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THE DEVELOPMENT OF IMITATION BY REINFORCING BEHAVIORAL SIMILARITY TO A MODEL[1]

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This research demonstrated some of the conditions under which retarded children can be taught to imitate the actions of adults. Before the experiment, the subjects were without spontaneous imitative behavior, either vocal or motor. Each subject was taught, with food as reinforcement, a series of responses identical to responses demonstrated by an experimenter; *i.e.*, each response was reinforced only if it was identical to a prior demonstration by an experimenter. Initially, intensive shaping was required to establish matching responses by the subjects. In the course of acquiring a variety of such responses, the subjects' probability of immediate imitation of each new demonstration, before direct training, greatly increased. Later in the study, certain new imitations, even though perfect, were never reinforced; yet as long as some imitative responses were reinforced, all remained at high strength. This imitativeness was then used to establish initial verbal repertoires in two subjects.

CONTENTS

The development of a class of behaviors which may fairly be called "imitation" is an interesting task, partly because of its relevance to the process of socialization in general and language development in particular, and partly because of its potential value as a training technique for children who require special methods of instruction. Imitation is not a specific set of behaviors that can be exhaustively listed. Any behavior may be considered imitative if it temporally follows behavior demonstrated by someone else, called a model, and if its topography is functionally controlled by the topography of the model's behavior. Specifically, this control is such that an observer will note a close similarity between the topography of the model's behavior and that of the imitator. Furthermore, this similarity to the model's behavior will be characteristic of the imitator in responding to a wide variety of the model's behaviors. Such control could result, for example, if topographical similarity to a model's behavior were a reinforcing stimulus dimension for the imitator.

There are, of course, other conditions which can produce similar behaviors from two organisms on the same occasion, or on similar occasions at different times. One possibility is that

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both organisms independently have been taught the same responses to the same cues; thus, all children recite the multiplication tables in very similar ways. This similarity does not deserve the label imitation, and hardly ever receives it; one child's recitation is not usually a cue to another's, and the similarity of their behavior is not usually a reinforcer for the children. Nevertheless, the children of this example have similar behaviors.

The fact that the world teaches many children similar lessons can lead to an arrangement of their behaviors which comes closer to a useful meaning of imitation. Two children may both have learned similar responses; one child, however, may respond at appropriate times whereas the other does not. In that case, the undiscriminating child may learn to use this response when the discriminating one does. The term imitation still need not be applied, since the similarity between the two children's responses is not functional for either of them; in particular, the second child is not affected by the fact that his behavior is similar to that of the first. This arrangement approaches one which Miller and Dollard (1941) call "matched-dependent" behavior. One organism responds to the behavior of another merely as a discriminative stimulus with respect to the timing of his own behavior; many times, these behaviors will happen to be alike, because both organisms will typically use the most efficient response, given enough experience.

It should be possible, however, to arrange the behavior of two organisms so that one of them will, in a variety of ways, produce precise topographical similarity to the other, but nothing else. A study by Baer and Sherman (1964) seemingly showed the result of such prior learning in several young children. In that study, reinforcements were arranged for children's imitations of three activities of an animated, talking puppet, which served both as a model and a source of social reinforcement for imitating. As a result of this reinforcement, a fourth response of the puppet was spontaneously imitated by the children, although that imitation had never before been reinforced. When reinforcement of the other three imitations was discontinued, the fourth, never-reinforced imitation also decreased in strength; when reinforcement of the original imitations was resumed, imitation of the fourth response again rose in rate, although it still was never reinforced. In short, these children apparently generalized along a stimulus dimension of similarity between their behaviors and the behaviors of a model: when similarity to the model in three different ways was reinforced, they thereupon displayed a fourth way of achieving similarity to the model. Thus, similarity between their behavior and the model's was a functional stimulus in their behavior.

Metz (1965) demonstrated the development of some imitative behavior in two autistic children who initially showed little or no imitative response. In this study, responses similar in topography to demonstrations by the experimenter were reinforced with "Good" and food. Metz found that, after intensive training, several imitative responses could be maintained in strength even when not reinforced with food, and that the subjects had a higher probability of imitating new responses after training than before. However, in one of the conditions used to evaluate the subjects' imitative repertoire before and after imitative training, "Good" was still said contingent upon correct new imitations. Thus, for one subject who initially showed a non-zero rate of imitation, it could be argued that the increased imitation in the test after training was due to an experimentally developed reinforcing property of "Good", rather than to the imitation training as such. Further, in the Metz study, due to a lack of extinction or other manipulation of the behavior, it is difficult to specify that the higher probability of imitating new responses, and the maintenance of unreinforced imitative responses, were in fact due to the reinforcement of the initial imitative responses during training.

Lovaas, Berberich, Perloff, and Schaeffer (1966) used shaping and fading procedures to establish imitative speech in two autistic children. They reported that as training progressed and more vocal behavior came under the control of a model's prior vocalization, it became progressively easier to obtain new imitative vocalizations. When reinforcement was shifted from an imitative-contingent schedule to a basically non-contingent schedule, imitative behavior deteriorated. In an additional manipulation, the model presented Norwegian words interspersed with English words for the children to imitate. Initially, the children did

not reproduce the Norwegian words perfectly. However, the authors judged that the subjects gradually improved their imitations of the Norwegian words even though these imitations were not reinforced.

