TEACHING AND GENERALIZING PRETEND PLAY IN CHILDREN WITH AUTISM USING VIDEO MODELING AND MATRIX TRAINING†

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Children with autism spectrum disorder often lack play skills. Video modeling has been effective in producing play; however, this play is often lacking in novelty. The purpose of the present study was to combine video modeling and matrix training to teach children with autism to engage in sequences of play with 30 vocalizations and 40 actions. Matrix training was used in an attempt to enhance generalization, specifically in recombining elements of play across play scenarios. Three participants were trained on three play scenarios for three play sets and materials using video modeling. Play scenarios were arranged in a 3-dimensional matrix, which also depicted the possible recombined sequences that could emerge. Probes were then conducted to determine whether different combinations of play would occur. Results for all participants showed that after training on three video modeling play scenarios, learned vocalizations and actions were recombined across previously unlearned combinations of play sets and materials. Results also showed that after video modeling began, novel play that was not seen in baseline sessions emerged for all participants. Copyright © 2015 John Wiley & Sons, Ltd.

INTRODUCTION

Pretend play emerges early in typically developing children, generally appearing by the age of 18 months and becoming more elaborate over the preschool years (McCune-Nicolich, 1981). It is related to the development of a variety of adaptive skills (Schrader, 1990; Weinberger & Starkey, 1994). Correspondingly, promotion of pretend play is a common goal of curricula and educational programs for young children.
children (Goldstein & Cisar, 1992; Sigafoos, Roberts-Pennell, & Graves, 1999). Pretend play deficits are so widely recognized in autism that a failure to use toys symbolically is an item on many diagnostic systems for autism (e.g., the Autism Diagnostic Observation Schedule-General (ADOS); Lord et al., 2000, and the Autism Diagnostic Interview (ADI); Lord, Rutter, & LeCouteur, 1994). A number of studies have reported the play of children of autism to be characterized as stereotyped and of limited duration (Koegel, Koegel, Frea, & Fredeen, 2001; Stone, Lemanek, Fishel, Fernandez & Altemeier, 1990; Wing, Gould, Yeates & Brierly, 1977). Studies have shown that children with autism spend less time interacting with toys and using toys appropriately and engage in fewer functional play acts (e.g., Stone et al., 1990). Deficits in pretend play skills may reduce opportunities for developing interactive play with other children and can consequently contribute to social isolation (Newsom, 1998; Schreibman & Charlop-Christy, 1998; Wolfberg & Schuler, 1993).

In a review by Stahmer, Ingersoll and Carter (2003), a number of behavioral approaches used to improve play skills in children with autism were described. Teaching techniques such as discrete-trial training, pivotal-response training, and reciprocal-imitation training present play activities, arrange motivational support, or both for children to participate in play in slightly different ways. In vivo modeling with play scripts and video modeling are two procedures that employ learning through observation of modeled behavior without arranging motivational support. D’Ateno, Mangiapanello, and Taylor (2003) assessed the effects of video modeling on acquisition of motor and verbal play sequences with a 3-year-old girl diagnosed with autism and found that video modeling led to an increase in the number of modeled motor and scripted verbal responses. MacDonald, Clark, Garrigan, and Vangala (2005) investigated the use of video modeling to teach thematic pretend play to two preschool aged children with autism. Results suggested that both participants acquired sequences of play following the introduction of video modeling and this behavior maintained during follow-up probes.

While video modeling has been shown to result in rapid acquisition of scripted play, the emergence of play that varies from the instructed play has been limited. D’Ateno et al. (2003) found no increase in the number of non-modeled or unscripted responses. Overall, novel play remained low throughout both baseline and intervention conditions. In MacDonald et al. (2005), only one of the two participants demonstrated unscripted play actions following video modeling interventions. Generalization of scripted play across other characters or stimuli within play sets has not been reliably demonstrated, and additional study is warranted.

Matrix training is a strategic approach to teaching, where some target combinations of skills are taught while others are not. Combinations of skills not directly taught are later tested for generative responding, which refers to emitting behavior that has not occurred previously and that has not been directly trained but may be related to other...
trained responses (Schumaker & Sherman, 1970). Novel responding has been noted to emerge without direct teaching with matrix training. For example, a matrix can be arranged with two stimuli (colors) on one axis and two stimuli (objects) on the other axis resulting in four color-object combinations. If two of the four combinations are trained, the other two can emerge. For example, if a child is taught to tact “red car” and “blue boat” without training, it is possible for tacts such as “blue car” and “red boat” to emerge. Goldstein (1983) termed this outcome recombinative generalization as the constituents of trained combinations are recombined into new responses. As learners progress through matrix training protocols, they begin to respond appropriately in novel situations with elements of established responses recombined as novel responses. When familiar stimuli are recombined in novel ways and stimulus elements continue to exert precise and appropriate control over corresponding portions of the response, recombinative generalization has occurred (Wetherby & Striefel, 1978). Applications of matrix training include observational learning of expressive identification of objects and locations (Goldstein & Mousetis, 1989) and receptive identification of objects and actions (McCuller & Salzberg, 1984).

There have been two studies that have used video models and matrix training. Kinney, Vedora, and Stromer (2003) explored video-enhanced activity schedules and matrix training as methods of teaching spelling and also discovered that the methods may encourage sociodramatic play. Target words were arranged in a matrix of three initial consonants and three new word endings to create nine words. Results showed that learning a subset of the matrices of the word families led to generalized spelling of untrained words and generalized imitation of actions modeled in videos of what to say and do during the play activities.

