

# Immediate and Deferred Imitation in Fourteen- and Twenty-Four-Month-Old Infants

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MELTZOFF, ANDREW N. *Immediate and Deferred Imitation in Fourteen- and Twenty-Four-Month-Old Infants*. CHILD DEVELOPMENT, 1985, 56, 62-72. A laboratory procedure is developed that can be used to assess imitation in the second year of life. The procedure uses a blind scoring technique and incorporates control conditions to distinguish infant imitation from spontaneous production of the target behavior. The procedure is used in 2 experiments evaluating the imitation of a simple action with a novel toy. The experiments assess both immediate and deferred imitation in each of 2 age groups, 14-month-olds and 2-year-olds. The deferred imitation task involved a 24-hour delay between the modeling and response periods. There was strong evidence that 2-year-old infants could perform both the immediate and deferred imitation tasks, which was expected. The results also showed that 14-month-olds could succeed in both tasks. The discussion considers the implications of the deferred imitation results in light of current data and theorizing concerning representational capacities and long-term memory in infancy.

There is near-universal acceptance of the view that imitative processes play an important role in the early cognitive and social development of the child. There is also an increasing consensus that the developmental course of imitation in infancy needs further empirical investigation.

Recent laboratory studies have shown that young infants are more proficient imitators than had previously been thought. Meltzoff and Moore (1977, 1983a), Jacobson (1979), and Field, Woodson, Greenberg, and Cohen (1982) have reported that infants in the first month of life are capable of imitating facial gestures displayed by an adult experimenter. Discussion continues about what mechanism underlies this early behavior (Meltzoff, 1985; Meltzoff & Moore, 1983b, 1985; Uzgiris, 1979), but such findings suggest that revisions may be needed in the standard accounts of imitative development, which place the onset of such behavior at about 1 year of age. They also suggest that it may be profitable to reexamine the imitative abilities of older infants, particularly in the 1-2-year-old age range itself, where there have been relatively few controlled laboratory experiments.

The study of imitation in this older age range raises several interesting methodological issues. First, there is the problem of distinguishing imitation from spontaneous behaviors that may happen to match the target behavior. Most of the early studies of imitation in the second year did not include the controls necessary to make this distinction (Mehrabian & Williams, 1971; Paraskevopoulos & Hunt, 1971; Rodgon & Kurdek, 1977; Uzgiris, 1972; Uzgiris & Hunt, 1975).<sup>1</sup> In these studies, various models were presented and infants were scored according to whether or not they performed similar behaviors during a given response period. Imitation was inferred if the infant produced a behavior that matched the adult's. Imitative development was inferred if older infants produced more behavior matching the target than did younger infants.

Such designs do not provide unambiguous evidence from which to draw inferences about the existence of imitation and its development. First, they do not provide conclusive evidence for imitation, because control conditions were not used to assess the spontaneous production of the target behaviors in absence of exposure to the model. The demonstration

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<sup>1</sup> These studies of imitation explored a broad range of infant skills and did not attempt to use strict, experimentally controlled procedures, perhaps out of necessity given their breadth.

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of imitation requires more than showing that infants produce behaviors that match the adult target behaviors. It also requires that the infants' productions are above the spontaneous rate when the infants have not been exposed to the target behavior at all. Second, inferences about imitative development cannot unambiguously be drawn from data showing that older infants produce more of the target behavior than do younger infants. For some of the behaviors under study, it is possible that older infants have a higher spontaneous rate of the target behavior than do younger infants. Imitative development is not assessed simply by testing whether the rate of the target behavior increases as a function of age, but by testing whether there is a differential increase in the rate of the target behavior in modeling versus the control conditions as a function of age.

There are only a few studies of imitation in older infants that attempted to distinguish the spontaneous production of the target behavior from imitation by including control conditions to assess baseline rates (e.g., Abravanel, Levan-Goldschmidt, & Stevenson, 1976; Killen & Uzgiris, 1981; McCall, Parke, & Kavanaugh, 1977). The results from these laboratory experiments suggest that older infants are rather poor imitators, certainly poorer than the earlier, less well-controlled studies had suggested.