The studies by Baer and Sherman (1964), Metz (1965), Lovaas *et al* (1966), and other reports (Bandura, 1962) suggest that for children with truly imitative repertoires, induction has occurred, such that (1) relatively novel behaviors can be developed before direct shaping, merely by providing an appropriate demonstration by a model, and (2) some imitative responses can be maintained, although unreinforced, as long as other imitative responses are reinforced.

The purpose of the present study was to extend the generality of the above findings and to demonstrate a method of producing a truly imitative repertoire in children initially lacking one.

METHOD

Subjects

Three children, 9 to 12 years of age, were selected from several groups of severely and profoundly retarded children in a state school. They were chosen not because they were retarded, but because they seemed to be the only children available of a practical age who apparently showed no imitation whatsoever. (The success of the method to be described suggests that it may have considerable practical value for the training of such children.) The subjects were without language, but made occasional grunting vocalizations, and responded to a few simple verbal commands ("Come here", "Sit down", *etc.*). They were ambulatory (but typically had developed walking behavior relatively late in their development, in the sixth or seventh year), could dress themselves, were reasonably well toilet trained, and could feed themselves. Fair eye-hand coordination was evident, and simple manipulatory skills were present.

The subjects were chosen from groups of children initially observed in their wards from a distance over a period of several days. No instances of possible imitation were noted in the subjects finally selected. (That is, on no occasion did any subject display behavior similar to that of another person, except in instances where a common stimulus appeared to be controlling the behaviors of both persons, *e.g.*, both going to the dining area when food was displayed on the table.) Subsequently, an experimenter approached and engaged the subjects in extended play. In the course of this play, he would repeatedly ask them to imitate some simple response that he demonstrated, such as clapping his hands, or waving. The children failed to imitate any of these responses, although they clearly were capable of at least some of them. Finally, during the training itself, every sample of behavior was initially presented to the child as a demonstration accompanied by the command, "Do this"; at first, none of these samples was imitated, despite extensive repetition.

First Training Procedures

Each subject was seen at mealtimes, once or twice a day, three to five times a week. The subject's food was used as a reinforcer. It was delivered a spoonful at a time by the experimenter, who always said "Good" just before putting the spoon into the subject's mouth. The subject and experimenter faced each other across the corner of a small table, on which were placed the food tray and the experimenter's records. Elsewhere in the room was another small table on which were placed some materials used later in the study, a desk with a telephone on it, a coat rack holding one or more coats, a wastebasket, and a few other chairs.

The basic procedure was to teach each subject a series of discriminated operants. Each discriminated operant consisted of three elements: a discriminative stimulus (S^D) presented by the experimenter, a correct response by the subject, and reinforcement after a correct response. The S^D was the experimenter's command, "Do this", followed by his demonstration of some behavior. The response required was one similar to the experimenter's. Thus, the operant learned was always topographically imitative of the experimenter's demonstration. The reinforcement was food, preceded by the word "Good".

Since none of the subjects was imitative, none of the initial S^D's was followed by any behavior which resembled that demonstrated by the experimenter. This was true even for those behaviors which the subjects were clearly capable of performing. Subject 1, for example, would sit down when told to, but did not imi-

tate the experimenter when he said "Do this", sat down, and then offered her the chair. Hence, the initial imitative training for all subjects was accomplished with a combination of shaping (Skinner, 1953) and fading (Terrace, 1963*a*, 1963*b*) or "putting through" procedures (Konorski and Miller, 1937).

The first response of the program for Subject 1 was to raise an arm after the experimenter had raised his. The subject was presented with a series of arm-raising demonstrations by the experimenter, each accompanied by "Do this", to which she made no response. The experimenter then repeated the demonstration, reached out, took the subject's hand and raised it for her, and then immediately reinforced her response. After several trials of this sort, the experimenter began gradually to fade out his assistance by raising the subject's arm only part way and shaping the completion of the response. Gradually, the experimenter's assistance was faded until the subject made an unassisted arm-raising response whenever the experimenter raised his arm. The initial responses for all subjects were taught in this manner whenever necessary.

Occasionally during the very early training periods a subject would resist being guided through a response. For example, with a response involving arm raising, Subject 3 at first pulled his arm downward whenever the experimenter attempted to raise it. In this case, the experimenter merely waited and tried again until the arm could be at least partially raised without great resistance; then the response was reinforced. After subjects had received a few reinforcements following the experimenter's assistance in performing a response, they no longer resisted. As the number of responses in the subjects' repertoire increased, the experimenter discontinued the guiding procedure and relied only on shaping procedures when a response did not match the demonstration.

A number of responses, each topographically similar to a demonstration by the experimenter, was taught to each subject. Training of most responses was continued until its demonstration was reliably matched by the subject. The purpose of these initial training procedures was to program reinforcement, in as many and diverse ways as practical, whenever a subject's behavior was topographically similar to that demonstrated by the experimenter.

Further Training Procedures

Probes for imitation. As the initial training procedures progressed, and the subjects began to come under the control of the experimenter's demonstrations, certain responses were demonstrated which, if imitated perfectly on their first presentation, were deliberately not reinforced on the first or any future occasion. These responses served as probes for the developing imitative nature of the subject's repertoire. A list of the responses demonstrated, including the reinforced ones for the initial training procedure and the unreinforced probe demonstrations, is given in Table 1 for Subject 1. These responses are listed in the order of first demonstration. Subject 1 had 95 reinforced and 35 unreinforced responses. Similar responses were used with Subjects 2 and 3. Subject 2 had 125 reinforced and five unreinforced probes; Subject 3 had eight reinforced responses and one unreinforced probe.

