JOURNAL OF APPLIED BEHAVIOR ANALYSIS 1994, 27, 685–697 NUMBER 4 (WINTER 1994)

GENERALIZED IMITATION AND RESPONSE-CLASS FORMATION IN CHILDREN WITH AUTISM

JILL M. YOUNG

QUEENS COLLEGE AND THE GRADUATE SCHOOL OF THE CITY UNIVERSITY OF NEW YORK

PATRICIA J. KRANTZ AND LYNN E. MCCLANNAHAN

THE PRINCETON CHILD DEVELOPMENT INSTITUTE

AND

CLAIRE L. POULSON

QUEENS COLLEGE AND THE GRADUATE SCHOOL OF THE CITY UNIVERSITY OF NEW YORK

An experimental analysis of imitation was conducted to examine the influence of response topography on generalization of imitation across three response types. Four children with autism were presented with both reinforced training trials and nonreinforced probe trials of models from vocal, toy-play, and pantomime response types. The probe trials were used to examine generalization within each response type. A multiple baseline design was used to analyze percentage of matching and nonmatching responses to models across response types. This study, the first to analyze imitative response classes in children with autism, showed that imitation generalized from reinforced training models to nonreinforced probe models within a response type, but it did not generalize across response types. Thus, functional response classes determined by topographical boundaries were exhibited within generalized imitation.

DESCRIPTORS: generalized imitation, vocal responding, toy play, autistic children, response classes

Generalized imitation refers to a class of responses that temporally follow and are topographically similar to behavior modeled by another person. Because of its possible role in social behavior and language development, imitation has received considerable attention in the research literature. Experimental analyses of imitation have been conducted with normally developing children and infants (Baer & Deguchi, 1985; Baer & Sherman, 1964; Brigham & Sherman, 1968; Poulson & Kymissis, 1988; Poulson, Kymissis, Reeve, Andreatos, & Reeve, 1991; Steinman, 1970a), and developmentally delayed children (Baer, Peterson, & Sherman, 1967; Garcia, Baer, & Firestone, 1971; Lovaas, Berberich, Perloff, & Schaeffer, 1966).

Baer and Deguchi (1985) described generalized imitation as a functional response class. That is, some imitative responding, although never directly reinforced, can be maintained as long as other imitative responding is reinforced (Baer et al., 1967; Lovaas et al., 1966; Steinman, 1970a, 1970b). In addition, imitative responding that is not directly reinforced decreases in probability when reinforcement is no longer contingent on other imitative responding. This covariation between reinforced and nonreinforced imitative responding defines imitation as a functional response class.

Subsequent research (Garcia et al., 1971), however, has suggested that generalized imitation does not constitute one large response class. Instead, imitation may be comprised of distinct subclasses that are defined by the topography of the imitative re-

Financial support for this research was made available through a Princeton Child Development Institute Fellowship to the first author. Partial support was also provided by Grant HD 22070 from the National Institute of Child Health and Human Development, and by Professional-Staff Congress/City University of New York Research Award 663434, Queens College/CUNY.

Correspondence concerning this paper should be sent to Claire L. Poulson, Department of Psychology, Queens College/CUNY, 65-30 Kissena Blvd., Flushing, New York 11367-1597.

sponses that are reinforced. Garcia et al. examined potential subclasses of generalized imitative responses using a multiple baseline design across four response types: short vocal, long vocal, small motor, and gross motor. Four developmentally delayed children (8 to 14 years old) were successively trained to imitate three of these different response types (short vocal, small motor, and gross motor). Some modeled responses were presented as nonreinforced probes to assess generalization within each response type. The results of their study showed that when reinforcement was delivered for the three response types, imitative responding increased within a response type, but generalization was contained within that response type. Imitative responding did not generalize to the fourth, untreated response type. Similar results with normally developing infants between 12 and 14 months old were obtained by Poulson, Kyparissos, Andreatos, Kymissis, and Parnes (1993).

The results of these studies suggest that generalized imitation may be restricted to the type of responses for which imitative behavior has been reinforced and not to all responses modeled by the experimenter. The current study examined potential response topographies that may form generalized imitative subclasses in children with autism. The children were presented with models of three different response types: vocal, toy play, and pantomime. These responses were selected because each type represents typical deficits in the repertoires of children with autism. Generalized, nonreinforced imitative responding was measured both within the same response type and across different response types.

METHOD

Subjects

Three boys and 1 girl participated in this study. Each child met the DSM-III–R criteria for autism according to an independent agency. The children were between the ages of 2 years 11 months and 4 years 5 months. The Peabody Picture Vocabulary Test and Vineland Adaptive Behavior Scales were administered to each child during the school year. On both tests, each child scored between 1 year 6 months and 2 years 6 months below his or her chronological age.

All 4 children were enrolled in the Princeton Child Development Institute (PCDI) education program. Three children showed no evidence of imitative behavior when they entered the program; David showed some echolalic responding. The 3 boys had attended the PCDI program for approximately 1 year prior to participation in this research and received preliminary training in vocal imitation. The girl was enrolled in the PCDI program at the beginning of the school year and began vocal imitation training in her day-treatment program concurrently with the start of this investigation. All children displayed some perseverative behavior with objects, such as spinning, rubbing, and squeezing, and/or some stereotypic behavior involving finger and eye movements or low-volume vocalizations.