Dauphin, Kinney, and Stromer (2004) used video-enhanced activity schedules and matrix training to teach sociodramatic play to a child with autism. In phase 1, a $3 \times 3$ instructional matrix defined nine scripts (Say) and corresponding actions (Do) to be performed involving combinations of three figurines and three actions. Three sociodramatic play activities were trained. When tested, 21 of the 28 novel Say components (88% of the words), and 4 of 6 Do components were observed correctly. In phase 3, three play activities were taught according to three matrices using video-enhanced schedules. During the tests, 4 of the 6 novel Say and Do components were observed in matrices 2, 3, and 4, respectively. The authors concluded that the instructional matrices resulted in novel and appropriate sociodramatic play, replicating the economy of teaching reported in other matrix training studies (e.g., Goldstein & Mousetis, 1989; Kinney et al., 2003; McCuller & Salzberg, 1984) and recommended the use of matrix training to program for generative learning outcomes.

The purpose of this study was to examine video modeling and matrix training for teaching children with autism sequences of play, which include multiple vocalizations and motor actions with toy play sets that have figurines and objects, and to
determine whether generalized play emerges across previously unlearned combinations of figurines and objects in related toy play sets. Video modeling has been shown to be an effective procedure to teach long sequences of play with children with autism (D’Ateno et al., 2003; MacDonald et al., 2005), but generalization has been limited. Matrix training was used to promote recombinative generalization of the learned play scripts across novel combinations of the materials used in the video models. In addition to fostering generalization, the number of potential responses incorporated in the present study is much larger than in previous matrix training research.

METHOD

Participants

Three male students were enrolled in a preschool program providing individualized intensive behavioral programming. Each participant was diagnosed with an autism spectrum disorder. Shane was 64 months old (ADOS: autism, communication, and social interaction = 8, imagination/creativity = 1; Mullens: average mental age (MA) = 42.75, development quotient (DQ) = 83.82) at the time of the study. Leigh was 75 months old (ADOS: autism, communication, and social interaction = 21, Imagination/creativity = 1; Mullens: average MA = 40.25, DQ = 64.92) at the time of the study. Steve was 65 months old (ADOS: autism spectrum, communication, and social interaction = 10, imagination/creativity = 1; Mullens: average MA = 45.25, DQ = 71.83) at the time of the study. The ADOS (Lord, Rutter, DiLavore, & Risi, 2001) and the Mullen Scales (Mullen, 1995) were administered by qualified assessment specialists. All participants communicated vocally, speaking in full sentences, and had video modeling objectives as part of their individualized education programs.

Setting

Baseline, training, and probe sessions were conducted in a small room (2.7 m × 4.3 m), separate from the classroom, consisting of a table and chair for the participant to view the video. Play materials were set up on an open area on the floor behind the participant. A video camera for recording each session was also present in the room.

Materials

Play scenarios were developed by the first author for three play sets based on observations of typical children engaging with similar materials. The three play set locations included a bank play set from Hasbro™ (Hasbro, Inc. 1027 Newport Boulevard, Newton, MA 02466).
Avenue, Pawtucket, RI) Marvel Superhero Squad® range of preschool toys, a mansion play set from Kenner® Batman Forever™ (http://www.amazon.com/WAYNE-MANOR-BATCAVE-BATMAN-ROBIN/sim/B0011FTJMI/2) range of action figure toys, and a castle play set from Fisher Price® Great Adventures™ (http://www.amazon.com/Fisher-Price-Adventures-Castle-Playset/dp/B00M3CE1CG) range of preschool toys. Each play scenario had one of the aforementioned locations (bank, mansion, or castle), two characters, one object, and one vehicle. A Batcave play set, “Batcomputer” play piece and “Bat-a-rang” weapon piece were also available across all scenarios. All of the materials were from the Fisher-Price® Imaginext® (http://www.fisher-price.com/en_US/brands/imaginext/products/Imaginext-DC-Super-Friends-The-Batmobile/) range of preschool toys unless otherwise stated. The characters were realistic models and included hero and villain characters. All play materials were novel to the participants.

Videos

Play scenarios were recorded on a camcorder and shown on a portable DVD player with a 13 × 18 cm screen. The play scenario training videos showed an adult manipulating the characters and other materials. The adult who served as the model in the videos was unfamiliar to the participants, and only his hands were depicted manipulating materials. The camera zoomed in on certain actions, but for the majority of the video length remained at the same zoom level. Some actions and vocalizations were presented simultaneously. Each video model was segmented into three scenes in which different materials and play sets were used: a villain stealing an object from one of the aforementioned locations, a hero responding to the actions in the first scene and driving a vehicle to the first scene location, and the hero stopping the villain in the third scene.

Independent Variable

The video models that portrayed the scripted play scenarios and the matrix training protocol served as the independent variables. On average, each of the video models was 3 min in duration and included 30–40 scripted actions and 30 scripted vocalizations (see definitions in the next paragraphs). The three-dimensional (3D) matrix was based on the example used in Goldstein and Mousetis (1989) and contained the components for each of the three scenes in each scenario (Figures 1 and 2). Specific play scripts were developed for each play set to be incorporated into the video models. The 3D matrices on the left indicate the three scenes for the bank scenario and all possible combinations of the materials, the 3D matrices in the middle indicate the three scenes for the mansion scenario and all possible combinations of the materials, and the 3D matrices on the right indicate the three scenes for the castle scenario.
Figure 1. Three dimensional matrices indicating the scripts trained in the video models (black). Possible emerging scripts in Shane’s alternative probes are grey.
Figure 2. Three dimensional matrices with black shaded boxes indicating the scripts trained in the video models. The dark grey shaded boxes indicate possible emerging script in first alternative probes, and light grey shaded boxes indicate possible emerging script in second alternative probes for Leigh and Steve.
and all possible combinations. The black shaded areas in the matrices indicate what was trained in each video model. The combinations of trained matrix elements were selected systematically to ensure that the participants learned to play with all the available materials. The white and dark grey (Figure 1), and white, dark, and light grey (Figure 2) areas of the matrix design indicate the potential emerging recombined play scripts that could emerge when participants were presented with combinations of play materials different from that which was trained using the video models.