During the probes, the experimenter continued to present S^D's for imitation. If the response demonstrated belonged to the group of reinforced responses and the subject imitated within 10 sec, reinforcement ("Good" and food) was delivered and the next response was demonstrated. If the subject did not imitate within 10 sec, no reinforcement was delivered and the experimenter demonstrated the next response. If it belonged to the unreinforced group of responses (probes), and if the subject imitated it, there were no programmed consequences and the experimenter demonstrated the next response no sooner than 10 sec after the subject's imitation. If it was not imitated, the experimenter performed the next demonstration 10 sec later. The purpose of the 10-sec delay was to minimize the possibility that the subjects' unreinforced imitations were being maintained by the possible reinforcing effects of the presentation of an S^D for a to-be-reinforced imitative response. Demonstrations for reinforced and unreinforced responses were presented to subjects in any unsystematic order.

Non-reinforcement of all imitation. After the probe phase, and after stable performances of reinforced and unreinforced imitative responses were established, non-reinforcement of all imitative behavior was programmed. The purpose of this procedure was to show the dependence of the imitative repertoire on the

Table 1

The Sequence of Responses Demonstrated to Subject 1

(Asterisks indicate unreinforced responses.)

1. Raise left arm.
2. Tap table with left hand
3. Tap chest with left hand
4. Tap head with left hand
5. Tap left knee with left hand
6. Tap right knee with left hand
7. Tap nose
*8. Tap arm of chair
9. Tap leg of table
10. Tap leg with left hand
11. Extend left arm
*12. Make circular motion with arm
13. Stand up
14. Both hands on ears
15. Flex arm
16. Nod yes
17. Tap chair seat
18. Extend both arms
19. Put feet on chair
20. Walk around
21. Make vocal response
22. Extend right arm sideways
23. Tap shoulder
24. Tap head with right hand
25. Tap right knee with right hand
26. Tap leg with right hand
27. Tap left knee with right hand
28. Raise right arm overhead
29. Tap chest with right hand
30. Tap table with right hand
31. Move chair
32. Sit in chair
33. Throw paper in basket
34. Pull up socks
35. Tap desk
36. Climb on chair
37. Open door
38. Move ash tray
39. Put paper in chair
40. Sit in two chairs (chained)
41. Tap chair with right hand
42. Move paper from basket to desk
43. Move box from shelf to desk
44. Put on hat
45. Move hat from table to desk
46. Move box from shelf to desk
47. Nest three boxes
48. Put hat in chair
49. Tap wall
50. Move waste basket
51. Move paper from desk to table
52. Stand in corner
53. Pull window shade
54. Place box in chair
55. Walk around desk
56. Smile
57. Protrude tongue
58. Put head on desk
*59. Ring bell
60. Nest two boxes
61. Crawl on floor
*62. Walk with arms above head
63. Sit on floor
64. Put arm behind back (standing)
65. Walk with right arm held up
66. Throw box
*67. Walk to telephone
*68. Extend both arms (sitting)
69. Walk and tap head with left hand
70. Walk and tap head with right hand
*71. Walk and clap hands
*72. Open mouth
73. Jump
74. Pat radiator
*75. Nod no
76. Pick up phone
77. Pull drawer
78. Pet coat
79. Tear kleenex
80. Nest four boxes
81. Point gun and say "Bang"
*82. Put towel over face
*83. Put hands over eyes
*84. Tap floor
*85. Scribble
*86. Move toy car on table
87. Place circle in form board
88. Place circle, square, and triangle in form board
*89. Crawl under table
*90. Walk and clap sides
*91. Lie on floor
*92. Kick box
*93. Put foot over table rung
*94. Fly airplane
*95. Rock doll
*96. Burp doll
*97. Tap chair with bat
*98. Open and close book
99. Work egg beater
100. Put arm through hoop
101. Build three block tower
*102. Stab self wth rubber knife
103. Put blocks in ring
104. Walk and hold book on head
105. Ride kiddie car
106. Sweep with broom
107. Place beads around neck
108. Ride hobby horse
*109. Put on glove
110. Use whisk broom on table
111. Work rolling pin
*112. Push large car
113. Put beads on doorknob
*114. Put hat on hobby horse
115. Sweep block with broom
116. Place box inside ring of beads
117. Put glove in pocket of lab coat
118. Push button on tape recorder
*119. Bang spoon on desk
120. Lift cup
121. Use whisk broom on a wall
*122. Put a cube in a cup
123. Rattle a spoon in a cup
*124. Throw paper on the floor
*125. Hug a pillow
126. Tap pegs into pegboard with hammer
*127. Wave a piece of paper
*128. Shake a rattle
*129. Hit two spoons together
130. Shake a tambourine

food reinforcement which was apparently responsible for its development.

Non-reinforcement of imitation was instituted in the form of reinforcement for any behavior other than imitation. Differential reinforcement of other behavior is abbreviated DRO (Reynolds, 1961). The experimenter continued saying "Good" and feeding the subject, but not contingent on imitations. Instead, the experimenter delivered reinforcement at least 20 sec after the subject's last imitation had taken place. Thus, for the group of previously reinforced responses, the only change between reinforcement and non-reinforcement periods was a shift in the contingency. For the group of unreinforced or probe responses there was no change; food reinforcement still did not follow either the occurrence or non-occurrence of an imitative response. This procedure involved simultaneously the extinction of imitation and also the reinforcement of whatever other responses may have been taking place at the moment of reinforcement.