For example, Abravanel et al. tested for imitation of 22 items in infants up to 15 months old. The items were simple acts such as patting an object, shaking a bell, and squeezing a toy. The results showed imitation (i.e., significant differences between the modeling and nonmodeling conditions) for only eight of the 22 items. These results are much weaker than the classic views of infant imitation would have predicted (Piaget, 1962), given the simple tasks used and the age range tested. Likewise, when spontaneous rates were taken into account, the Killen and Uzgiris study was unable to find significant imitation of simple acts such as shaking or banging in infants less than 16 months of age (see their Table 2), although there was some suggestion of mimicking conventional actions such as drinking from a cup at younger ages. Similarly, McCall et al. reported rather poor imitative performance below 18 months.

There are, however, two reasons for caution in interpreting these laboratory experiments. First, the type of tasks and their sheer number (up to 22 items in a repeated-measures design) may have dampened infants' performance. Abravanel et al. and

McCall et al. both noted that their experimental procedures may well have "perplexed" or "puzzled" the infants. Second, despite adding needed controls, these newer experimental studies retained some of the methodological shortcomings of the earlier work. Neither the stimulus presentations nor the response periods were of fixed duration. This opens the possibility that the experimenter could wait longer for an imitative response at the older ages, or on certain tasks, and thus obtain biased developmental or task effects. Moreover, these experiments did not ensure that the scorer was kept uninformed about the experimental condition. The studies were videotaped (a potential improvement upon the earlier work using "live" scoring); however, the experimenter's behavior was visible on the videotape, and thus scorers were still informed about the behavior shown to the infants. A rigorous test of infant imitation requires that the infant's behavior be scored by an observer who is uninformed about the experimental condition.

Most recent studies of infant imitation have focused on tasks in which the infant is allowed to copy what he sees with no temporal delay. From the point of view of both social and cognitive development, it is also interesting to investigate the development of infants' ability to imitate after a delay. Imitative processes can play only a limited role in early socialization and learning as long as the infant is limited to copying the adult actions immediately after witnessing them and cannot yet duplicate actions that have been absent from the perceptual field for some time. A common age estimate for the onset of deferred imitation is about 18–24 months (McCall et al., 1977), and it has been suggested that infants below this age may lack the perceptual-cognitive sophistication, in terms of long-term recall memory and representational capacities, to succeed on such tasks (Flavell, 1977; McCall et al., 1977).

Despite its relevance for social- and cognitive-developmental theory, deferred imitation has not been the focus of much experimental work. The only laboratory experiment focused on deferred imitation was the McCall et al. study, which contained the methodological shortcomings noted earlier. The study demonstrated deferred imitation, but was conducted with 2-year-olds, an age at which most theorists and observers would expect such behavior. What was left untested was whether the ability to perform deferred imitation first emerged at about 18–24 months, as McCall et al. and others have argued, or

## 64 Child Development

whether even younger infants can also succeed on such tasks.

There were three goals of the present studies: (a) to develop a methodologically sound test of imitation in the second year of life by using blind scoring techniques and incorporating control conditions to distinguish true imitation from spontaneous behavior emitted without exposure to the model; (b) to test for the existence of immediate and deferred imitation in 2-year-old infants, an age at which most theorists would predict both to occur; (c) to assess immediate and deferred imitation in 14-month-old infants. A demonstration of deferred imitation under strict laboratory-controlled conditions in infants younger than the 18–24-month age range would provide new data bearing on imitative development, memory, and representation in infancy.

### Study 1

#### Method

**Subjects.**—The subjects were 60 normal 2-year-old infants. The mean age at the time of first test was 104.8 weeks ( $SD = .56$ , range = 103.6–105.4). The mean birth weight was 8.0 pounds ( $SD = .98$ , range = 5.8–9.8). All the subjects were full-term (over 37 weeks gestation and 5.5 pounds at birth) according to maternal report. There were equal numbers of males and females. An additional five subjects were eliminated from the study: four for not returning for the second visit and one for refusing to touch the test object. These eliminations were distributed approximately equally across test conditions.

**Test environment and apparatus.**—The test room (3.2 × 2.1 m) was unfurnished except for the test equipment. The parent and experimenter faced each other across a small (1.2 × .60 m) black table, with the infants on their parents' laps. A camera to the left (10 m) of the experimenter was focused to include the infant's torso, head, and most of the tabletop. The experiment was electronically timed by a character generator that mixed the elapsed time in .10-sec increments onto the videotapes. Friends and family observed the test session through a one-way mirror in an adjacent room.