Setting and Apparatus

The study was conducted in a small classroom used for the children's regularly scheduled one-to-one sessions. The classroom was carpeted and contained two tables (46 cm by 66 cm), two chairs (71 cm by 76 cm), and a General Electric VHS-HQ camcorder. Experimenter and child sat facing each other across the corner of one table. The camcorder was mounted so that the table, the front of the child, and the side of the experimenter were visible.

Modeling Stimuli

Vocal models. Vocal modeling stimuli were selected individually for each child. Each vocal model included a combination of words already in the child's repertoire and words not present in the repertoire. For example, if the word "bubble" was in a child's repertoire but "blow" was not, the vocal model might be "blow bubble." The words in a child's repertoire were determined during approximately six 20-min prebaseline observational sessions conducted in the child's classroom, with the experimenter evoking the child's verbal behavior through physical contact, such as tickling, lifting the child into the air, manipulating the child's

Table 1
Examples of Vocal and Vocal-with-Toy Models for Individual Children[a]

Vocal models		
Vocal models		
Neal	my cookie	a good boy[b]
	you help me	you hug me[b]
	tie a shoe	
Seth	I ride a bike	I love mommy[b]
	you hug me	blow a bubble[b]
	do a puzzle	
Heidi	hi mommy	my baby doll[b]
	happy girl	blow bubble[b]
	eat cookie	

Vocal-with-toy models

David

Toy/vocal	Response
Cat/"meow"	Pick up cat in one hand, with other hand pet its head, saying "meow."
Lizard/"boing"	Hold toy by tail and "hop" across table, saying "boing" each time lizard hits table.
Cars/"crash"	Hold one car in each hand, roll towards each other until their front ends touch, saying "crash."
Truck[b]/"honk"	Hold truck by hitch, push across table, saying "honk, honk."
Dinosaur[b]/"ow"	Pick up dinosaur, wrap its arms around index finger saying "ow, ow."

[a] Complete lists of vocal and vocal-with-toy models available on request.
[b] Probe models.

Table 2
Examples of Toy-Play Models[a]

Toy	Response
Tea set	Make pouring motion over cup with pot, lift cup to lips.
Bowl/spatula	Pick up spatula, stir around inside of bowl.
Stuffed animal	Hug animal to chest with both arms, twist side to side.
Marbleworks	Fasten tube to base, drop marble into tube.
Mailbox	Drop two letters into mail slot, open door, remove letters.
Dog collar	Fasten collar around dog's neck.
Horn	Pick up horn, press bulb so horn sounds.
Tractor	Place sheep in trailer, attach to tractor, roll tractor and trailer across table.
Car/ramp	Place man in car, drive car on and off ramp.
Camera[b]	Bring camera to eye, push button.
Chalkboard[b]	Make mark on board with chalk, erase with eraser.
Doll[b]	Sit doll upright, clap doll's hand together twice.
Potato head[b]	Place hat and pipe onto potato head.

[a] Complete list of toy-play models available on request.
[b] Probe model.

mouth, and bouncing the child on her knees, and presenting toys, such as blowing bubbles, whistling, and reading from books. Examples of vocal models are presented in Table 1.

Vocal-with-toy models. For David, who was echolalic, the vocal models were changed to a vocal-with-toy response type. These models consisted of a simple motor response combined with a vocalization, such as lifting a toy plane off the table and saying "whee." Examples of vocal-with-toy models are listed in Table 1.

Toy-play models. A total of 45 different toys were used. Each toy-play model consisted of two to three motor movements interacting with the toy. For example, a toy-play model might be to bring a toy camera up to eye level and press the button to "take a picture." Examples of toy-play models are listed in Table 2.

Pantomime models. Pantomime models included motor movements that resembled activities performed with objects or movements of the body that have social meaning, such as blowing a kiss or using hands to form a "telescope" around one eye. Examples of pantomime models are listed in Table 3.

Stimulus Sets

Within each response type (i.e., vocal, vocal-with-toy, toy play, and pantomime), two thirds of the models were training (reinforced) models, and one third of the models were probe (nonreinforced) models. Training and probe models of each response type contained approximately the same number of movements or words.

There were 20 different stimulus sets that each

Table 3
Examples of Pantomime Models[a]

Model	Body movement
Eating	One hand scoops to open palm of other, then comes to lips.
Violin	Hold one arm outstretched, move other arm back and forth between shoulder and hand of outstretched arm.
Fist and scissors	Hit fist to open palm twice, extend index and middle fingers of fist.
Entwined fingers and steeple	Entwine fingers, extend index fingers, touch tips of index fingers together.
Flying	Put thumbs into armpits, flap elbows up and down.
Thumbs up	Bring fists to chest level, extend thumbs upward.
Telescope[b]	Bring hands up to face, form "telescope" around one eye.
Walking fingers[b]	Middle and index fingers alternate and "walk" across table.
Blow kiss[b]	Bring palm to lips, bring fingers downward, "blow" over open palm.