For Subject 1, the DRO period was 30 sec. For Subject 2, DRO periods were 30, 60, and 0 sec. (DRO 0-sec meant reinforcement was delivered immediately after the S^D, before an imitative response could occur.) This sequence of DRO intervals was used because, as displayed in the Results section, Subject 2 maintained stable imitation under the initial DRO procedures, unlike the other subjects. For Subject 3, the DRO period was 20 sec. After the DRO procedure for each subject, contingent reinforcement of imitation was resumed and the procedures described below were instituted.

Imitative chains. After reinforcement for imitative behavior was resumed with Subjects 1 and 2, the procedure of chaining together old and new imitations was begun. At first only two-response chains were demonstrated; then three-response chains, after two-response chains were successfully achieved; and so on. During chaining, the experimenter demonstrated the responses the subject was to imitate as an unbroken series. In all cases, the demonstrated chain contained both responses previously learned by the subject and relatively new ones. Walking from one locale to another in the process of performing these behaviors was not considered part of the imitative chain and was not judged for imitative accuracy.

Verbal imitations. Late in the training program for Subjects 1 and 3, when virtually any new motor performance by the experimenter was almost certain to be imitated, vocal performances were begun with simple sounds. The experimenter, as usual, said "Do this", but instead of making some motor response made a vocal one, for example, "Ah". Subjects 1 and 3 repeatedly failed to imitate such demonstrations. Different procedures were then employed to obtain vocal imitations. For Subject 1, the vocal response to be imitated was set into a chain of non-vocal responses. For example, the experimenter would say, "Do this", rise from his chair and walk to the center of the room, turn towards the subject, say "Ah", and return to his seat. To such a demonstration Subject 1 responded by leaving her seat, walking toward the center of the room, turning toward the experimenter, and then beginning a series of facial and vocal responses out of which eventually emerged an "Ah" sufficiently similar to the experimenter's to merit reinforcement. This coupling of motor and vocal performances was maintained for several more demonstrations, during which the motor performance was made successively shorter and more economical of motion; finally, the experimenter was able to remain seated, say "Do this", say "Ah", and immediately evoke an imitation from the subject. Proceeding in this manner, simple sounds were shaped and then combined into longer or more complex sounds and finally into usable words.

Subject 3, like Subject 1, initially failed to imitate vocalizations. In his case, the experimenter proceeded to demonstrate a set of motor performances which moved successively closer to vocalizations. At first the experimenter obtained imitative blowing out of a lighted match, then blowing without the match, then more vigorous blowing which included an initial plosive "p", then added a voiced component to the blowing which was shaped into a "Pah" sound. Proceeding in this manner, a number of vocalizations were produced, all as reliable imitations.

Generalization to other experimenters. When the imitative repertoire of Subject 1 had developed to a high level, new experimenters were presented to her, of the opposite or the same sex as the original male experimenter. These novel experimenters gave the

same demonstrations as the original experimenter in the immediately preceding session. The purpose of this procedure was to investigate whether the subject's imitative repertoire was limited to demonstrations by the original male experimenter. During this procedure, the new experimenters delivered reinforcement in the same manner as the original experimenter; *i.e.*, previously reinforced imitations were reinforced and probes were not.

RESULTS

Reliability of Scoring Imitative Responses

Checks on the reliability of the experimenter's scoring of any response as imitative were made at scattered points throughout the study for Subjects 1 and 2. The percentage of agreement between the experimenter's scoring and the independent records of a second observer exceeded 98%.

First Training Procedures

The initial training procedure contained occasions when the extent of the developing imitative repertoire of each subject could be seen. These were occasions when behavior was demonstrated by the experimenter to the subject for the first time. Any attempt by the subject to imitate such new behavior before direct training or shaping could be attributed to the history of reinforcement for matching other behavior of the experimenter. Thus, it was possible to examine the sequence of initial presentations to each subject to discover any increasing probability that new behavior would be imitated on its first presentation.

The sequence of 130 responses in Subject 1's program was sufficient to increase her probability of imitating new responses from zero at the beginning of the program to 100% at the end. This was demonstrated by grouping the 130 responses into 13 successive blocks of 10 each. As shown in Fig. 1, the proportion imitated on the first presentation within each block rose, not too steadily, but nonetheless clearly, to 100% by the 13th block.

The proportion of new responses successfully imitated by Subject 2 upon their first presentation rose from 0% to 80%, through a sequence of 130 new responses, as shown in Fig. 2.

Subject 2 displayed both more variable and less thorough imitation of new responses on their first presentation than did Subject 1, although the general form of the data is similar.

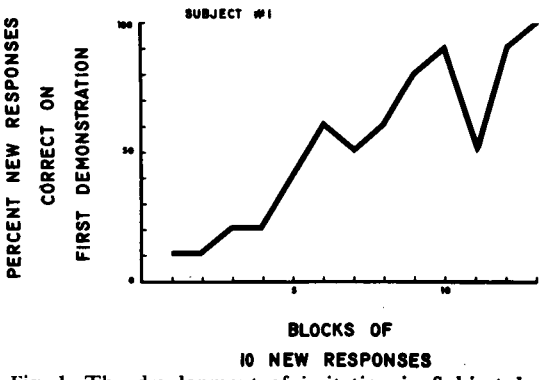

Fig. 1. The development of imitation in Subject 1.

