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Generalized Imitation within Three Response Classes in Typically Developing Infants

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Effects of modeling and contingent praise on infant imitation of three different responses was analyzed. Generalization to nonreinforced probe models was assessed both within and across response types. Three 12- to 14-month-old infants and their mothers participated in this study. During baseline the mothers provided models only. During treatment mothers modeled and also praised contingent upon infant matching of the training models. During interspersed probe trials the mothers modeled different responses, which, if matched by the infant, produced no praise. The three responses modeled were motor-with-toy, motor-without-toy, and vocal responses. The dependent measure was the percentage of maternal models that were matched by the infant within 6 s. Nonmatching responses of the same response type were also measured. Results showed a systematic increase in the percentages of training and probe models matched by the three infants following the introduction of the model-and-praise treatment condition. Nonmatching responses did not systematically increase. Thus, imitation generalized within response class, but not across response classes.

Key Words: behavior analysis; generalized imitation; infants; parental modeling; social reinforcement; response classes.

Generalized imitation refers to the observation that when some imitative responses are explicitly reinforced, other, nonreinforced imitative responses also increase in probability of occurrence. Baer and Sherman (1964) conducted the first behavior-analytic study of generalized imitation in children. They found that reinforcing some imitative behavior systematically increased not only that reinforced behavior, but also other nonreinforced imitative behavior. Thus, generalized imitation refers to a functional response class as defined by Skinner (1938). When two sets of responses covary with the effects of an operation applied to only one set of responses, all the responses are members of a single functional response class. The term "response class" is invoked to describe, but not to

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explain, the phenomenon. Generalized imitation as a case of response-class formation is discussed extensively in a review of the generalized imitation literature by Baer and Deguchi (1985). A general discussion of generalized operant classes can be found in Barnes-Holmes and Barnes-Holmes (2000).

There is a large body of literature on generalized imitation in infants and children, both those who are typically developing and those who are developmentally delayed. Generalized motor imitation has been demonstrated to occur in 10-month-old infants by Poulson and Kymissis (1988). Generalized vocal imitation has been demonstrated in infants 9 to 12 months old by Poulson, Kymissis, Reeve, Andreatos, and Reeve (1991). Generalized motor and verbal imitation has been demonstrated in preschool boys by Kymissis and Poulson (1994).

Older children also have participated in studies of generalized imitation. Generalized motor imitation has been demonstrated in typically developing children by Baer and Sherman (1964) and in children with developmental disabilities by Baer, Peterson, and Sherman (1967) and Metz (1965). Generalized vocal imitation has been demonstrated in typically developing children by Brigham and Sherman (1968) and by Burgess, Burgess, and Esveldt (1970). It has also been analyzed in research with children with developmental disabilities by Lovaas, Berberich, Perloff, and Schaeffer (1966).

In all the above studies, generalized imitation occurred to novel or nonreinforced modeled response demonstrations as long as the imitation of other modeled responses produced reinforcement. In all cases, the same types of responses were modeled during both training and generalization trials. Differences in types of models used during training and generalization testing would be expected to have an effect on the amount of generalized imitation obtained. In fact, the above literature does suggest that there are limits to the kinds of models that will be imitated during generalization testing. For example, Baer et al. (1967) first trained previously nonimitative children with developmental delays to imitate reinforced and nonreinforced motor responses. Subsequently, they attempted to teach vocal imitation to two of their children who reliably imitated any new motor model exhibited by the experimenter. One of these children initially failed to imitate vocalizations, and he had to be trained with a set of motor models that successively approximated the vocal models. The other child experienced the vocal models chained to motor responses. That child correctly imitated the motor part of the model chained to a series of facial and vocal responses, which, in turn, were shaped into vocal imitation. The Baer et al. (1967) study indicates that reinforced imitative motor responding does not necessarily generalize to imitation of other types of behavior, in this case, to vocal imitation.

Some additional evidence of the control that the topography of reinforced responses has over the boundaries of generalization of imitation is found in studies by Steinman (1970); Bandura and Barab (1971); and Sherman, Clark, and Kelly (1977). Results of Steinman's (1970, Experiment 2) study with four elementary school boys demonstrated that the more dissimilar nonreinforced from reinforced imitative responses, the less likely nonreinforced imitation became.