[a] Complete list of pantomime models available on request.
[b] Probe models.

consisted of 27 trials (nine vocal models, nine pantomime models, and nine toy-play models). One stimulus set was used for each session. Stimulus sets were constructed to ensure that probe models and models from the same response type were never presented more than twice in succession and to ensure that a session did not begin or end with a probe model. Otherwise, presentation was randomized across stimulus sets.

Response Categories

Following the presentation of each model, responses emitted by the child were recorded as matches or nonmatches. Toy-play and pantomime matches included responses that contained an established number of distinct motor movements of the response modeled by the experimenter. To be scored as a match, a response was required to contain all or all but one movement of the model. For example, if a model involved placing a toy person in a toy car, pushing the car up a ramp, and then rolling it back down the ramp, a match may have been recorded if all the movements except rolling the car back down the ramp were performed. For vocal models, a match was scored only if all vocal components were present.

Nonmatching responses were defined by response type. For vocal models, nonmatching responses were any vocal responses that did not match the model. For vocal-with-toy models, a nonmatch was scored if either the vocal or the toy-play component was absent or did not match the model. For toy-play models, nonmatching responses included all motor interactions with the toy that did not match the model. For pantomime models, nonmatching responses included any motor responses that did not match the model.

During the interval following each model, a child could emit both a matching and a nonmatching response. In this case, both response categories were recorded. Therefore, the percentages of matches and nonmatches did not always sum to 100% of the responses scored. Nonmatching responses were scored to determine whether increases in imitative responding occurred with treatment or whether an overall increase in responding occurred.

Design and Monitored Experimenter Behavior

Data were obtained from videotapes of each session. A multiple baseline across responses design (Baer, Wolf, & Risley, 1968) was used to assess generalization of imitation across and within response types. The dependent measures were the percentages of matching and nonmatching responses emitted within 6 s following the model. Data were also obtained for the experimenter's behavior, including correctness of model, number of models presented, instruction presentation, correct placement of toy items, correct order of models presented according to stimulus set, contingent delivery of reinforcers within 2 s of a matching response, and absence of reinforcers during probe trials. In general, the experimenter's monitored behavior was scored as correct on 100% of the trials. Four of 2,246 vocal nonmatches and 1 of 3,297

toy-play nonmatches emitted during treatment were inadvertently reinforced. The modeling stimuli were presented in the correct order during 99.1% of the 475 sessions.

Interobserver Agreement

Observers were trained to a criterion of 90% agreement on each response type before the study began. Occurrence agreement was calculated by dividing the total number of agreements by total number of agreements plus disagreements and multiplying by 100% for matching and nonmatching. Observers scored each session simultaneously but independently and were allowed to view any segment of the session tape up to three times to score responses.

Interobserver agreement data were obtained for approximately 33% of each child's sessions, with baseline and treatment conditions equally represented. Interobserver agreement for all children across each response type during each phase of the study was between 98.4% and 100%. During all experimental conditions, the percentage of interobserver agreement for the experimenter's monitored behavior was 100%.

Procedure

Each session began following two successful, praised trials of the following sequence of responses: (a) The experimenter said, "Look at me," and the child looked at the experimenter, and (b) the experimenter held up her hand with her palm facing the child, and the child sat quietly and looked at the experimenter for 2 s. Descriptive praise for behaviors such as sitting in the chair at the table was occasionally delivered during these two trials.

Model-alone condition. Prior to modeling the target response, the experimenter said, "Look at me." When the child was quiet and looking at the experimenter, the experimenter held up her hand with her palm facing the child and paused for 2 s. Following this pause, the experimenter brought her hand down, said "ready," and presented the model. Following the completion of each model presentation, the experimenter waited 6 s before modeling the next response. During the model-alone phase, no praise was given for responding during the 6-s interval.

Model-and-praise condition. During the model-and-praise condition, training models were presented in the same manner as during the model-alone condition with the exception that verbal praise was provided when the child produced a match within 6 s. Praise was always accompanied by an edible reinforcer (e.g., a piece of pretzel or chip, a sip of juice) and/or physical contact (e.g., a pat on the knee or arm, a tickle, a hug). Prompts for matching (e.g., manual guidance) were not provided if a matching response did not occur within 6 s of a model. Instead, the experimenter presented the next trial.

For Seth, an additional procedure was implemented during this condition because he showed only slight increases in matching. An instruction-following procedure (Mace et al., 1988), consisting of two models that had a high probability of compliance, was implemented with one model being a motor response (clap hands) and the other a verbal response ("hi"). These models were presented in the same manner as the models in the model-alone condition. Matching responses that followed these instruction-following models were not reinforced but were immediately followed by presentation of the regular training trial model. The instruction-following procedure was implemented only prior to the training models.

Generalization probe trials. During all conditions of the study, probe models were presented in the same manner as in the model-alone condition. Reinforcers were not delivered for matching during the 6-s period following probe model presentations.

RESULTS

Figure 1 shows the percentage of matches and nonmatches emitted by Neal during training and probe trials on consecutive sessions. During training trials, Neal's vocal matching showed steady increases to 100%. Toy-play matches increased above baseline levels but reached 100% during only one session. Pantomime matching showed a delayed increase but improved to a consistent level of 83%.

Nonmatching systematically decreased during training trials for each response type as matching increased. During vocal and pantomime trials, the relationship between matching and nonmatching responding reversed.