**Dependent Variable**

The dependent variables were the percentages of actions and vocalizations completed in the response chain for each play set. The actions and vocalizations completed did not need to be performed in the order specified in the response chain. The participants’ responses were scored from video recordings subsequent to each session. Percentages were calculated by dividing the number of actions or vocalizations completed by the total number for that scenario and multiplying by 100. These included the following vocal and motor responses.

**Scripted Action**

These were defined as any action that was identical or similar to those modeled in the video using the exact play materials and resulted in the same change in the environment as seen in the model. For example, the participant moves Batman in the Batmobile from the Batcave to the bank. A non-example would include the participant moving the empty Batmobile from the Batcave to the Bank. Examples of scripted actions are depicted in Table 1.

**Scripted Vocalizations**

These were defined as vocal statements that matched or were similar to the modeled statement in the video model. For example, the statement “Crime doesn’t pay Joker!” rather than the scripted “Remember Joker, crime doesn’t pay!” was acceptable. Statements that included the incorrect tacting of characters, objects, vehicles, or locations were not scored as correct. One example would be when the participant tacted Batman as Superman when Superman is not present. Statements that were repeated a second time were not scored again. Examples of scripted vocalizations are depicted in Table 1.

**Recombined Actions**

These were defined as any action identical to those modeled in the video in which an appropriate character, object, or vehicle was substituted for an unavailable one in
the probes after training. For example, the participant moves Penguin to the top of the Bank play set instead of the unavailable Joker or moves Superman in the Batcopter to the Mansion play set instead of the unavailable castle play set. A non-example would be the participant turns the red elevator button around repeatedly with no character inside.

**Recombined Vocalizations**

These were defined as vocal statements that matched or were similar to the modeled statement in the video involving an appropriate character instead of an unavailable character in the probes after training. For example, the participant emitted the statement “I’ve arrived at the Castle” while holding the Batman character instead of the unavailable Joker character. Recombined vocalizations also included vocal statements in which an appropriate character, object, or vehicle was substituted for an unavailable one in the probes after training. For example, the participant emitted the statement “I’m going to steal the *money* from the mansion” instead of the unavailable diamond object or the participant emitted the statement “To the *Castle!*” instead of the unavailable mansion play set.

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Table 1. Scripted actions and vocalizations from scene 1 of bank video model.

<table>
<thead>
<tr>
<th>Object</th>
<th>Action</th>
<th>Vocalization</th>
</tr>
</thead>
<tbody>
<tr>
<td>Joker</td>
<td>Joker walks in from the left</td>
<td></td>
</tr>
<tr>
<td>Joker</td>
<td></td>
<td>“Ha, ha, ha! I’m going to steal all the money from the bank!”</td>
</tr>
<tr>
<td>Joker</td>
<td>Walk Joker to the white door</td>
<td></td>
</tr>
<tr>
<td>White door</td>
<td>Open white door</td>
<td></td>
</tr>
<tr>
<td>Joker</td>
<td></td>
<td>“Rats! It’s not in this room!”</td>
</tr>
<tr>
<td>White door</td>
<td>Close white door</td>
<td></td>
</tr>
<tr>
<td>Joker</td>
<td>Walk Joker to the black door</td>
<td></td>
</tr>
<tr>
<td>Black door</td>
<td>Open black door</td>
<td></td>
</tr>
<tr>
<td>Joker</td>
<td></td>
<td>“Double rats! It’s not in this room!”</td>
</tr>
<tr>
<td>Black door</td>
<td>Close black door</td>
<td></td>
</tr>
<tr>
<td>Joker</td>
<td>Walk Joker to the vault door</td>
<td></td>
</tr>
<tr>
<td>Joker</td>
<td></td>
<td>“The money must be in the vault!”</td>
</tr>
<tr>
<td>Joker</td>
<td></td>
<td>“I’ll use the dynamite to open the vault!”</td>
</tr>
<tr>
<td>TNT button</td>
<td>Push TNT button</td>
<td>“BOOM!”</td>
</tr>
<tr>
<td>Joker</td>
<td></td>
<td>“Wow! That’s a lot of money! I’m going to be rich! Ha, ha, ha!”</td>
</tr>
<tr>
<td>Joker and money</td>
<td>Pick Joker up, place money on arm.</td>
<td></td>
</tr>
<tr>
<td>Joker</td>
<td></td>
<td>“I’ll climb to the top of the bank to wait for my getaway driver to arrive!”</td>
</tr>
<tr>
<td>Joker and money</td>
<td>Climb Joker to the roof of the bank</td>
<td></td>
</tr>
<tr>
<td>Joker</td>
<td></td>
<td>“Now I’ll be able to see any silly hero coming here to try and stop me before they see me!”</td>
</tr>
</tbody>
</table>
Unscripted Vocalizations