Bandura and Barab's (1971) study of a group of 4 children with severe developmental delays and 12 children with typical development who were of kindergarten age showed that nonreinforced motor responses, displayed by the model who reinforced 20 other motor responses, were imitated nearly as frequently as the 20 reinforced motor responses. In contrast, nonreinforced vocal responses displayed by the same model were imitated by children at much lower frequency, which further decreased over consecutive blocks of trials. Finally, in Experiment 3 of the Sherman et al. (1977) study with 3 typically developing preschoolers, four topographically different groups of responses were modeled. These were hand and arm, leg and foot, vocal, and entire-body responses. Each group consisted of three training (i.e., reinforced) responses and one probe (i.e., nonreinforced) response. After each child correctly imitated the three training responses of a group, the probe response of each of these four groups was modeled, with each probe of each group being displayed during different experimental sessions. This procedure was repeated with the next group of responses. One child was trained with two of four topographically different groups of responses, whereas the 2 other children were trained with three of these four groups of responses. The results of the Sherman et al. (1977) study were that the topography of the reinforced imitative responses exerted some control over the types of probe responses that were imitated. Steinman (1970), Bandura and Barab (1971), and Sherman et al. (1977) have provided some evidence that the topography of the reinforced imitative responses affects the probability of imitation of nonreinforced responses by virtue of their topographies. Thus, there is evidence that there are topographical boundaries that delimit the extent of generalized imitation.

The question whether there are topographically defined limits to the generalization of imitation was directly addressed in two studies, one by Garcia, Baer, and Firestone (1971) and one by Young, Krantz, McClannahan, and Poulson (1994). Garcia et al. (1971) used a multiple-baseline design across different response topographies and demonstrated that generalized imitation was established only within the response class trained. In that study four nonimitative children with developmental delays between 8 and 14 years of age were taught three classes of imitative responses: small-motor, large-motor, and short-vocal. Results showed that generalized imitation occurred within each of the three response types trained, but that generalization in each case was confined to the response type reinforced. Imitation did not transfer across the three types of responses. Thus, the Garcia et al. (1971) findings indicated that small-motor, large-motor, and short-vocal responses were members of different imitative response classes.

Similarly, Young, et al. (1993) found that generalization of imitative responding was limited to the response class associated with reinforcement by four preschool-aged children with autism. The three imitative response classes under study consisted of vocal, toy-play, and pantomime responses.

It is possible that the failure to generalize across all response types in the above two studies was the result of limitations based on participant characteristics because all the participants were children with mental retardation or autism.

Although it is common to find that individuals with developmental delays exhibit particular difficulty in generalizing their repertoires, we might be less inclined to expect such limitations with typically developing infants. Thus, further experimentation is needed to provide more information on the extent to which response topography or other variables such as participant characteristics limit the generalization of imitation.

The present study was a systematic replication of the Garcia et al. (1971) and the Young et al. (1993) studies, but with participants who were typically developing infants, rather than children with developmental delays, between the ages of 14 and 17 months. In a multiple-baseline-across-responses experimental design, maternal social reinforcement for infant imitation was introduced sequentially across motor-with-toy responses, motor-without-toy responses, and vocal response types. The purpose of the study was to determine the extent to which generalized (nonreinforced) imitation occurred both within and across response types. In other words, the purpose of the study was to determine whether response classes would form within generalized imitation in infants. The term “response type” is used to describe the experimenter’s categorization of stimuli, and the term “response class” is used to describe the categorization demonstrated by the infant’s behavior.

METHOD

Participants

Three typically developing infants and their mothers participated in the study. During the first baseline session the ages of the participants, Kate, John, and Kevin, were 12 months and 18 days, 14 months and 9 days, and 14 months and 18 days respectively. Their mothers reported no prenatal, perinatal, or postnatal complications. All infants were tested with the Bayley Scales of Infant Development (1969). These scales, standardized on over a thousand children throughout the United States, provide a means of individually evaluating a child’s development during the first 2 1/2 years of life. Although the Bayley has both a mental and a motor scale, we administered only the mental scale. The mental scale, with 163 items, is intended to assess sensory and perceptual skills; discriminations; “object constancy”; memory; learning; problem-solving ability; vocalizations; and early communication, generalization, and classification. Results are expressed as a standard score, the Mental Development Index. The mean score for typically developing infants is 100. The participating infants’ scores were found to be within typical limits. Their specific Mental Development Index scores were 126 for Kate, 131 for John, and 118 for Kevin.

Setting and Apparatus

The study was conducted in an infant laboratory of a metropolitan area university. The experimental room contained a highchair (51 cm tall) where the infant was seated facing the mother, who sat across a small table 60 cm high with a 75

× 45 cm surface. Two video recording cameras (Panasonic Model WV-3260/8AF) were mounted on tripods, one facing the mother's side view and the other the infant's front view and the table surface. The cameras were linked through a special effects generator system switcher (Panasonic Model WJ-3500) that combined their input into a vertically split image, which was in turn fed to a video cassette recorder (Panasonic Model AG-1830) and a 20-inch color TV monitor (Panasonic Model CTJ-2062R).