During probe trials, Neal's vocal matching also reached a consistent level of 100%, and toy-play matching also increased but was variable. Pantomime matching showed less improvement but showed an overall increase over baseline. Nonmatching across each response type did not decrease consistently until late in the treatment phase and did not decrease as substantially as it did during training trials.

Figure 2 shows the percentage of matches and nonmatches emitted by David during training and probe trials across consecutive sessions. David's baseline for vocal-with-toy models was too short (five sessions) to unequivocally show an increase with the implementation of treatment. Nevertheless, during training trials, vocal-with-toy matches did increase by the seventh session of treatment. David's vocal-with-toy matching increased while baselines for toy play and pantomime remained stable. In addition, matching for toy play and pantomime increased systematically with the introduction of treatment. Nonmatching systematically decreased for each response type with the introduction of treatment. As with Neal's data, an inverse relationship between David's matching and nonmatching responding occurred during vocal-with-toy and pantomime training trials.

During probe trials, David's response patterns mirrored those of his training data. Matching systematically increased across each response type with the introduction of treatment for training trials. The increases in matching during probe trials did not, however, reach the levels of performance displayed during training trials. Nonmatching during probe trials did not systematically increase.

Figure 3 shows the percentage of matches and nonmatches emitted by Heidi during training and probe trials across consecutive sessions. Heidi's matching during vocal and pantomime training trials systematically increased following the introduction of treatment. Heidi's toy-play matching increased only during the final 30 experimental sessions. Nonmatching during vocal and pantomime training trials decreased as matching increased. As with Neal's and David's nonmatching data, an inverse relationship between matching and nonmatching occurred during vocal and pantomime trials. Nonmatching during toy-play trials, however, did not decrease until the final three sessions.

During probe trials, Heidi's matching showed a systematic increase for vocal and pantomime models. Her performance on toy-play probe models mirrored that of training trials, showing only a slight and inconsistent increase in matching. Nonmatching responding also mirrored that of training trials. An inverse relationship between matching and nonmatching responding occurred during vocal and pantomime probe trials, but nonmatching did not decrease during toy-play probe trials.

Figure 4 shows the percentage of matches and nonmatches emitted by Seth during training and probe trials across consecutive sessions. When treatment was introduced for Seth during vocal training trials, a slight increase in matching occurred during the 14th treatment session. Matching during vocal probe trials reached a high of 33% in only three of 40 sessions. With the added instruction-following procedure, Seth's matching increased across all three response types. Nonmatching during training trials decreased during vocal and pantomime training trials. Like the other children's data, an inverse relationship between nonmatching and matching responding occurred during vocal training trials. Nonmatching during toy-play training trials did not increase.

Seth's probe data, in general, mirrored his training data, and probes showed an increase in matching across each response type with the introduction of treatment for training trials. He did not, however, maintain a high percentage of matching during toy-play probe trials, nor did his matching during pantomime probe trials reach the level of performance displayed during training trials.

Overall, these results show increases in matching within each response type with the introduction of treatment. More importantly, there was a corre-