Verbal statements that did not meet the definition of the scripted statements in the video model but that were contextual with respect to both the object and the situation (e.g., talking about characters, objects, vehicles, and/or locations or talking to the characters using vocalizations that were not present in the video model) were scored as unscripted vocalizations. Repetitions of the same statement were scored only on the first time that the statement was made. Statements in which the participants commented on what they were doing (e.g., “I’ll put the money here” or “The Batmobile goes here”) when setting the materials up were not scored as unscripted vocalizations. There was no minimum statement length for appropriate unscripted vocalizations. Unscripted vocalizations were scored by frequency using a data sheet with a column for recording unscripted vocalizations that each participant emitted. A 1-s break between vocalizations, change in the participant’s tone of voice, or both while engaging with two or more characters indicated the end of one vocalization and the beginning of another. Unscripted vocalizations were scored only during baseline sessions and probes after training. This was to assess the changes in unscripted play as a result of video modeling (MacDonald, Sacramone, Mansfield, Wiltz, & Ahearn, 2009).

Experimental Design

We used a multiple probe design across participants and a multiple probe design across play sets within participant as a means of asserting functional control over responding by the introduction of video modeling training and to control for testing effects. When mastery level had been attained for the first participant, the independent variable was applied to another participant, and so on. The play scripts were taught in the same order for all participants starting with the bank, then the mansion, and finally the castle. Participants were required to perform at or above mastery levels on scripted vocalizations and scripted actions before training could begin on the next play set. Baseline sessions were conducted prior to the introduction of training for each play set, and mastery probes were conducted following the acquisition of each script.

Procedure

Baseline

Prior to each baseline, training, and probe sessions, materials were arranged in front of the location and Batcave™ play sets. Only the materials present in each training video were available for each play set. Baseline sessions began with the participant seated or standing by the materials. The experimenter gave the instruction, “It’s time to play” and the participant had 5 min to engage with the materials. During
all sessions, the video camera was hand held by the experimenter to record the session while remaining outside of the play area (approximately 61 cm around the materials). All sessions were video recorded and later scored by the experimenter. Baseline sessions were conducted for each play set with only the materials specific to each script available.

Training

Participants were trained on the play scenarios depicted in the videos as prescribed by the black shaded areas in Figure 1 one at a time. The participants sat at the table with the portable DVD player in front of them. The materials were set up on the floor behind and to the side of where the participant was seated. The experimenter started the video and told the participant, “It’s time to watch the video”. All participants attended to the video during each presentation. There were no programmed consequences for attending or not attending. After the participant viewed the model two consecutive times, he was given the instruction, “It’s time to play”. Sessions were 5 min in duration with no prompts or reinforcement delivered. At the end of 5 min, the participant was told “Play is all done”. Participants were able to request an additional minute to engage with the materials in order to avoid problems with terminating the play period; this period was also recorded on the video camera but initially not scored. Mastery probes without the video model were conducted when 80% of scripted vocalizations and actions were completed over two consecutive sessions.

Mastery Probes

Mastery probes were identical to baseline sessions, with the distinction of the participants having completed training sessions with the specific play set and materials in the training video. As with baseline, the participants were told “It’s time to play” and given 5 min to engage with the play sets and materials. A play scenario was determined to be mastered when 80% or greater of both scripted actions and vocalizations were completed.

Alternative Probes

The alternative probes for Shane were the same as baseline sessions and mastery probes except the smaller materials specific to the trained play scenarios (characters, vehicles, etc.) for each play set were removed, and the smaller materials from the other play sets were made available. For example, in an alternative probe for the bank play set, the Batman and Joker characters, the money, and the Batmobile™ were
removed, and the characters, items, and vehicles paired with the other play sets were presented. In Figure 2, the dark grey shaded areas indicate the potential emerging scripts in each alternative probe. For example, in the alternative bank (mansion and castle materials) probe, materials from the video model were not presented, and the characters, objects, and vehicles from the mansion and castle videos were made available.

The alternative probes for Leigh and Steve were identical to baseline sessions and mastery probes except the smaller materials specific to the trained play scenarios for each play set were removed, and the smaller materials from one of the other videos were made available. In Figure 3, the dark grey shaded areas indicate the potential emerging script in the first alternative probes for each play set. Lighter grey shaded areas indicate the potential emerging play behavior in the second alternative probe for each play set. For example, in the alternative bank (mansion materials) probe, the characters, object, and vehicle from the mansion script were available, and in alternative bank (castle materials) probe, the characters, object, and vehicle from the castle script were available. The alternative probes for Leigh and Steve were different from those for Shane because of Shane only engaging with the materials depicted in the bank play scenario in his alternative probes. The decision was made to restrict the remaining two participants’ play to specific sets of materials to better test for generalized play across a wider range of materials.

**Interobserver Agreement**

Sessions were independently scored by a second observer so that interobserver agreement (IOA) could be calculated. IOA scores were calculated by dividing the number of agreements by the total number of agreements and disagreements and multiplying by 100%. IOA was assessed for over 33% of sessions for scripted and recombined vocalizations and actions across all participants. IOA was assessed for 50% of scored sessions for unscripted vocalizations for Participant 1, 33.3% of scored sessions for unscripted vocalizations for Participant 2, and 25% of scored sessions for unscripted vocalizations for Participant 3.