**Stimulus.**—The object used during the experiment was a specially constructed, unfamiliar toy that could be pulled apart and put back together again. It consisted of two plain wooden squares (2.5 × 2.5 cm), each with a 7.5-cm length of rigid tubing extending from

it. The plastic tubing attached to one square was 1.3 cm in diameter; the tubing attached to the other was slightly smaller, .95 cm in diameter. It was thus possible for one piece to fit inside the other. When the test object was placed on the table it gave the appearance of a solid, one-piece, dumbbell-shaped toy consisting of two wooden squares with a gray plastic tube attaching them. The object could be pulled apart by grasping the two wooden cubes and exerting an outward force of 4.91 kg·m/s<sup>2</sup>. The object was constructed to meet these specifications because pilot studies indicated that infants under 2 years old could pull it apart, but that it fit together snugly enough to prevent it from falling apart accidentally if banged.

**Procedure.**—Each subject and parent was escorted to a reception room. For approximately 10 min the infant was allowed to explore the room, while the male experimenter described the test procedure to the parent. Next, the infant and parent were brought to the test room and the infant given approximately 2 more minutes to acclimate to that environment, while the experimenter handed the infant a series of small rubber warm-up toys to explore. Once the infant seemed comfortable, the experiment began.

Each infant was randomly assigned to one of the two groups according to whether he or she was to partake in the "immediate" ( $N = 30$ ) or "deferred" ( $N = 30$ ) test. Within each group, infants were randomly assigned to one of three test conditions such that there were 10 infants in each, including equal numbers of males and females. The three conditions were the baseline control, the activity control, and the imitation test.

In the imitation condition the experimenter brought the toy up from below the table to about the center of his chest. Once the infant fixated the toy, the experimenter pulled it apart with a very definite movement. He then reassembled it and repeated the act, pulling it apart in the same way two more times. This stimulus presentation period lasted for 20 sec. The toy was then lowered below the table edge and immediately brought back into view and placed on a spot 17 cm away and directly in front of the infant. A 20-sec response period was then timed, starting from when the infant touched the object. During this response period, the experimenter fixated the spot where he had placed the toy, assumed a relaxed facial pose, and said nothing, regardless of the infant's response.

In the baseline condition, the toy was simply brought up from below the table and placed on the same spot in front of the infant. As before, a 20-sec response period was timed from when the infant first touched the object, and the experimenter again fixated a spot on the table.

It can be argued that the baseline condition alone is not a sufficient control for assessing imitation. Infants who see the experimenter pick up and play with the toy may be especially interested in the object and promoted to engage in nonspecific manipulations of it. Such nonspecific manipulations might lead infants to discover by chance that the toy can be pulled apart, thus yielding significantly more of the target behavior (toy pulling) in the modeling condition versus the baseline condition. A more rigorous test of imitation would be to include a control condition in which the experimenter performs a second behavior with the same toy at approximately the same rate of movement. If the infant pulls the object apart significantly more often after seeing the pull-apart demonstration than after seeing the experimenter perform this control action, then one can be more secure in inferring imitation.

This was the procedure followed in the activity-control condition. The experimenter brought the toy up from below the table to about chest height in the identical way as before. When the infant fixated the object, it was moved in a circle and returned to the starting point. The experimenter then paused before repeating the action two more times. The diameter of the circle traced by the object was the same as the linear movement used in pulling apart the toy in the imitation condition (42 cm). The timing of the three demonstrations was kept the same as the imitation condition, and the entire stimulus-presentation period again lasted 20 sec. After this, the toy was briefly lowered beneath the table and then placed on a spot 17 cm away and directly in front of the infant. The 20-sec response period was then timed.

The same three test conditions were used to assess imitation in the "deferred" group. The only difference in procedure was that a 24-hour delay was interposed between the modeling and the response periods (delay range = 24.0–24.5 hours). In the imitation condition, the infants were given the warm-up procedure, shown the pulling movement, and then sent home until the next day. In the activity-control condition, the infants were given the warm-up, shown the circle move-

ment, and sent home. In the baseline condition, the infants simply came into the experimental room, went through the warm-up, and then were sent home. The test on day 2 was identical for all three conditions. The experimenter brought the toy up from below the table, placed it on the spot in front of the child, and timed the 20-sec response period identically as before.