Procedure

General procedure. Each mother brought her infant to the laboratory and made sure that the infant was comfortable, fed, dry, and alert. Before each session, the experimenter showed the mother how to model with each of the toys to be presented. The mother then secured the infant into the highchair in the experimental room, and she sat in the chair facing the infant across the small table. The experimenter sat in a chair on the mother's right facing away from the infant, and he/she timed the session by looking at the TV monitor. The experimenter handed the mother stimulus materials, which were either toys or stimulus cards. A small tray containing a variety of treats (small bits of chocolate, cereal, etc.) was placed next to the mother outside the infant's view. The mother was instructed to praise and give small pieces of treats to her infant contingent upon appropriate sitting throughout the study. Such treats were not delivered during imitation trials, but could be delivered 6 s following the end of an imitation trial.

One to three 20-min free-play prebaseline sessions were conducted to obtain nine different discriminable vocalizations emitted by each infant. Each experimental session lasted approximately 20 min and consisted of 27 trials: 9 motor-with-toy, 9 motor-without-toy, and 9 vocal trials were presented during each session in a controlled randomization sequence. Within each of the above response types 6 of the 9 trials were training trials and 3 were probe trials. During training trials, imitative responding during treatment was associated with reinforcement. Imitative responding during probe trials was never associated with reinforcement. Two probe trials never appeared consecutively within a session. Also, the first 2 and the last 2 trials in a session were training trials.

A trial began with the mother's presentation of the model to the infant and ended 6 s after the offset of the model. The mother modeled the response, waited for 6 s, and then prepared for the next trial. If at any time during the session the infant became fussy or cried for more than 1 min or the mother informed the experimenter that the infant had had enough for the day, the session was terminated. Only 6% of all 105 sessions were terminated for those reasons. Kate had 4 such sessions, John 2, and Kevin 0.

Response types. Three response types comprised a total of 63 different responses: 45 motor-with-toy, 9 motor-without-toy, and 9 vocal responses. We selected these three types of responses because we had had previous success in demonstrating generalized imitation within each class during previous studies of imitation in infants (Poulson & Kymissis, 1988; Poulson, Kymissis, Reeve, Andreatos, and Reeve, 1991) We made no attempt to differentiate gross and fine-motor skill requirements because we needed the infants to remain seated in front of the video cameras at a table during all activities. We merely selected responses we guessed would be within the repertoires of the infants. To identify nine different vocal responses that could be reliably scored for each infant, we sometimes had to wait 2 or 3 months after an infant's first visit to the laboratory for an infant to develop those vocalizations.

Motor-with-toy responses. We presented five times the number of motor-with-toy responses as we did motor-without-toy or vocal responses to minimize the possibility that the mere presentation of a toy would evoke the targeted response from the infant without his or her having to attend to the modeled response. Forty-five different toys, each associated with a predefined placement and a movement that the parent modeled were used with the motor-with-toy responses. Only 9 of those 45 motor-with-toy responses were used per session, so that all the toys were presented during five consecutive sessions. Six of those nine responses were used during training trials, and three were used during probe trials. Table 1 lists the 45 toys and their associated movements.

TABLE 1
The 30 Training and the 15 Probe (Marked with an Asterisk) Motor-with-Toy Responses

Toys	Movements
1. Clock	Press Button
2. Truck	Push
3. Hammer	Bang
4. Shovel and Bucket	Place into Bucket
5. Toy on String	Pull Ring
6. Teddy Bear	Squeeze
7. Bird	Smack
8. Plastic Book	Turn Page
9. Horn*	Bring to Mouth
10. Ball	Toss in Air
11. Pillow Case	Put on Head
12. Pillow	Clutch and Pivot
13. Tube*	Look Through
14. Mr. Saw and Mr. Wrench*	Flip
15. Airplane	Move Over Head
16. Triangle, Square, and Circle	Stack
17. Mirror	Flip
18. Telephone*	Bring to Ear
19. Open Ring	Look Through
20. Hat	Place on Head
21. Hourglass*	Turn
22. Helicopter	Pull
23. Flower Puzzle*	Remove and Replace
24. Three Small Blocks*	Stack
25. Small Blocks and House	Place into House
26. Fish in a Ball	In and Out

TABLE 1–*Continued*

Toys	Movements
27. Doll and Crib*	Place into Crib
28. Yellow and Blue Boxes	Remove and Replace
29. Giraffes in Boat*	Put in
30. Clown and Red Stand*	Place in and out Stand
31. Doll and Carriage	Place into Carriage
32. Stacking Boxes*	Fit into Other
33. Plastic Pliers	Open and Close
34. Red and Blue Barrels	Place on
35. Stand and Rings	Remove Ring
36. Turtle and Man*	Fit together
37. M & M Doll	Clap Limbs together
38. Wrench and Ball*	Hit Ball
39. Cookie Monster	Touch Head
40. Rubber Crab*	Touch to Cheek
41. Block and Cloth	Uncover
42. Ring on String	Dangle
43. Cylinder and Cube*	Place into
44. Plastic Car	Roll
45. Boat and Triangle	Remove and Replace

Motor-without-toy responses. Nine different hand–arm movements, each with its predefined topography and number of repetitions, were used in every session, six during training trials and three during probe trials. Table 2 lists the nine motor-without-toy responses.