For Participant 1, the mean IOA score for scripted actions was 95% (range: 82.9–100%), and the mean IOA for scripted vocalizations was 97.4% (range: 89.7–100%). The IOA score for recombined actions was 93.8% and 100% for recombined vocalizations. For unscripted vocalizations, the mean IOA score was 100%. For Participant 2, the mean IOA score for scripted actions was 92.6% (range: 83.3–100%), and the mean IOA score for scripted vocalizations was 96.1% (range: 86.2–100%). For the alternative probes, the mean IOA score for recombined actions was 93.2% (range: 88.2–97.4%) and for recombined vocalizations was 96.6% (range: 93.3–100%). For unscripted vocalizations, the mean IOA score was 93.3% (range: 85.7–100%).

Figure 3. Percentage of scripted (closed symbols) and recombined (open symbols) actions completed by Shane (upper panel), Leigh (center panel), and Steve (lower panel). Circles represent bank sessions, squares represent mansion sessions, and triangles represent castle sessions.
For Participant 3, the mean IOA for scripted actions score was 95% (range: 83.3–100%), and the mean IOA score for scripted vocalizations was 94.4% (range: 72.1–100%). For alternative probes, the mean IOA score for recombined actions was 93.7% (range: 86.8–97.1%) and for recombined vocalizations was 98.9% (range: 96.7–100%). For unscripted vocalizations the mean IOA score was 93.7% (range: 81–100%).

RESULTS

Figure 3 shows the percentage of scripted and recombined actions completed for all three participants. Figure 4 shows the percentage of scripted and recombined vocalizations completed for all three participants. These graphs demonstrate experimental control in that the percentage of completed scripted vocalizations, and actions did not increase until video modeling was initiated. As depicted in Leigh and Steve’s graphs, additional exposure to baseline did not result in increases in scripted play.

Shane’s results are shown in Figure 5. Shane’s percentage of completed scripted vocalizations and actions in the two initial baseline sessions were very low for all three play sets. After bank training, 96.7% and 92.7% of scripted vocalizations and actions were observed in the mastery probe. Percentages of recombined actions and vocalizations completed in the alternative bank (mansion and castle materials) probe were low. Scores in subsequent baseline sessions with the other play sets after training on the bank script remained low. Fewer training sessions were required for the mansion script. In the alternative mansion (bank and castle materials) probe, 52.9% and 61.7% of possible recombined vocalizations and actions were observed. In a further castle baseline session, 44.8% of scripted vocalizations and 44.4% of scripted actions were observed. In a mastery probe for the castle script, 69% of scripted vocalizations and 72.2% of scripted actions were observed. This was due to the novel play actions and unscripted vocalizations emitted that resulted in a similar ending as the video model. In the alternative castle (bank and mansion materials) probe, 62.2% and 83.3% of possible recombined actions and vocalizations were completed.

In the bank baseline session before training began, no unscripted vocalizations were observed. In the mastery probe after training, two unscripted vocalizations were observed. In the alternative bank (mansion and castle materials) probe, one unscripted vocalization was observed. In the mansion baseline session before training, no unscripted vocalizations were observed. In the mansion mastery probe after training, five unscripted vocalizations were observed. In the alternative mansion (bank and castle materials) probe, 7 unscripted vocalizations were observed. In the
Figure 4. Percentage of scripted (closed) and recombined (open) vocalizations completed by Shane (upper panel), Leigh (center panel), and Steve (lower panel). Circles represent bank sessions, squares represent mansion sessions, and triangles represent castle sessions.
Figure 5. Percentage of vocalizations and actions completed by Shane across all three play sets. Closed grey diamonds represent % of scripted vocalizations completed, closed black squares represent % of scripted actions completed, open grey diamonds represent % of recombined vocalizations completed, and open black squares represent % of recombined actions completed.
castle baseline before training, one unscripted vocalization was observed. In the mastery probe after training, four unscripted vocalizations were recorded. In the alternative castle (bank and mansion materials) probe, four unscripted vocalizations were observed.

Figure 6 shows Leigh’s results across the three play sets. Five baseline sessions were conducted with Leigh before training. Percentages of completed scripted vocalizations and actions were very low. Bank training began after Shane had acquired all three scripts. After training on the bank script, in the alternative bank (mansion materials) probe 1, 76.2% of recombined vocalizations and 73.7% of recombined actions were observed. In the alternative bank (castle materials) probe 2, 64.5% of recombined vocalizations and 67.4% of recombined actions were completed. In subsequent baseline sessions, 41.4% and 46.7% of scripted vocalizations and actions (mansion baseline) and 37.9% and 47.2% of scripted vocalizations and actions (castle baseline) were observed. After training on the mansion video model, in the alternative mansion (bank materials) probe 1, 96.6% and 76.5% of recombined vocalizations and actions were observed. In the alternative mansion (castle materials) probe 2, 86.7% and 69.4% of recombined vocalizations and actions were completed. In a second set of alternative bank probes, 93.3% and 82.1%, and 83.9% and 84.1% of recombined vocalizations and actions were observed, respectively. In a further castle baseline, 55.2% of scripted vocalizations and 63.9% of scripted actions were observed. After training on the castle video model, in the alternative castle (bank materials) probe, 96.4% and 82.4% of recombined vocalizations and actions were completed. In the alternative castle (mansion materials) probe, 96.4% and 80% of recombined vocalizations and actions were observed. In a third set of alternative bank probes, 93.3% and 84.2%, and 90.3% and 81.8% of recombined vocalizations and actions were completed. In a second set of alternative mansion probes, 96.6% and 79.4%, and 93.3% and 80.6% of recombined vocalizations and actions were observed.