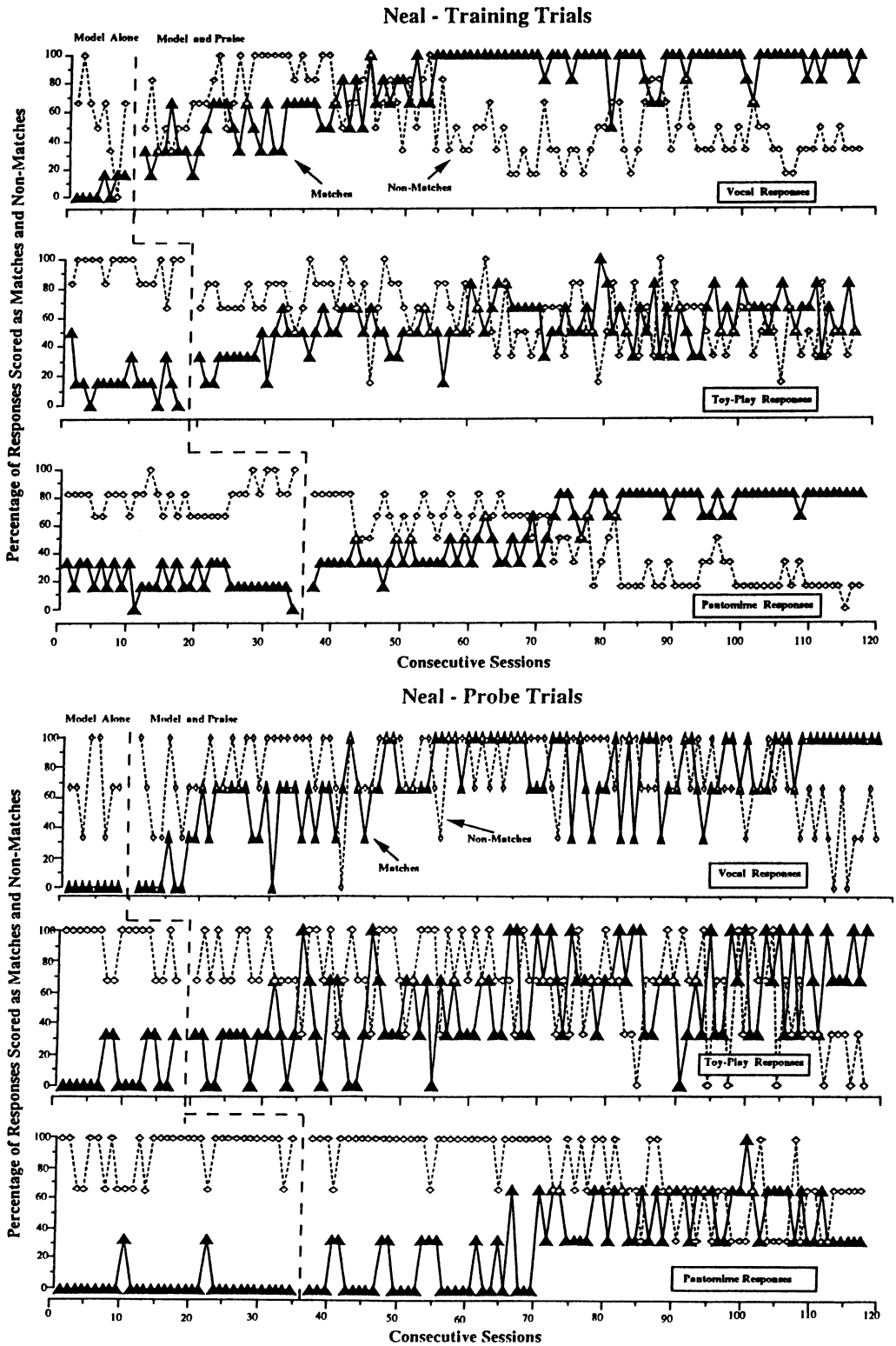

Figure 1. Percentage of responses scored as matches and nonmatches for Neal on reinforced (praise/edible item) training (top graph) and nonreinforced probe trials (bottom graph) across vocal, toy-play, and pantomime response types. The dashed line on the probe trials graph indicates when treatment was introduced during training trials.