Vocal responses. Nine vocalizations were chosen during prebaseline observation from the participants' vocal repertoires. These were different for each participant. All nine vocalizations were used in every session, six of them during training trials and three during probe trials. All vocalizations were classified as low-, medium-, or high-frequency based on prebaseline observations in the laboratory. Table 3 lists the vocalizations for each participant, along with their phonetic transcriptions (1966). It should be noted that infants did not always distinctly articulate the exact vocalization represented in the table, but that pairs of observers were able to use those representations to sufficiently distinguish one vocalization from another so that they were able to obtain acceptable levels of interobserver agreement.

All motor-with-toy and motor-without-toy training responses were matched for difficulty with the corresponding probe responses. All vocal training responses were matched with the vocal probe responses based on the high, medium, or low frequency of occurrence in the infant's vocal repertoire during prebaseline.

Experimental Conditions and Design.

Two experimental conditions were used in the study: a model-alone baseline condition and a model-and-praise treatment condition. In the model-alone baseline condition the mother was instructed to model one of the three types of

TABLE 2
The Six Training and the Three Probe (Marked with an Asterisk) Motor-without-Toy Responses

1. Clap Hands*
2. Tap Table
3. Wave Bye-Bye
4. Open and Close Hand
5. Extend Arms*
6. Twist Hand
7. Touch Arm
8. Brush Palm on Table
9. Tap Chest*

responses once per trial. During the motor-with-toy trials, the experimenter handed the mother the toy, reminding her how to model with it. During the motor-without-toy and vocal trials the experimenter gave the mother a card that described the movement or the vocalization the mother was to model. The mother was instructed not to provide praise following any infant matching responses during baseline.

During the model-and-praise treatment condition the mother provided the models as during the baseline condition, but she was instructed to provide praise within 2 s of the infant matching during training models and to withhold praise for infant matching of probe models.

A multiple-baseline-across-responses experimental design was used to assess the effect of contingent praise upon matching responses in the infants.

Response Definitions

A matching response was any infant response that included a predetermined number of topographical components of the modeled response and that occurred within 6 s of the model. The response definitions for each of the 63 modeled responses were defined prior to the beginning of the experiment. A nonmatching response was defined as any response of the same type that was not a match and that occurred during the 6 s following the model. Both matching and nonmatching responses of the same type could occur within the same 6-s period.

Praise was defined individually by each mother–infant dyad and depended on the preexisting patterns of interaction this dyad shared. All mothers used statements such as “good boy” or “good girl,” but each one also had an additional praise repertoire.

Data Analysis

The dependent measures were represented as percentages of modeled training or probe trials of each response type in which the infant produced matching or nonmatching responses. Data also were obtained for the following independent measures: correct model presented by the mother, correct placement of toy in front of infant, correct order of models presented according to stimulus sets,

TABLE 3
The Six Training and the Three Probe Vocal Responses with Phonetic Transciption in Brackets for Each Infant with Low, Medium, and High Prebaseline Vocalization Frequencies[a]

Training	Probe
Kate	
1. GAH [gɑ] (M)	1. EH [e] (L)
2. OO [u] (L)	
3. MAH [mɑ] (L)	2. TEE [ti] (H)
4. DAH [dɑ] (H)	
5. BAH [bɑ] (M)	3. PAH [pɑ] (M)
6. AH [ɑ] (H)	
John	
1. DAH [dɑ] (H)	1. AH [ɑ] (H)
2. KEE [ki] (H)	
3. EH [e] (M)	2. BAH [bɑ] (L)
4. OH [o] (M)	
5. AY [aj] (L)	3. TEE [ti] (M)
6. EE [i] (L)	
Kevin	
1. DAH [dɑ] (H)	1. BAH [bɑ] (M)
2. OH [o] (L)	
3. GEE [gi] (M)	2. EE [i] (L)
4. AH [ɑ] (H)	
5. MAH [mɑ] (L)	3. NAH [nɑ] (H)
6. EH [e] (M)	

[a] marked L, M, or H, respectively.

instructions given by the mother (i.e., “Do this”), and praise delivered by the mother within 2 s of the infant’s matching response.