In one of the initial bank baselines before training, two unscripted vocalizations were recorded. In the bank baseline before training, five unscripted vocalizations were emitted by Leigh. In the mastery probe, 8 unscripted vocalizations were observed. In the first alternative bank probe, one unscripted vocalization was emitted by Leigh. In the initial mansion baseline, no unscripted vocalizations were recorded. In the baseline prior to training, three unscripted vocalizations were observed. In the mastery probe, eight unscripted vocalizations were observed. In the first alternative mansion probe, three unscripted vocalizations were recorded. In initial castle baseline, no unscripted vocalizations were recorded. In the baseline prior to training, five unscripted vocalizations were emitted by the participant. In mastery probe, five unscripted vocalizations were recorded. In alternative castle probe, eight unscripted vocalizations were observed.
Figure 6. Percentage of vocalizations and actions completed by Leigh across all three play sets. Closed grey diamonds represent % of scripted vocalizations completed, closed black squares represent % of scripted actions completed, open grey diamonds represent % of recombined vocalizations completed, and open black squares represent % of recombined actions completed.
Steve’s results are shown in Figure 7. Eight baseline sessions were conducted with Steve prior to any training. Percentages of completed scripted vocalizations and actions were very low. Bank training began after Shane and Leigh had acquired all three scripts. After training on the bank video model, in the alternative bank probes 93.3% and 78.9%, and 67.7% and 76.7% of recombined vocalizations and actions were observed. Scores in subsequent baseline sessions with the mansion and castle scripts remained low. After training on the mansion video model, in the first alternative mansion probe, 6.9% of recombined vocalizations and 23.5% of recombined actions were observed. This probe was conducted two more times as Steve’s play behavior was similar to that of baseline sessions before training. While he was engaging with the materials, he emitted little to no vocalizations and very little functional play actions, scripted or unscripted. In these subsequent probes, the instruction was changed to that of training: “It’s time to play, say and do what you saw on the video”. The percentage of recombined vocalizations and actions observed in these probes were 6.9% and 23.5%, and 10.3% and 26.5%, respectively. However, a large number of unscripted vocalizations and play actions that were unseen in any of the previous sessions were recorded. In the alternative mansion (castle materials) probe, 3.3% and 27.8% of recombined vocalizations and actions were recorded. The instruction given was the same as the last two probes. Like those probes, a large number of unscripted vocalizations and play actions were completed that were not seen in earlier sessions. In a second set of alternative bank probes, 3.3% and 18.4%, and 3.2% and 23.3% of recombined vocalizations and actions were recorded. After training on the castle video model, in alternative castle probes, 0% and 2.9%, and 0% and 3.3% of recombined vocalizations and actions were recorded. While recombined actions and vocalizations were not being completed in these probes, Steve was engaging in novel play for the full 5 min sessions. This was also the case for the third and second sets of alternative bank and mansion probes: low percentages of recombined actions and vocalizations but larger frequencies of unscripted vocalizations and play actions. In further bank and mansion probes after castle training, Steve completed high percentages of scripted vocalizations and actions.

In the initial bank baseline, the bank baseline prior to training, the first bank mastery probe, and the first alternative bank probe, no unscripted vocalizations by Steve were observed. In the first mansion baseline, no unscripted vocalizations were observed. In the mansion baseline prior to training, one unscripted vocalization was recorded. In the mansion mastery probe, no unscripted vocalizations were recorded. In the second alternative mansion probe, 15 unscripted vocalizations were observed. In the initial castle baseline, no unscripted vocalizations were recorded. In the castle baseline prior to training, 20 unscripted vocalizations were observed. In the castle mastery probe, one unscripted vocalization was observed. In the first alternative castle probe, 21 unscripted vocalizations were observed.
Figure 7. Percentage of vocalizations and actions completed by Steve across all three play sets. Closed grey diamonds represent % of scripted vocalizations completed, closed black squares represent % of scripted actions completed, open grey diamonds represent % of recombined vocalizations completed, open black squares represent % of recombined actions completed.
DISCUSSION

The purpose of this study was to evaluate the effects of video modeling and matrix training in producing generalized repertoires of play behavior. The results of this study demonstrate that video modeling increased extended sequences of scripted pretend play in all participants, replicating similar results in previous research (e.g., D’Ateno et al. 2003; MacDonald et al., 2005; Paterson & Arco, 2007). As shown in Figures 3 and 4, there was no change in target responding until video modeling was introduced for any of the participants. Following the introduction of video modeling, each participant’s target responding increased immediately and substantially, thus demonstrating stimulus control over responding. However, the individual participants did show some generalization in the within subject multiple probe as depicted in Figures 5, 6, and 7. Given that there was very little scripted play for any of the subjects until video modeling was introduced (as is evident in Figures 3 and 4), this increase occurred with each participant upon the introduction of the initial video modeling training.

The data depicted in the within-subject graphs shows that generative responding in the alternative probe sessions increased with the acquisition of additional video modeling scripted play. Thus, the results show that the matrix training protocol was successful in producing generalization of the scripted vocalizations and actions across three different combinations of the play sets and materials for all three participants. Given that the main target of the intervention was generalized responding, it is important to verify that the initial introduction of training is responsible for the change in behavior. When generalized responding is obtained, this often obscures the assertion of functional control over responding. It was for this reason that two multiple baselines were established in this study, one across participants and the other within participant across play sets. As stated earlier, substantial changes in responding were obtained across participants with respect to the introduction of the intervention. As anticipated, generalization of responding was obtained for each participant at some point during the exposure to the intervention across the play sets. Therefore, functional control over responding occurred with respect to the introduction of treatment, while generalization was obtained with the exposure to intervention across the activities used during training.