Subject 3 was taught only eight discriminated operants of imitative topography, which he acquired much more rapidly than did either Subject 1 or 2. He imitated the ninth spontaneously on its first presentation, although he had not imitated it before training.

The progressive development of imitation was apparent in other aspects of the data as well. The number of training sessions required to establish new imitations was displayed by plotting this number of sessions for each successive block of 10 new responses. The criterion for establishment of a new imitative response was that, for one trial, a subject displayed the response demonstrated by the experimenter with no shaping or fading procedures required for that trial. This is shown in Fig. 3 for Subject 1 and in Fig. 4 for Subject 2, as solid lines. Both graphs show a systematically decreasing number of sessions required to establish successive new imitations. The dotted portions of each graph represent deviations from the usual type of training

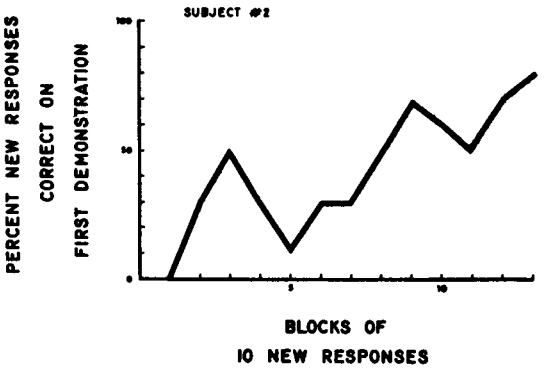

Fig. 2. The development of imitation in Subject 2.

procedure and thus are plotted differently. For Subject 1 the dotted portion represents a period in which verbal responses were introduced (not plotted as part of Fig. 3, but discussed later in this report). For Subject 2 the dotted portion represents a sequence of sessions in which few new imitative responses were introduced. Rather, two previously established imitative responses of similar topography, which the subject no longer clearly displayed, were worked on intensively.

DRO Procedures

For all subjects, both reinforced and unreinforced imitative behavior was maintained over continuing experimental sessions as long as food reinforcement was contingent upon at

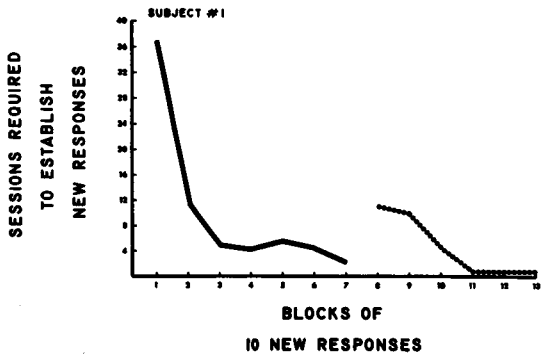

Fig. 3. The rate of development of imitation in Subject 1.

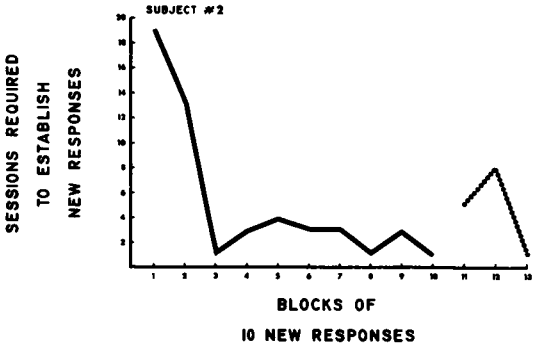

Fig. 4. The rate of development of imitation in Subject 2.