Interobserver Agreement

All data were scored from videotapes by two trained observers. Observers could rescore any given segment of videotape up to three times. Interobserver agreement was calculated on a point-by-point basis by dividing the number of agreements by the number of agreements and disagreements and multiplying by 100 to obtain a percentage agreement score. Across all three infants, the percentage of interobserver agreement on infant matching during baseline and treatment conditions for the training and probe trials was 100%. The interobserver agreement on the nonmatching responses during baseline and treatment for the training and probe trials averaged 99.7% (range = 95–100%). Agreement on contingent praise of infant matching responses averaged 99.6% (range = 92–100%).

RESULTS

The results indicated that the percentage of trials in which all three infants produced matching training and probe responses systematically increased following the introduction of the model-and-praise treatment condition, whereas the infants' nonmatching responding did not increase systematically following the introduction of treatment.

Figure 1 shows Kate's training and probe data. The *y* axis represents the percentage of responses scored as matching and nonmatching during each session. The *x* axis represents consecutive sessions. The left set of graphs depicts the training trials and the right set of graphs depicts the probe trials. The infant matching responses are designated by the closed circles, and the nonmatching responses are indicated by the open circles. The data on the training graphs represent percentages of six trials, and the data on the probe graphs represent percentages of three trials each session. As described in the method section, occasionally a session was terminated before all trials were presented. The three responses of the multiple-baseline design are vocal responses, motor-with-toy, and motor-without-toy responses. The vertical dashed line indicates the point at which the treatment condition was introduced for each of these response types. Data to the left of this dashed line represent responding during the model-alone baseline condition; data to the right represent responding during the model-and-praise treatment condition.

This figure shows the percentage of trials during which Kate produced matching and nonmatching responses during training and probe trials. Vocal responses were treated first, followed by motor-with-toy and motor-without-toy responses. During training trials (shown on the left side of the figure), Kate's vocal, motor-with-toy, and motor-without-toy matching, shown with closed circles, was low and very stable during all three model-alone baseline conditions. Matching showed a systematically ascending trend during the model- and praise-treatment condition across all three response types. Kate's nonmatching, shown with open circles, was high and less stable during all three baseline conditions and showed a systematically descending trend during treatment.

During probe trials (shown on the right side of the figure), Kate's matching was stable and low during all three baseline conditions, and it showed an ascending trend during treatment that occurred systematically with the increase in matching during the reinforced training trials, shown on the left side of the figure. Nonmatching was higher than matching during baseline, but this relation reversed during the model-and-praise treatment for all three response types.

Figure 2 shows the percentage of trials in which John produced matching and nonmatching responses across all three response types. As a partial control for order-of-treatment effects, John received treatment on the three response types in a different from order from Kate. Motor-with-toy responses were treated first, followed by motor-without-toy responses and vocal responses. During training trials (left side of Fig. 2), the percentage of trials in which John produced matching responses systematically increased with the introduction of the model-and-praise treatment condition, and the percentage of nonmatching responses systematically decreased with the introduction of treatment. During probe trials (right side of Fig. 2), the percentage of trials in which John produced matching responses sys-