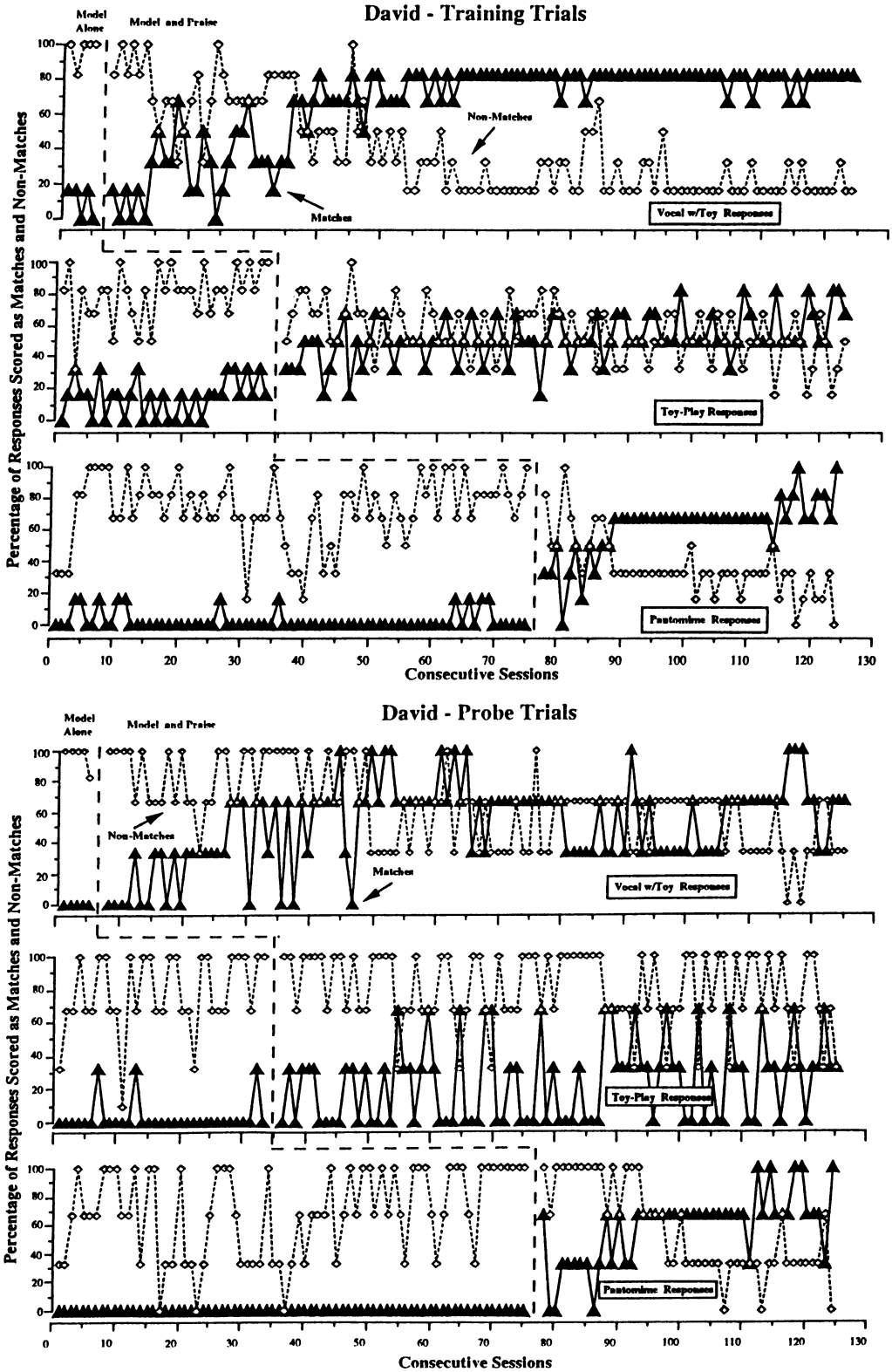

Figure 2. Percentage of responses scored as matches and nonmatches for David on reinforced (praise/edible item) training (top graph) and nonreinforced probe trials (bottom graph) across vocal-with-toy, toy-play, and pantomime response types. The dashed line on the probe trials graph indicates when treatment was introduced during training trials.

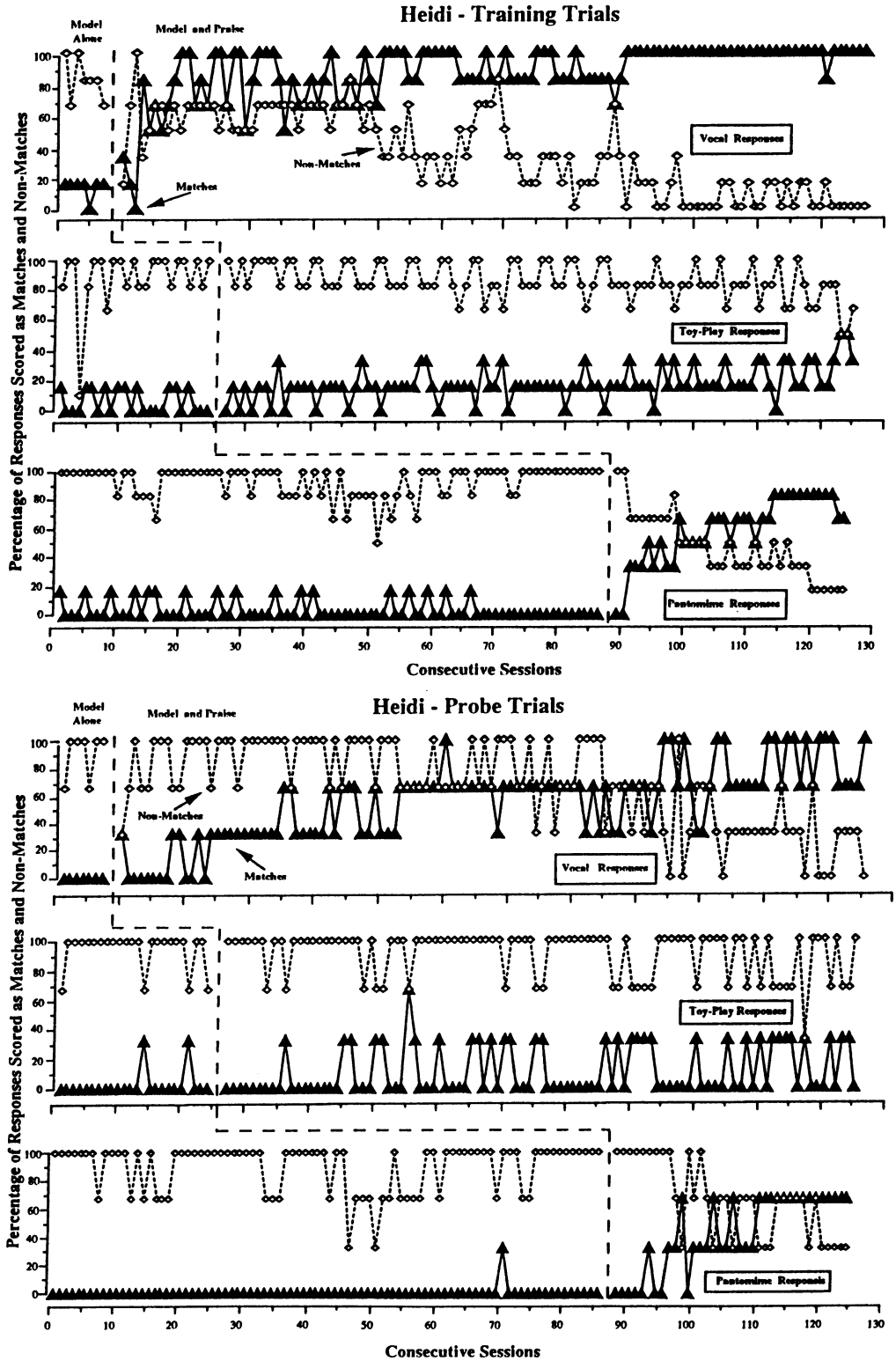

Figure 3. Percentage of responses scored as matches and nonmatches (open diamonds) for Heidi on reinforced (praise/edible item) training (top graph) and nonreinforced probe trials (bottom graph) across vocal-with-toy, toy-play, and pantomime response types. The dashed line on the probe trials graph indicates when treatment was introduced during training trials.

sponding increase in nonreinforced probe matching for all children in at least two response types. Matching did not generalize to the probe models across the response types, and nonmatching responding did not increase with the introduction of treatment.