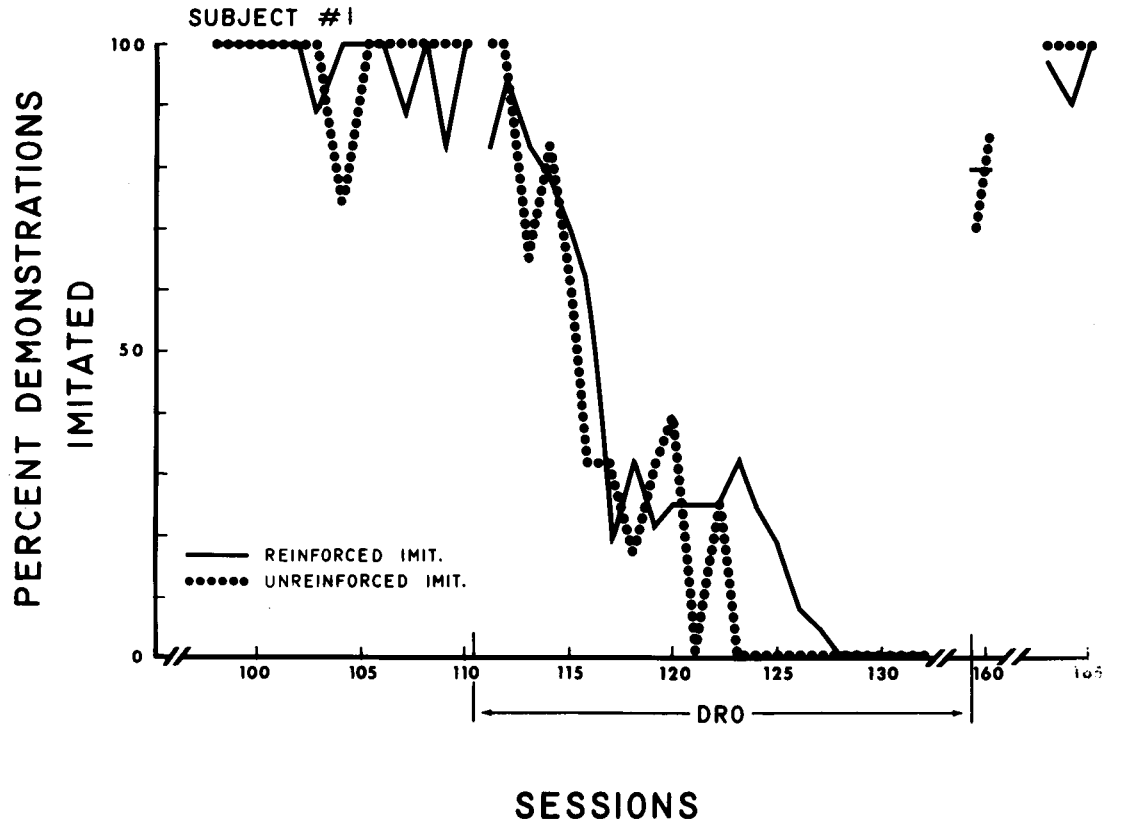

Fig. 5. The maintenance and extinction of reinforced and unreinforced imitation in Subject 1. (The breaks in the data before and after session 160 represent periods of experimentation aimed at other problems.)

least some imitative behavior. When reinforcement was no longer contingent upon imitative behavior during the DRO periods, both the previously reinforced imitations and the never-reinforced probe imitations decreased markedly in strength.

Figure 5 is a plot of the percentages of each type of imitative response by Subject 1. It shows that her probability of imitating the 35 probes varied between 80 and 100%, as long as the other 95 imitations, within which the probes were interspersed, were reinforced. The application of the DRO 30-sec procedure extinguished virtually all imitative behavior within about 20 hr. The previously reinforced imitations and the probe imitations extinguished alike in rate and degree. All imitative behavior recovered when, with a small amount of shaping, reinforcement was again made contingent upon imitative behavior.

Figure 6 is a similar plot of the imitative behavior of Subject 3. It shows the maintenance of the one probe imitation and eight reinforced imitations during reinforcement of imitation, a marked decrease in both types of imitative behavior during the DRO 20-sec period, and a recovery when contingent reinforcement of imitations was resumed.

Figure 7 is a plot of the imitative behavior of Subject 2. Her results were similar to those obtained for Subjects 1 and 3, in terms of the maintenance of 125 reinforced and five probe imitations, under conditions of reinforcement of imitations. However, her data depart from the others' during the DRO period. Initially, this subject showed no reliable signs of extinction after four sessions of DRO with a 30-sec delay. Next, DRO 60-sec was instituted for four sessions, still without any reliable effect. At that point, a procedure of DRO 0-sec was begun, meaning that the experimenter demonstrated some behavior, and instantly, before the subject could respond, said "Good" and delivered the food to her mouth. Thus, reinforcement served to forestall the durable imitative responses this subject was displaying. Figure 7 demonstrates the immediacy of effect of this procedure. After four sessions of DRO

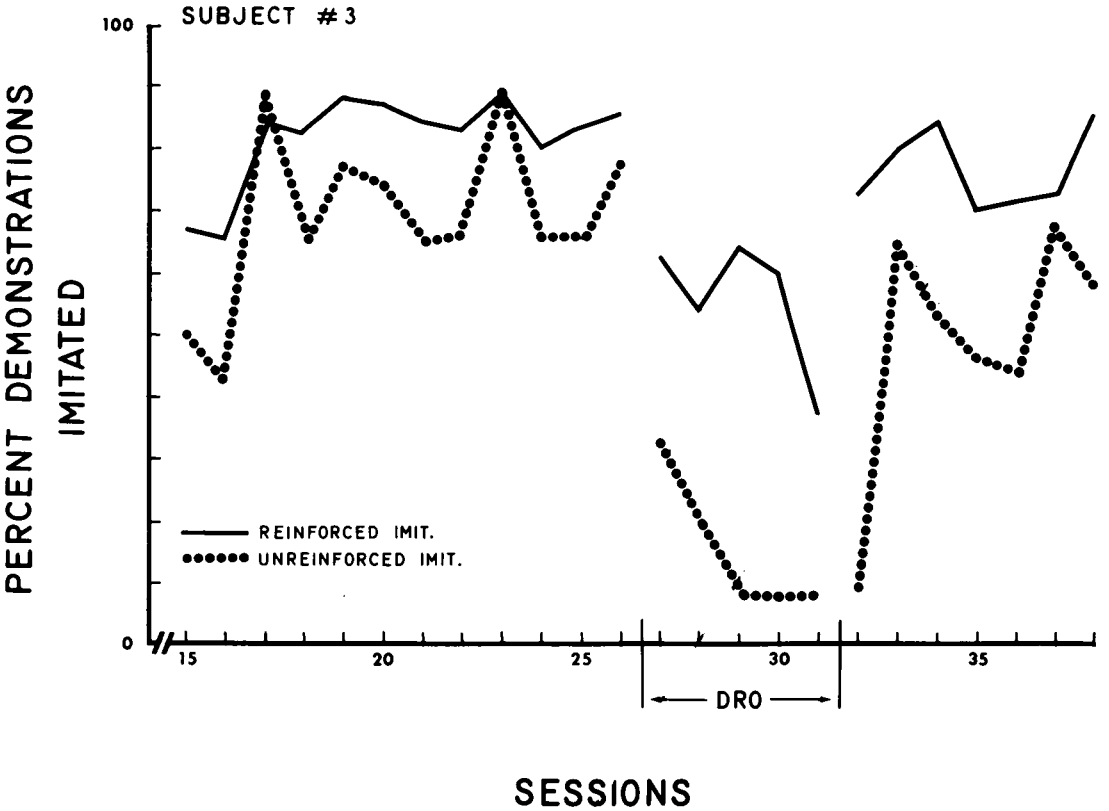

Fig. 6. The maintenance and extinction of reinforced and unreinforced imitation in Subject 3.