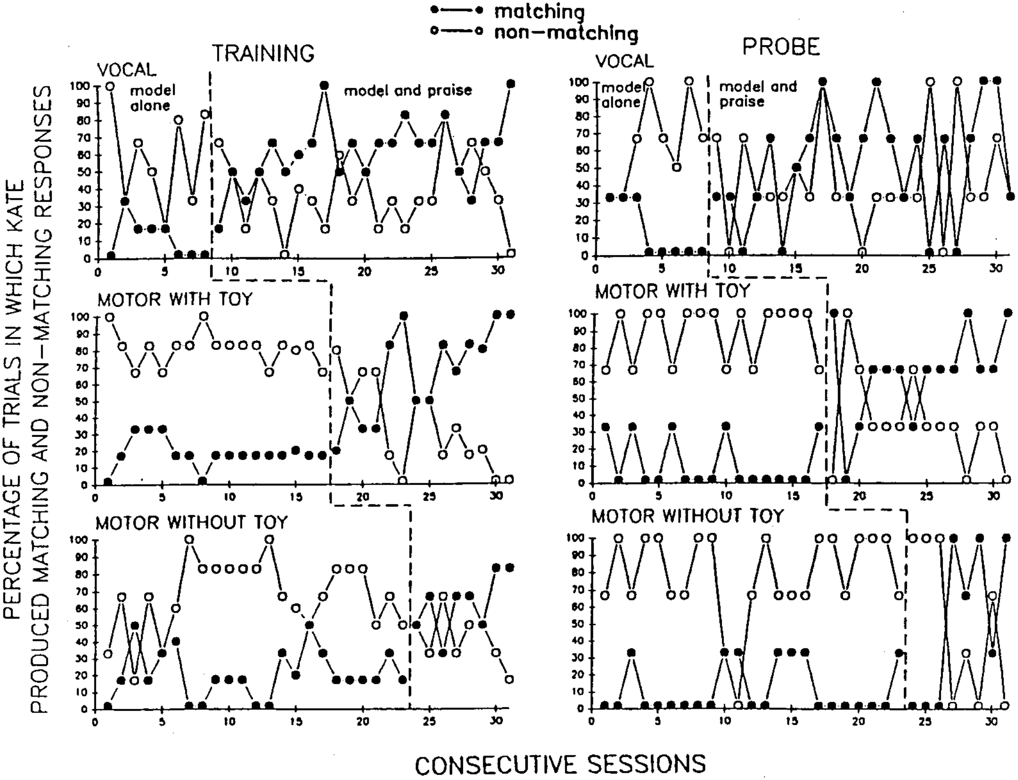

FIG. 1. Kate's matching responses (closed circles) and nonmatching responses (open circles) that occurred within the 6 s following maternal motor-with-toy, motor-without-toy, and vocal models of the training trials (left) and the probe trials (right) expressed in percentages of modeling trials and plotted across consecutive sessions.

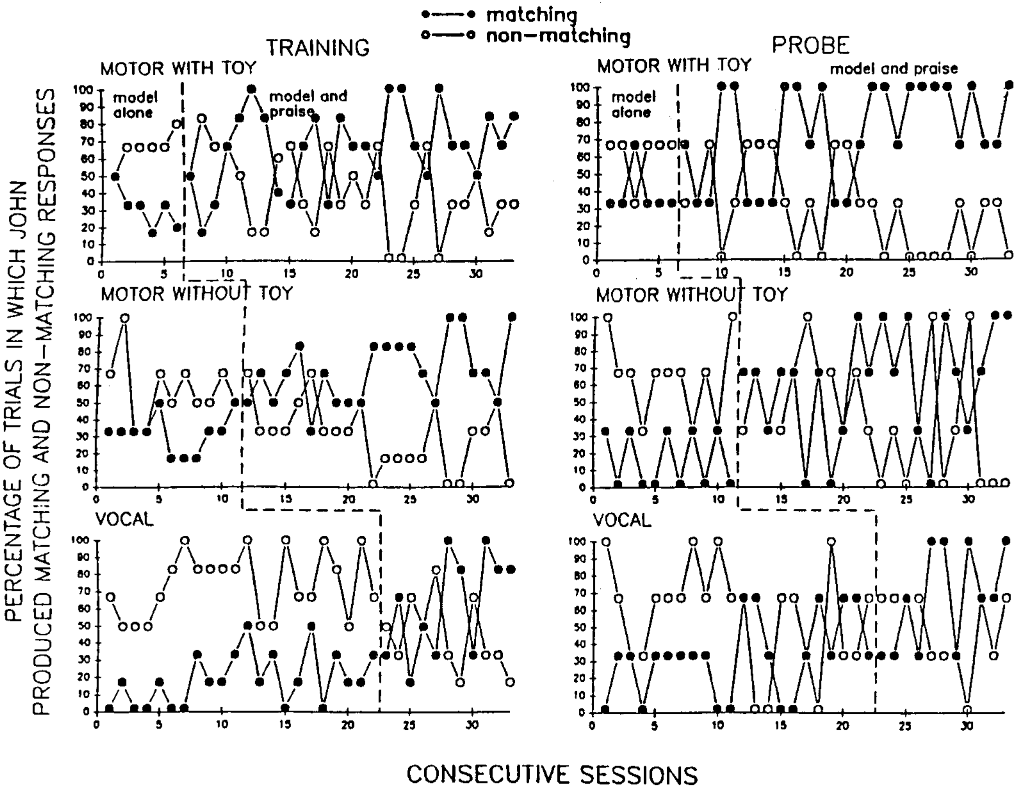

FIG. 2. John's matching responses (closed circles) and nonmatching responses (open circles) that occurred within the 6 s following maternal motor-with-toy, motor-without-toy, and vocal models of the training trials (left) and the probe trials (right) expressed in percentages of modeling trials and plotted across consecutive sessions.

tematically increased with the introduction of the model-and-praise treatment on the training trials. The percentage of nonmatching was higher overall during baseline than during treatment, although there was no systematic change with the introduction of treatment.

