associated with recreation (Dowrick, 1986). In addition to enhancing motivation, video modeling may increase attention because of its novelty to the learning environment. It has long been known that stimulus novelty increases attention (e.g., Cantor & Cantor, 1964; Daehler & Bukatko, 1977; Fantz, 1964; Hutt, 1975). Indeed, Bandura (1965) has suggested that the attention factor may account in a large part for variation in the amount of observational learning.

Video modeling's superiority over in vivo modeling may also be related to the social deficits characteristic of children with autism (Charlop & Milstein, 1989). It is frequently reported that children with autism tend to relate better to objects than to people, or that they treat people as objects (e.g., Rimland, 1968; Schreibman, Koegel, & Koegel, 1989). For example, a child will climb on his or her mother, not for affection but to use her as a ladder to reach for a desired object. Therefore, video modeling may compensate for this social deficit because children viewing the videotape do not expect any social interactions, as they would with in vivo modeling, and they do not have any added pressures, such as requirements of eye contact, that may distract them from the observation (Charlop & Milstein, 1989).

Finally, past reinforcement history may affect the efficacy of the modeling procedures in this study. Many children with autism are likely to have experienced in vivo modeling, because most programs, classrooms, and the like generally practice live instruction. Thus, in vivo modeling may be associated with a history of inadvertent reinforcement of disruptive behaviors, inconsistent contingencies, and prompt dependence and/or other unintentional but likely misadministration, whereas video modeling may not.

Video modeling promoted generalization of tasks across persons, settings, and stimuli for all five children. While a lack of generalization of acquired skills has always been a problem of traditional prompting and reinforcement procedures (McGee *et al.*, 1985), the results of the present study, which showed that all children generalized their acquired skills, suggest that generalization can be achieved as a result of video modeling. The behaviors acquired through video modeling may have generalized because this procedure provides more facilitators of generalization as described in the seminal article on generalization (Stokes & Baer, 1977). In the 1990s, televisions are just about everywhere: at home, school, waiting rooms, and other familiar places. Thus, video viewing has strong associations with the children's natural environments and may serve as "common stimuli" (Stokes & Baer, 1977). Also, natural contingencies of imitating models on the video may have further facilitated generalization in that children with autism frequently act out or recite segments from their favorite videos and television shows (Schreibman, 1988). Generalization may also have occurred for video modeling because the television allows children to be one step removed from the context of the structured learning environment. That is, the behavior to be learned is now on television and is not part of the child's actual environment. The child's actual environment is now much more "loose," or less structured and more casual than the learning environment, a transition that would maximize generalization (Charlop-Christy & Kelso, 1997; Stokes & Baer, 1977). With in vivo modeling, on the other hand, the child is actually part of the environment and is bound by that environment, which may make it less conducive to generalization (Stokes & Baer, 1977).

The most striking finding of this study is that generalization occurred only for those tasks taught through video modeling. Not only does video modeling include facilitators of generalization, as discussed in Stokes and Baer (1977), many other differences between video modeling and in vivo modeling may have also affected the generalization results. First, it has been suggested that the mode of learning significantly affects later generalization (Stephens & Ludy, 1975). These researchers suggested that video modeling is superior to live demonstration because it (a) presents concepts in a systematic way and in a relatively simple format, (b) effectively gains and keeps the child's attention, and (c) is a less emotionally laden way to learn. Conversely, in vivo teaching is less systematic, contains more cognitively complex surroundings, is less efficient in keeping attention, and is more anxiety arousing for the child than video modeling.

The finding of no generalization for behaviors taught through in vivo modeling may initially appear contradictory to previous literature such as Charlop *et al.* (1983) and Egel *et al.* (1981) which showed generalization following in vivo modeling procedures. However, it is important to keep in mind several points. First, the behaviors taught in the Charlop *et al.* study (labeling of two objects) and the Egel *et al.* study (one-step commands, "put in," etc.) were much less complex than the behaviors taught in the present study, thus easier to learn and generalize. Second, in these two previous studies, generalization was assessed across one dimension (i.e., across persons), but in the present study, generalization was assessed across multiple dimensions (settings, persons, and stimuli) simultaneously. However, further research to address when in vivo modeling is effective and sufficient versus when video modeling is required needs to be done. As Dowrick (1986) suggested, for some behaviors either video or in vivo modeling would be effective, while for others, the difference between which procedure is selected is crucial.

Video modeling was found to be more time and cost efficient than in vivo modeling. Overall, the amount of time it took for training and implementing the video modeling procedure was approximately one third that of in vivo modeling. Furthermore, the cost to employ the models for video modeling was approximately half that of in vivo modeling. Video modeling appears to be a promising technique that is effective, as well as efficient, for teaching children with autism new behaviors.

Findings from the present study may raise some suggestions for possible future research. For example, a study designed to look at skill maintenance can be carried out to determine if the effects of video modeling last. Also, because most of the tasks in the present study involved academic, language, and social skills, it is not known whether video modeling would be effective with longer chains of behaviors such as completing homework assignments or independent living skills. The findings from this study, as well as other video modeling studies (e.g., Charlop & Milstein, 1989; Haring *et al.*, 1987) do suggest that this procedure is effective, as well as efficient, for teaching new behaviors to children with autism. Also, the production and steps of video modeling are easy to follow so that parents and other researchers may choose to implement this procedure in combination with other behavior management programs.

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