DISCUSSION

The present study demonstrated that generalized imitation may be limited by the topographical boundaries of response type. In general, the children emitted nonreinforced matches more frequently following probe models that were topographically similar to reinforced training models than they did following dissimilar models. Thus, imitation generalized only within each response type, a finding that replicates the results of Garcia et al. (1971). Furthermore, nonmatching responding did not increase with the introduction of treatment, suggesting that increases in matching occurred because of increased imitation rather than a general increase in overall responding.

A consistent finding was that the toy-play response class was the most slowly acquired. Several studies have shown a negative correlation between perseverative behavior and appropriate toy play in children with autism (Koegel, Firestone, Kramme, & Dunlap, 1974; Tryon & Keane, 1986). In the present study, perseverative behavior included rubbing, spinning, and squeezing the toys. It is likely that these responses interfered with imitation related to toy play.

It is also interesting that the addition of high-probability instructions was needed to produce generalized imitation by Seth. These findings are consistent with those of Mace et al. (1988), who showed that the use of requests with a high probability of compliance can sometimes increase compliance to other requests. The fact that this high-probability instruction sequence enhanced the treatment's effectiveness suggests that imitation might be viewed as a subclass of instructional control. Seth engaged in perseverative behavior (e.g., stereotypic finger and eye movement and low-volume vocalization) more frequently than did the other children. Thus, when competing responses such as perseverative behavior interfere with imitiation, compliance procedures such as the one described by Mace and colleagues should be considered.

Several investigators (Baer et al., 1967; Baer & Sherman, 1964; Parrish, Cataldo, Kolko, Neef, & Egel, 1986) have suggested that similar contingencies may control the formation of both imitative and instruction-following response classes. For both response classes, the model's or instructor's behavior serves as both a discriminative stimulus and a conditioned reinforcer. Response-class relationships observed in instruction-following behavior have, in fact, shown similarities to those obtained in imitative behavior. For example, Neef, Shafer, Egel, Cataldo, and Parrish (1983) investigated generalized compliance to "do" and "don't" instructions within and between response classes. Their results showed that compliance generalized to untrained probe requests within the class of instructions (i.e., "do" and "don't") for which compliance to training requests was reinforced. The effects of training one class of instructions, however, did not generalize to the other class of instructions.

In a subsequent study, Parrish et al. (1986) found an inverse relationship between compliant and noncompliant behavior. When compliance to requests was reinforced, the authors observed an increase in compliant responding and a corresponding decrease in other noncompliant responding for which no consequences were experimentally arranged. Similarly, in the present study, no corrective or preventive procedures were implemented to decrease nonmatching. A child might have emitted a nonmatching response as well as a matching response during the same trial. Nevertheless, in several cases there was a corresponding decrease in