Figure 3 shows percentage of trials in which Kevin produced matching and nonmatching responses during training and probe trials. Kevin received treatment on the three response types in the same order as John. During training trials (left side of Fig. 3), the percentage of trials in which Kevin produced matching responses increased systematically with the introduction of treatment. Nonmatching was slightly higher than matching in baseline, but this relation reversed in treatment. During probe trials (right side of Fig. 3), the percentage of trials in which Kevin produced matching responses systematically increased with the introduction of treatment for the training trials. Nonmatching occurred more frequently than matching in baseline, but this relationship reversed with the introduction of treatment.

Across the three infants and for all response types, praise was delivered by the mother to her infant contingent upon matching during 1% of the baseline training trials and 0% of the baseline probe trials. During treatment praise was delivered by the mother to her infant contingent upon matching during 94% of the training trials and only 3% of the probe trials. These data show that the mothers were able to implement the experimental procedures as intended throughout the experiment. Additional data concerning procedural reliability included the extent to which each modeled response was correctly presented to the infants and, during model-with-toy trials, the extent to which the correct toy was placed in the correct position on the table following modeling. The correct model was presented during 99% of all baseline trials and during 99% of all training trials. The correct toy was presented in the correct positions during 98% of baseline trials and during 99% of treatment trials during model-with-toy trials. Furthermore, the correct models were presented in the correct order during 99% of baseline sessions and during 99% of training sessions. These data show that the procedures described were implemented as intended during this study.

DISCUSSION

The above results show a systematic increase in matching across each of the three response types with the introduction of the model-and-praise treatment procedure for all three infants. Nonmatching did not increase systematically following the introduction of the treatment condition. These two sets of data allow the conclusion that it was imitation that systematically increased with the introduction of treatment and not simply the general activity levels of the infants.

Furthermore, the probe trials for all infants mirrored the effect of reinforcement on matching during the training trials, demonstrating generalized imitation within the response types trained. Because treatment was introduced in a different order for Kate than for John and Kevin, and because we observed the same stimulus functions for all infants, order of treatment did not appear to be impor-

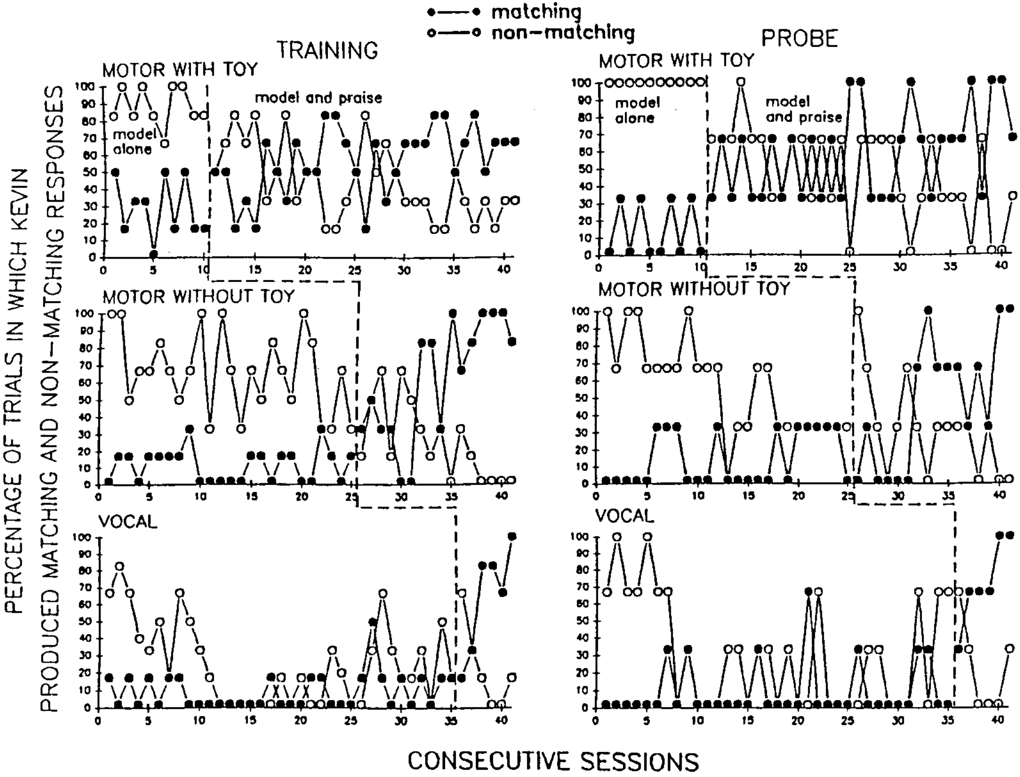

FIG. 3. Kevin's matching responses (closed circles) and nonmatching responses (open circles) that occurred within the 6 s following maternal motor-with-toy, motor-without-toy, and vocal models of the training trials (left) and the probe trials (right) expressed in percentages of modeling trials and plotted across consecutive sessions.

tant in the present study. Overall, imitation generalized within each response class, but failed to generalize across response classes, demonstrating that generalized imitation may be limited by the topographical boundaries of the reinforced response class. Thus, we replicated the findings of Garcia, Baer, and Firestone (1971), but with typically developing infants rather than 8- to 14-year-olds with mental retardation.