*Scoring.*—The videotapes shown to the scorer did not contain any record of the experimental condition. The scorer was shown 60 20-sec response periods in a random order, all of which started when the infant first touched the toy. The scorer used paper and pencil to record whether or not the infant pulled apart the object, and if so, the latency to pull. The toy was scored as having been pulled apart the moment that the two halves of it were visibly separated. Intra- and interobserver agreement was assessed by having all 60 periods scored twice by one scorer and once by a second, independent scorer. For the dichotomous judgment of whether or not the infant pulled apart the toy in a given response period, there was 100% agreement for both the intra- and interobserver assessments. The intra- and the interobserver agreements for the latency measures were both .99, as measured by Pearson correlations. The largest disagreement in the latency-to-pull measure was .10 sec.

### *Results and Discussion*

Preliminary analyses revealed that there were no sex differences in the number of subjects who pulled apart the object ( $p > .50$ ). Nor were there any significant differences between the proportion of infants pulling apart the toy in the baseline versus activity control conditions ( $p > .50$ ). The data were therefore collapsed across these factors for subsequent analyses.

The results clearly support the hypothesis that the subjects were imitating. The number of subjects who produced the target behavior as a function of experimental condition is displayed in Table 1. Collapsing across delay and considering all 60 subjects together, infants were over three times as likely to produce the target behavior after it was modeled (75%) than in the control condition (23%),  $\chi^2(1) = 13.20$ ,  $p < .001$ . As expected, the results from the immediate group alone provide the strongest evidence for imitation. For that group, 80% of the infants exposed to the model produced the target behavior, as compared to 20% in the control condition,  $\chi^2(1) = 7.66$ ,  $p < .01$ . However, there was also

TABLE 1  
 PERCENTAGE OF 24-MONTH-OLDS PRODUCING THE TARGET BEHAVIOR IN THE  
 IMMEDIATE- AND DEFERRED-IMITATION TESTS

| TEST TYPE           | CONDITION |    |          |    | $\chi^2$ |
|---------------------|-----------|----|----------|----|----------|
|                     | Imitation |    | Controls |    |          |
|                     | %         | N  | %        | N  |          |
| Immediate . . . . . | 80        | 10 | 20       | 20 | 7.66**   |
| Deferred . . . . .  | 70        | 10 | 25       | 20 | 3.91*    |

\* $p < .05$ .

\*\* $p < .01$ .

evidence for deferred imitation. After the 24-hour delay, 70% of the subjects matched the target, as compared to only 25% in the control condition,  $\chi^2(1) = 3.91$ ,  $p < .05$ . There was no significant reduction in imitation for the deferred versus immediate test groups. This can be seen by inspection and is shown statistically by a chi-square test for homogeneity (Fleiss, 1981), which reveals no significant difference ( $p > .50$ ) between the two chi-square tables just reported.

The latency scores for all those infants who produced the target behavior were also analyzed using a two-way ANOVA, examining the effects of test condition (control vs. imitation) and delay (immediate vs. deferred). There was a significant main effect for test condition,  $F(1,20) = 24.70$ ,  $p < .001$ , indicating that the infants in the imitation condition were faster to produce the target behavior than those in the control condition. The mean latency in the imitation condition was 2.00 sec (SD = 2.32), as compared to 9.53 (SD = 4.92) in the control condition. There was no

main effect of delay ( $p > .50$ ) and no delay  $\times$  test condition interaction ( $p > .50$ ).<sup>2</sup>

This experiment shows that 2-year-olds can imitate a simple action with an unfamiliar toy. The data provide evidence not only for immediate imitation but also for deferred imitation, when infants are forced to delay their imitation of a display for 24 hours after it was perceived. The long delay did little to dampen the imitation effect. Infants were as likely to imitate after a 24-hour delay as they were immediately. A second study was therefore undertaken to determine whether younger infants, 14-month-olds, could also succeed on these imitation tasks. According to some theorists (McCall et al., 1977), the 14-month-old group should succeed on the immediate imitation task but fail on the deferred task.