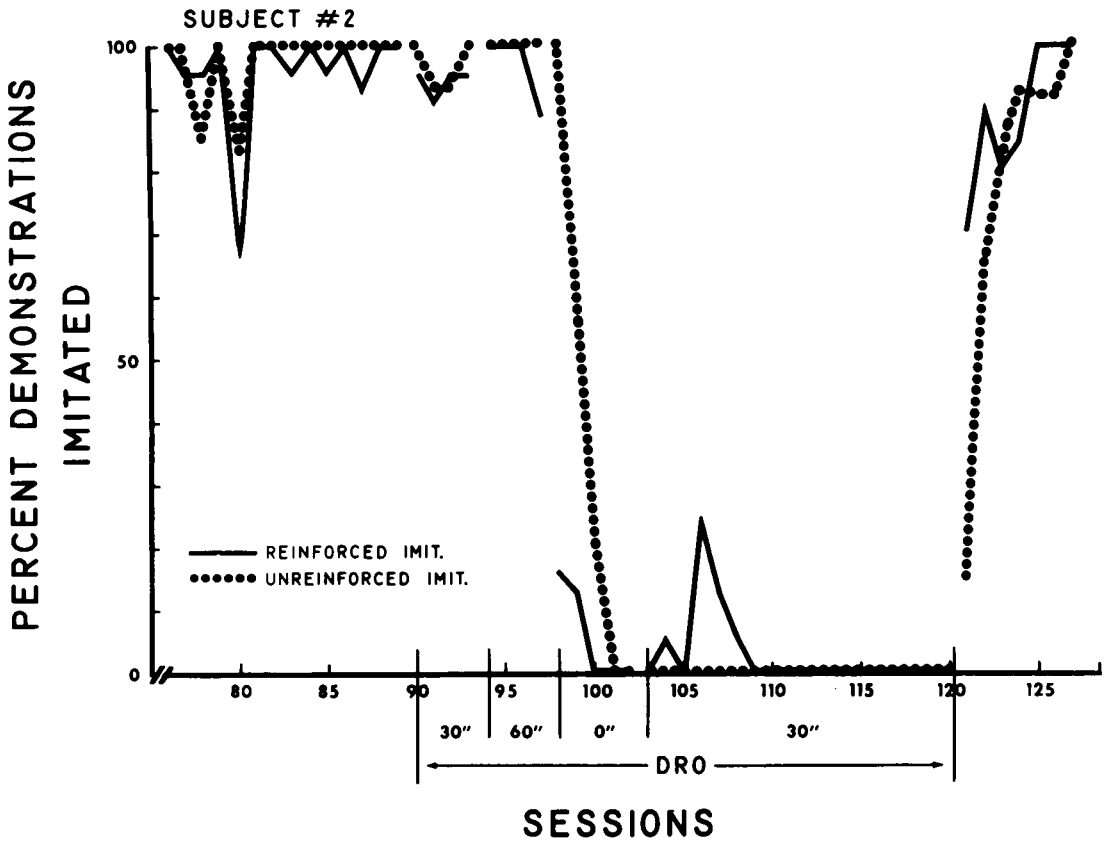

Fig. 7. The maintenance and extinction of reinforced and unreinforced imitation in Subject 2.

0-sec, it was possible to resume the procedures of DRO 30-sec and produce only a brief and partial recovery of the rate of imitation, which then declined to zero. A return to contingent reinforcement, with a small amount of shaping, quickly reinstated the high rate of imitation previously displayed.

In all cases, then, it is clear that the imitative repertoire depended on reinforcement of at least some of its members. It is noteworthy that those responses which had developed and been maintained previously without direct reinforcement could not survive extinction applied to the entire class of behaviors.

Imitative Chains

Subjects 1 and 2 were exposed to the procedure of chaining together old and new imitative responses. At the end of 10 hr of the procedure for Subject 1, lengthy chains containing already established and new imitative responses became practical. It was possible to obtain perfect imitation on 90% of the chains, some of which involved as many as five responses. Subject 2 received only 2 hr of training on chains. At the end of this time, she would imitate 50% of the three-response chains demonstrated to her, and 80% of the two-response chains.

Verbal Behavior

Subjects 1 and 3 were used in the procedures for the development of verbal imitation. Verbal imitations were established for Subject 1 by chaining together motor and vocal behaviors and then fading out the motor components. Twenty hours of training resulted in 10 words which were reliably imitated such as, "Hi", "Okay", the subject's name, and the names of some objects. Subject 3's training in vocal imitations was accomplished by evoking a set of motor imitations which moved successively closer to vocalizations. Approximately 10 hr of training produced the reliable imitative vocalizations of seven vowel and consonant sounds.