This study answers a question concerning the extent to which failure to generalize across all three classes by the Garcia et al. (1971) and Young et al. (1993) participants might have been the result of participant characteristics. Failure to generalize from training to testing situations has long been a hallmark of the learning problems associated with mental retardation and autism. Because the infants in the above study appeared to be grossly typical in achieving developmental milestones, and because they, too, showed limited generalization from training to testing or probe trials, we are less inclined to attribute this failure of generalization to participant characteristics. Conversely, we might assume that infants, as immature organisms, might share such limitations with older people with developmental delays. Thus, research on imitative response-class formation with older normally developing children would help resolve this particular issue.

Although the present study provides evidence that generalized imitation of motor-with-toy, motor-without-toy, and vocal responses consists of separate imitative classes in infants, we do not know whether these imitative classes had a previous learning history or whether they emerged only as a result of the experimental procedures to which we introduced them. Concerning the possibility that we taught them, certainly the multiple-baseline experimental design we used created a discrimination between currently-under-treatment imitative classes and those still in baseline because we reinforced no exemplars of the types of imitative responses still in baseline. In other words, the infants discriminated nonreinforced probes of the same types of imitative responses that were under reinforcement, from the nonreinforced probes of types that were not. The enduringly intriguing fact about generalized imitation may not be that even infants can make such a discrimination, but that they do not make it in relation to the presence or absence of reinforcement for training and probe trials within a given imitative class, such as vocal imitation. They continue to imitate vocal models during nonreinforced vocal probe trials, as long as imitation of other vocal training trials produces reinforcement.

Concerning the possibility that these imitative classes were in some sense preexisting, there is evidence in the developmental literature that these types of imitative responses may exist as independent classes in infants quite apart from any local experimental operations.

In cross-sectional studies with large groups of infants, Abravanel, Levan-Goldschmidt, and Stevenson (1976) and Rodgon and Kurdek (1977) found increasing proportions of models imitated by infants from 6-month-olds to 20-month-olds when motor-with-toy models were presented, but relatively little increase in proportions of motor-without-toy responses imitated by the same groups of infants. From a learning point of view, that outcome would be expected because during motor-with-toy modeling, at least some of the toys, themselves, could become discriminative for the actions modeled with them and thereby facilitate or even obviate the imitation of modeled behavior.

Furthermore, in a cross-sectional study of 8-, 14-, and 20-month-old infants, Rodgon and Kurdek (1977) found more motor than vocal imitation in each age group. Again, from a learning point of view, it would not be surprising that motor imitation would be easier to acquire than vocal imitation, and, therefore, that motor imitation might be acquired earlier in life by most infants. After all, it is usually easier to teach motor imitation than vocal imitation because motor responses can be easily prompted using manual guidance, whereas vocal responses are not as easy to prompt if they do not occur initially. In our laboratory, we have often found it easier to reliably discriminate differences among motor responses than differences among vocal responses of infants and young children when we have set out to measure their behavior. Perhaps the rest of the world also finds it easier to differentially reinforce motor imitation rather than vocal imitation in infants.

More recent correlational studies based on mother–infant interaction have also supported the observation that imitation of motor-with-toy, motor-without-toy, and vocal models is not highly related in infants between about 8 and 24 months of age (Masur, 1989; Masur & Ritz, 1984; Snow, 1989; and Uzgiris, Broome, & Kruper, 1989).

Relevant to the examination of effects of local experimental procedures in the present study, there is another interesting feature of the data. If we were teaching a discrimination among the three types of imitative response through the use of the multiple-baseline experimental design, systematically reinforcing imitation of one type while extinguishing imitation on one or two others, one might expect to see an initial increase in imitation of nonreinforced types with the introduction of reinforcement for the first, and then the second, type, followed by a decrease in imitation in the nonreinforced types. The data do not bear that out, as there was no systematic increase in the nonreinforced types with the introduction of reinforcement for a target type.

Further research on response-class formation in generalized imitation is needed to determine the extent to which these imitative classes tend to occur naturally, as part of more global learning histories, or whether the experimental reinforcement procedures we used in our laboratory produced them. What we do know is that generalized imitation has now been shown to be reliably limited by topographically defined boundaries.

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