## Study 2

### Method

The test environment, stimulus, and procedure were identical to those already de-

<sup>2</sup> The results demonstrate imitation of toy pulling. It might also be noted that a second act was shown to infants as part of the "activity control" condition, namely, holding the toy with both hands and moving it in a circle. Infants were not observed to perform full and precise circling movements in response. However, some infants seemed to mimic aspects of the modeled behavior by making small twirling or twisting motions with the toy after observing this movement. The morphology of these reactions varied across infants, which made behavioral scoring difficult. However, we sought to substantiate our impressions by using a forced-choice "perceptual judgment" scoring procedure (Meltzoff & Moore, 1983b). On the basis of watching the videotape of the 20-sec response period, a scorer who was blind to the test conditions made a forced-choice judgment as to which of the two control conditions an infant was in (baseline or circle-movement). The scorer also wrote down the basis of the judgment. The results supported our initial observations: There was evidence that the scorer could distinguish the infants' reactions in the two control conditions (65% correct;  $p < .05$ , binomial test, one-tailed), and inspection of the scorer's written record showed that there were more observations of twisting, twirling, rolling, and other directed manipulatory activity in the activity-control than the baseline condition. This underscores our basic idea that the activity control was useful to incorporate when testing for the imitation of the toy-pulling act, because in that condition the infants were prompted to manipulate the toy. It also lends support to the notion that infants will sometimes mimic certain features of a display even without duplicating it precisely. The manner in which motor constraints and other factors interact to influence whether infants try to imitate at all, and when they do what features of the display they choose to duplicate, is an interesting topic that must be left for future studies.

TABLE 2  
 PERCENTAGE OF 14-MONTH-OLDS PRODUCING THE TARGET BEHAVIOR IN THE  
 IMMEDIATE- AND DEFERRED-IMITATION TESTS

| TEST TYPE           | CONDITION |    |          |    | $\chi^2$ |
|---------------------|-----------|----|----------|----|----------|
|                     | Imitation |    | Controls |    |          |
|                     | %         | N  | %        | N  |          |
| Immediate . . . . . | 75        | 20 | 20       | 40 | 14.81*** |
| Deferred . . . . .  | 45        | 20 | 7.5      | 40 | 9.49**   |

\*\* $p < .01$ .

\*\*\* $p < .001$ .

scribed. The subjects were 120 14-month-olds. Half were randomly assigned to the immediate and half to the deferred group (delay range = 24.0–25.5 hours). The mean age at the time of the first test was 60.8 weeks (SD = .62, range = 59.7–61.9). The mean birth weight was 7.8 pounds (SD = 1.0, range = 5.9–9.8). All subjects were full-term according to maternal report.

Within both the immediate and deferred groups, there were three test conditions, as previously described, with equal numbers of males and females in each test condition. Fourteen additional subjects were eliminated from the study, three for excessive fussing, eight for refusal to pick up the toy, and three for not returning for the second visit. These eliminations were distributed approximately equally across test conditions. The scoring was done exactly as described in Study 1. There was 100% intra- and interobserver agreement for the dichotomous judgment of whether or not the target behavior was produced in a given response period. Intra- and interobserver Pearson  $r$ 's for the latency were, respectively, .98 and .99.

### Results and Discussion

Preliminary analyses revealed no differences in the production of the target behavior as a function of sex of the subjects ( $p > .20$ ) or for the baseline versus activity-control conditions ( $p > .50$ ). Therefore, in subsequent analyses the data were collapsed across these factors.

The results provide strong evidence for imitation. Considering all 120 subjects, infants were over four times as likely to produce the target behavior after seeing it modeled (60%) than they were in the control condition (14%),  $\chi^2(1) = 25.42$ ,  $p < .001$ . As predicted, there were significant results in the immediate imitation group alone,  $\chi^2(1) = 14.81$ ,  $p < .001$ . Table 2 shows that about 75% of the

infants produced the target behavior after seeing it modeled, as compared to 20% of the controls. There were also significant results in the deferred imitation group,  $\chi^2(1) = 9.49$ ,  $p < .01$ . After the 24-hour delay, 45% of the infants in the imitation condition produced the target behavior, as compared to 7.5% of the controls. There was no significant difference in the strength of the imitation effect in the immediate versus deferred groups, as revealed by a chi-square test for homogeneity comparing the two chi-square tables just reported ( $p > .50$ ).

The latency scores for subjects producing the target behavior were analyzed using a two-way ANOVA examining test condition (control vs. imitation) and delay (immediate vs. deferred). There was a significant main effect of test condition,  $F(1,31) = 19.17$ ,  $p < .001$ . The infants in the imitation condition were faster to produce the target behavior. The mean latency in the imitation condition was 4.02 sec (SD = 3.58), as compared to 9.83 sec (SD = 5.06) in the control. There was no main effect of delay ( $p > .30$ ). The test condition  $\times$  delay interaction could not be validly assessed due to the small number of subjects producing the target behavior in one of the cells. (In the control condition in the deferred test, only three infants pulled the toy apart.)