The results for Shane show that a large percentage of recombined vocalizations and actions were completed in the alternative materials probes after acquisition of the second script. While Leigh’s results show a number of recombined vocalizations and actions completed in all the alternative materials probes after acquisition of the bank script, percentages of recombined actions and vocalizations increased following acquisition of the subsequent scripts. For Shane and Leigh, there was an increase in the percentages of completed scripted vocalizations and actions in baseline sessions before training on the mansion and castle play sets. The results for Steve show...
completed recombinations in the alternative bank probes after acquisition of the bank script only but not in any of the subsequent alternative probes.

For Shane, recombined vocalizations and actions increased substantially in the alternative probes after training on the second and third video scripts. While in the alternative bank probe, Shane emitted no recombined vocalizations and few recombined actions; however, in the alternative mansion probe, his recombined vocalizations and actions were higher. Shane correctly tacted the materials; he did not simply repeat the mansion video script word for word (i.e., calling the villain character he chose to play with “Penguin” when Penguin is not available). In the alternative castle probe, the percentage of completed recombined vocalizations and actions increased further with near perfect tacting of the materials. In both of these probes, he began using the Batmobile™ vehicle to transport Batman to the mansion and castle play sets but stopped half way and transported Batman using the Batcopter™ and the Batcycle™ instead. He also engaged in some novel play actions in the last scene in these probes, manipulating Batman to punch or kick the Joker off the top of the mansion and castle play sets instead of using the Bat-a-rang weapon. As depicted in Figure 5, in session 25 after acquisition of the bank and mansion scripts, half of scripted vocalizations and scripted actions were completed, indicating generalization of the mastered bank and mansion scripts to the last remaining untrained play set. These percentages may have been higher if Shane had been able to correctly tact the Mr. Freeze character.

For Leigh, the results showed completed recombined vocalizations and actions in the alternative bank probes after training on the first script. However, Leigh was not properly tacting the materials he was playing with but instead repeated the bank video script. After training on the mansion script, the percentage of recombined vocalizations and actions Leigh completed increased, and he was correctly tacting the materials in the alternative probes featuring the materials he had already been trained with (the materials in the bank and mansion scripts). While a large percentage of the recombined vocalizations and actions were completed in the alternative bank and mansion probes featuring the materials from the castle play set, Leigh was not correctly tacting all of the materials. After training on the castle script, high percentages of recombined vocalizations and actions were observed in all alternative probes (bank, mansion, and castle), and all materials were correctly tacted in nearly every statement. In mansion and castle baselines after acquisition of the bank script, almost half of scripted actions were completed, indicating generalization of the mastered bank script across the other two untrained play sets. In session 7 of the baseline phase with the castle, after acquisition of the bank and mansion scripts, over half of scripted vocalizations and scripted actions were observed.

For Steve, recombined vocalizations and actions were observed in the alternative bank probes after training on the bank script; however, he inserted identical
vocalizations from the bank video script. In the second alternative bank probe, which included materials from the castle play set, Steve used Superman as the villain and Mr. Freeze as the hero but tacked Superman as “Joker” and Mr. Freeze as “Batman”. Steve’s play in the alternative probes, after training on the mansion and castle scripts, was very interesting as he did not engage in any action or vocalization, scripted or recombined, from the scripts he had previously been trained on. Instead, Steve engaged in novel vocalizations and actions for the duration of the sessions. Also, once the scripts in the second bank probe after the mansion were mastered, and the third bank probe and second mansion probe were mastered, he completed all three scripts to near perfect accuracy, and no unscripted vocalizations were observed. Steve engaged in novel play only when presented with combinations of play sets and objects for which he had not received training.

For all three participants, unscripted vocalizations increased with the introduction of video modeling especially after acquisition of two of the three play scenarios. This is important to note as reports of a lack of novel play following video modeling is often cited as a limitation in previous research (e.g., D’Ateno et al., 2003; MacDonald et al., 2005). For Shane and Leigh, unscripted play usually appeared after the scripted story was completed. Shane’s novel play involved returning the stolen item in the script to its proper location or the Batcave, with the hero character going to the Batcave also to prepare for a new mission. Leigh’s novel play involved the hero and villain characters talking to each other in a friendly manner, dancing together, taking turns on the elevator, taking turns hiding in the bank vault, and commenting on their appearance (e.g., Liam used Joker to say to Batman, “I have a green bow-tie and green hair Batman”). For Steve, high frequencies of unscripted play emerged in the alternative probes sessions and in the castle baseline session after training on the mansion script and before training on the castle script. Steve’s novel play was quite varied. In alternative mansion probe 2, for example, he had Batman chasing and catching the Joker using the claw on the front of the Batmobile. In castle baseline 10, Mr. Freeze and Superman were commenting on the castle play set (i.e., its height, doors, etc.) and who owned it. The emergence of any unscripted play was encouraging because, as stated earlier, children with autism tend to have very limited repertoires of play.

From a procedural point of view, the high frequencies of unscripted vocalizations scored in the present study compared with previous research may have been a result of the definition used, in that unscripted vocalizations could be a minimum of one word in length. D’Ateno et al. (2003) required unscripted statements to be at least three words in length, and later concluded that because of its stringent definition, some novel or unscripted responses were not scored as correct novel responses. However, other possible explanations for the emergence of novel play may have been the use of three video vignettes and the similar physicality of the materials. D’Ateno et al.
(2003) suggested that the little novel responding found in their study may have also been because a sufficient number of exemplars may not have been included in the teaching procedure. The training of a sufficient number of exemplars is an important factor in response and stimulus generalization (Stokes & Baer, 1977). The presentation of the three play sequences in the present study depicting similar responses with different types of stimuli might have been the factor for the emergence of novel play. Paterson and Arco (2007) suggested that toys with common physical components and natural reinforcement properties should generate higher levels of novel play. The fact that most of the materials in the current study came from the same toy line may have helped generate high levels of novel play.