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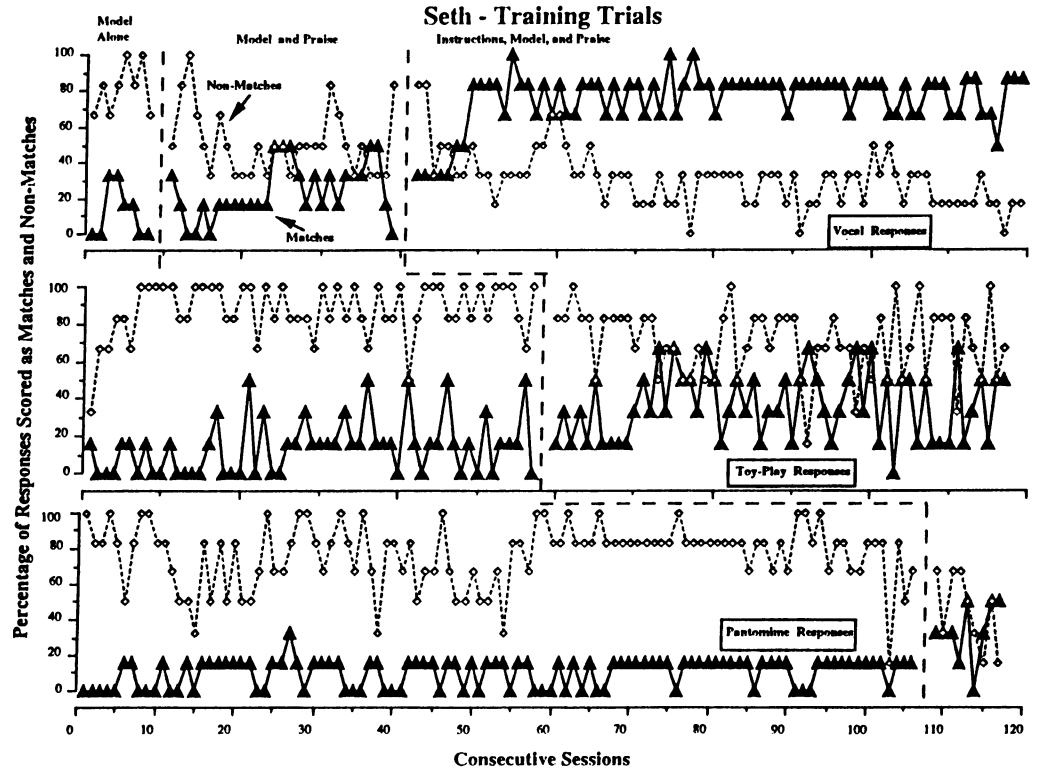
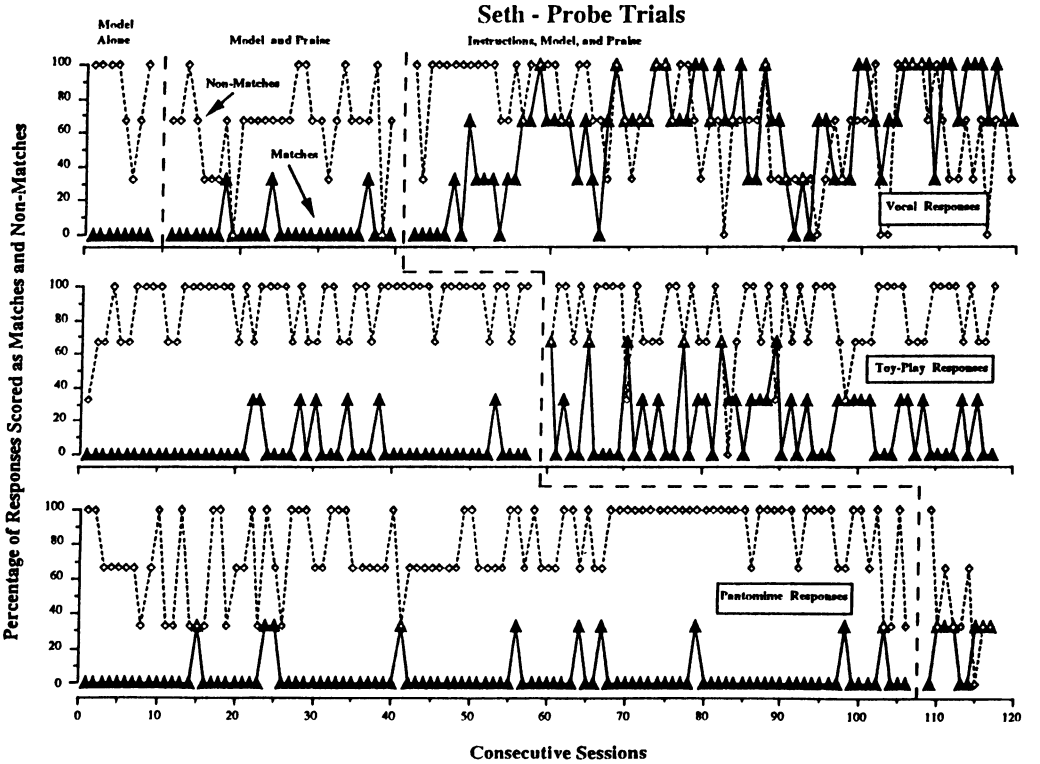
Figure 4. Percentage of responses scored as matches and nonmatches for Seth on reinforced (praise/edible item) training (top graph) and nonreinforced probe trials (bottom graph) across vocal-with-toy, toy-play, and pantomime response types. The dashed line on the probe trials graph indicates when treatment was introduced during training trials.


Seth - Training Trials
Model Alone
Model and Praise
Instructions, Model, and Praise
Non-Matches
Matches
Vocal Responses
Toy-Play Responses
Pantomime Responses
Percentage of Responses Scored as Matches and Non-Matches
Consecutive Sessions


Seth - Probe Trials
Model Alone
Model and Praise
Instructions, Model, and Praise
Non-Matches
Matches
Vocal Responses
Toy-Play Responses
Pantomime Responses
Percentage of Responses Scored as Matches and Non-Matches
Consecutive Sessions

nonmatching as reinforced matching responding increased.

This study replicates and extends the results of previous studies (e.g., Garcia et al., 1971; Poulson et al., 1993) in describing the formation of response classes associated with generalized imitation. Further research is needed to assess the manner in which imitative response classes are formed. It is unclear, for example, whether imitative response classes are formed based on topography, a feature of the antecedent model, or both. It is also unclear whether preexisting classes are acquired through learning histories, neurological make-up, or some interaction of neurology and learning.

In addition, the number of separate, topographically defined response classes that are trained before imitative behavior generalizes to all models regardless of topography is still unknown. Haring (1985) and Haring, Breen, and Laitinen (1989) investigated the training of multiple sets of stimuli to produce between-class responding. They postulated that multiple-class training may control between-class generalization in the same manner that multiple-exemplar training might control generalization within a response class. Their results indicated that the occurrence of between-class generalization required training across a range of three to five distinct classes. Only three imitative classes were trained for each child in the present study. Therefore, the effects of multiple-class training on generalization to other imitative classes warrant further assessment in subsequent research.

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Received July 6, 1993
Initial editorial decision October 27, 1993
Revisions received January 28, 1994; March 2, 1994; May 25, 1994
Final acceptance June 2, 1994
Action Editor, David P. Wacker