Generalization to Other Experimenters

When Subject 1 was presented with new experimenters, of both the opposite and same sex as the original male experimenter, she showed approximately the same degree of imitation displayed to the original experimenter. That is, she imitated all of the three probe demonstrations given by one new male experimenter and imitated 12 of 15 reinforced demonstrations by a second new male experimented on the first demonstration and the remaining three by the third demonstration. On another occasion, the second new male experimenter re-presented the 15 demonstrations; all were imitated on their first demonstration. The subject also imitated all of a series of demonstrations by a female experimenter.

DISCUSSION

The procedures of this study were sufficient to produce highly developed imitation in the experimental subjects. However, a noteworthy point is the relative difficulty experienced in obtaining initial matching responses from a subject even when the response required (*e.g.*, arm raising) clearly was in the subject's current repertoire. This suggests that the subjects were not so much learning specific responses as learning the instruction, "Do as the experimenter does." Initially, then, the procedures of this study seem to have involved bringing a number of the subjects' responses under the instructional control of the experimenter's demonstration.[4] To establish this type of instructional control by demonstration requires that the subjects either have or develop responses of observing their own behavior as well as the experimenter's behavior.

As an increasing number of the subjects' behaviors came under the instructional control of demonstration, additional behavior, not previously observed in the subjects' repertoires, became increasingly probable, merely as a result of presenting an appropriate demonstration by a model. In the terminology suggested by Miller and Dollard (1941), a sufficiently extensive arrangement of one child's behavior into matched-dependent response with a model's behavior was sufficient to induce a tendency to achieve similarity in more ways than were originally taught.

The development of imitative repertoires, including the unreinforced imitation of probe demonstrations, could be accounted for by the effects of conditioned reinforcement. Conditioned reinforcement may have operated in the present study in the following way: the basic procedure was that of teaching the subject a series of responses, each of which was topographically similar to a demonstration just given by a model. Initially, each response had to be established separately. When established, such responses were imitative only topographically and would better be called matched-dependent behavior; the fact that a subject's response was similar to the experimenter's behavior at that point had no functional significance for any of the subject's other responses. Nevertheless, topographical similarity between child and experimenter was there to be attended to by the child, and this similarity was potentially discriminative with respect to the only reinforcement delivered in the experimental situation. One of the most effective ways of giving a stimulus a reinforcing function is to make it discriminative with respect to reinforcement. In these applications, the stimulus class of behavioral similarity was, in numerous examples, made discriminative with respect to positive reinforcement. Hence, similarity could be expected to take on a positive reinforcing function as well as a discriminative function. As a positive reinforcer, it should strengthen any new behavior that produced or achieved it. Behaviors that achieve similarity between one's self and a model are, of course, imitative behaviors; furthermore, they are imitative by function and not by coincidence.

This analysis is simple only at first inspection. In particular, it should be noted that "similarity" is not a simple stimulus dimension, like the frequency of sound or the intensity of light. Similarity must mean a correspondence of some sort between the stimulus output of the child's behavior and the stimulus output of the model's. A correspondence between two stimuli is not too esoteric a stimulus to consider as functional in controlling behavior. However, for an imitative repertoire to develop, a class of correspondences must become functional as stimuli. The child must

[4]The authors are indebted to Israel Goldiamond for his suggestions in clarifying this point.

learn to discriminate a correspondence between the appearance of his hand and the model's hand, his arm and the model's arm, his leg and the model's leg, his voice and the model's voice, *etc.* It would seem reasonable that each of these kinds of difference must require some prior experience on the child's part to appreciate. A scantiness of such experience may well be characteristic of retarded children, and makes them intriguing subjects for such studies. The ability to generalize similarities among a considerable variety of stimuli, which the children of these studies evidenced, suggests that the training they were subjected to was adequate to the problem. An immediate next problem, it would seem, is the detailed analysis of those procedures to find out which of them accomplished what part of this generalization. That analysis might yield a fair understanding of imitative behavior.

REFERENCES

Baer, D. M. and Sherman, J. A. Reinforcement control of generalized imitation in young children. *J. exp. Child Psychol.*, 1964, **1**, 37-49.

Bandura, A. Social learning through imitation. In M. R. Jones (Ed.) *Nebraska symposium on motivation.* Lincoln: University of Nebraska Press, 1962, Pp. 211-269.

Konorski, J. and Miller, S. On two types of conditioned reflex. *J. gen. Psychol.*, 1937, **16**, 264-272.

Lovaas, O. I., Berberich, J. P., Perloff, B. F., and Schaeffer, B. Acquisition of imitative speech by schizophrenic children. *Science*, 1966, **151**, 705-707.

Metz, J. R. Conditioning generalized imitation in autistic children. *J. exp. Child Psychol.*, 1965, **2**, 389-399.

Miller, N. E. and Dollard, J. *Social learning and imitation.* New Haven: Yale University Press, 1941.

Reynolds, G. S. Behavioral contrast. *J. exp. Anal. Behav.*, 1961, **4**, 57-71.

Skinner, B. F. *Science and human behavior.* New York: Macmillan, 1953.

Terrace, H. S. Discrimination learning with and without "errors". *J. exp. Anal. Behav.*, 1963, **6**, 1-27. (*a*)

Terrace, H. S. Errorless transfer of a discrimination across two continua. *J. exp. Anal. Behav.*, 1963, **6**, 223-232. (*b*)

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