The instructional matrix used in the present study resulted in the generalization of scripted play across different combinations of play sets and materials, replicating the economy of teaching reported in other matrix training studies (e.g., Dauphin et al., 2004; Goldstein & Mousetis, 1989; Kinney et al., 2003; McCuller & Salzberg, 1984). However, other research (Foss, 1968; Palermo & Parrish, 1971) reports a lack of recombinative generalization using a diagonal or non-overlapping matrix design, such as the one used in this study. The distinction between the non-overlap and overlap or stepwise training strategies is that a greater number of training items are included in overlap training, and that the inclusion of non-diagonal training items provides overlap. In the present study, the non-overlap matrix utilized provided the potential recombinations depicted by the white and grey portions of Figures 1 and 2. An overlap matrix design may have produced recombinative generalization in Steve’s alternative probe sessions. In this type of instructional matrix, more combinations of the stimuli would have been directly trained; however, this arrangement would provide fewer opportunities to test for recombinative generalization in the alternative probe sessions.

Although there were a number of opportunities to demonstrate recombinative generalization with the non-overlapping matrix used in this study, only a small number of these possible recombination opportunities were tested (as depicted in the grey shaded areas in Figures 1 and 2). Future research should plan on testing more of the possible recombinations following training. The results of this study have implications for the development and generalization of pretend play in children with autism. Many toy lines in the market today have a large number of play sets and materials that are similar in form and appearance.

There were a number of additional limitations with this study. First, there were a number of fine motor issues with some of the actions. For example, all the participants were unable to complete the action of putting the Bat-a-rang weapon on any of the heroes’ hands. Subsequently, this action and the action of taking the weapon off of the heroes’ hands were not scored as correct, decreasing overall completed action percentages for each participant. There were issues with some of the materials
staying upright. In the training videos, the adult acted out the play sequences on a tabletop where the characters and objects such as the Batcomputer were able to stand. The participants engaged with the materials on a carpeted floor where the characters and Batcomputer were not as stable. Consequently, time was lost attempting to stand materials upright as depicted in the video that kept falling over.

Another limitation of the study was the limited number of alternative probes run with Shane. Further, alternative probes should have been included in his protocol, and while additional alternative probes after he was run through the protocol would have better indicated his generalized play behavior, these were impossible to run as he left the preschool program shortly after completing the protocol. As stated earlier, some alternative probe and baseline scores prior to training scores could have been higher if participants had prior training of the names of the characters, objects, vehicles, and so on. Dauphin et al. (2004) noted that one variable determining the effectiveness of matrix training is the learner’s familiarity with the materials involved. Training with “known” materials may yield more rapid learning than training with “unknown” materials (Goldstein & Mousetis, 1989). An initial assessment to determine whether the participants can correctly tact the materials should be included in future research.

Shane and Leigh may have benefited from longer sessions in which to complete the script. Although each video model was roughly 3 min, and the original time given to play with the materials was 5 min, both participants struggled to finish the script in the time allotted. Even when sessions were increased to 6 min, there was still some difficulty. One reason for this was that the materials were laid out in front of the play sets before each session and were not in the “starting positions” that they appeared in the video models, meaning that participants were required to set the materials up themselves. Longer sessions may have lessened the number of sessions Shane and Leigh needed to reach mastery probe criteria and also provided all participants more time to complete novel play vocalizations and actions. There was no follow-up in the participants’ natural play settings. Follow-up sessions could have determined whether the participants could have appropriately played with the play sets in their normal everyday environments and may have set the occasion for cooperative play with other peers. Follow-up sessions in the participants’ natural play environment should be an important feature of future research.

The alternative probes for Leigh and Steve were rigid in their design in that only one change was made (e.g., in the alternative mansion [bank materials] probe, all the bank materials were available with the mansion play set). Alternative probes in which materials from both the other play scripts were combined together (e.g., the bank play set presented with Penguin and the Batcycle from the mansion play set, and Superman and the ring from the castle play set) may have better indicated recombinative generalization and produced more varied play, and is an important area for future research. The alternative probes were not rigid, however, for Shane: there were two sets of materials to engage in, or a combination of both. However,
in the alternative probes in which a large percentage of recombined vocalizations and actions were completed, only the materials that were paired with the bank play set in the training video (Joker, Batman, money, and Batmobile) were manipulated. It would be interesting to see whether the other play set materials that were present would have been engaged with if more of these types of alternative probes were run.

Future research should also look at generalization of the sequences of play taught in the present study with similar but different materials. All materials used were from preschool toy ranges. Future studies could explore whether generalization of the play sequences learned with the preschool toys in the present study could be achieved with the same characters and play set locations but in the form of action figures and materials for older children. Although each video had some actions and vocalizations unique to their script, each was very similar (villain steals object from location; hero drives vehicle to location; hero stops villain). Future research should investigate whether similar results using video modeling and a matrix training protocol could be found if the three sequences of play, while still having similar materials, were different in their “storyline”. As discussed earlier, for two of the three participants, novel play emerged after they completed the training video modeling scripts. Future research could investigate if after video modeling training, additional materials were added that were not present in baseline and training sessions, would these materials be engaged with to lengthen the scenarios after they the script is completed.

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REFERENCES