The power of the modeling on the infants' subsequent behavior is best illustrated by combining the results from the two studies. Figure 1 shows that over both studies ( $N = 180$ ), 65% of the infants in the imitation condition produced the target behavior, in contrast to only 17% in the control condition. Moreover, it depicts the remarkable speed with which this imitative behavior was produced. As shown, the probability of infants spontaneously producing the target behavior within the first 5 sec of the response period in the control condition was near zero; it simply

## 68 Child Development

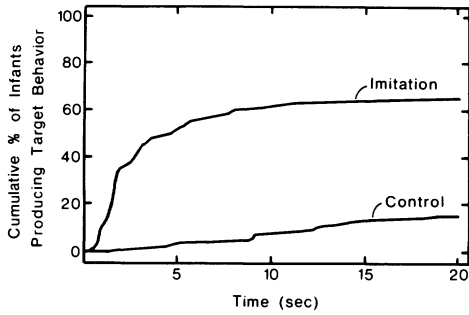


FIG. 1.—Cumulative percentage of infants in the imitation ( $N = 60$ ) and control ( $N = 120$ ) conditions producing the target behavior as a function of time.

was not a high probability event if infants were not shown the behavior. Yet 52% of the infants in the imitation condition produced it. Indeed, in the imitation condition, most (79%) of the infants who produced the target behavior did so within 5 sec of first touching the toy.

This captures what one sees in testing the infants. The infants go directly to reproducing the behavior themselves without much fumbling with the novel object. Even the younger infants do this, and they do so even in the deferred imitation task. (The mean latency to pull for the young infants after the 24-hour delay was only 5.02 sec.) The infants reached out to the toy and pulled it apart without engaging in exploratory manipulations before imitating. Evidently a short demonstration with an unfamiliar toy has profound influence on the subsequent actions of infants for as long as 24 hours later. Moreover, even the 14-month-old infants need not reconstruct what they saw through trial and error, but can remember it well enough to duplicate the act immediately.

### General Discussion

These experiments demonstrate that 14- and 24-month-olds can imitate a simple action with an unfamiliar object, both immediately and after a 24-hour delay. They provide the first experimental demonstration that infants as young as 14 months old are capable of performing deferred imitation. The results have implications both for the design of imitation experiments and for theories of infant memory and representational development.

### Design Implications

The present studies developed a rigorous test procedure for assessing imitation in the second year. The design improved upon previous research by using blind scoring techniques and incorporating controls to distinguish between imitation and spontaneous production of the target response. Two types of controls were used. The first was a baseline control in which infants were simply given the test object to manipulate without any prior exposure to it. In the second control condition, the experimenter used the test object to demonstrate a different movement from the target behavior but at approximately the same rate. These controls were introduced to help distinguish true imitation from the spontaneous production of the target behavior that would occur even in the absence of seeing the model.

The pattern of results illustrates the importance of including these controls when assessing imitation. For the 14-month-olds in the deferred imitation condition, 45% produced the target behavior after the 24-hour delay. Is this sufficient evidence for deferred imitation? In order to answer this question, we need to know how many infants would be expected to produce this behavior spontaneously, without seeing the adult demonstration. The control conditions show that infants are very unlikely to produce the target behavior on their own, without previous exposure to the demonstration. Only 7.5% of them did so. The comparison of the controls versus the imitation conditions is significant and thus permits the inference of deferred imitation within the 14-month-old group. The results allow us to conclude that the infants were basing their behavior on the perception of the modeled action—that it was not a chance event or one occurring simply because infants had previously seen the experimenter handling the test object.<sup>3</sup>

While 45% of the younger group produced the target behavior after the delay, 70% of the older group did so. If we had not included the control groups, these data might be taken for a developmental change in imitative capacities per se. However, the experiment shows that this inference cannot legitimately be drawn, because the controls showed comparable increases in the production of the target behavior as a function of age.

<sup>3</sup> The findings show that 14-month-olds are capable of performing deferred imitation, at least of this particular action under the conditions of this test. It is a matter for further research to determine whether or not there are interesting restrictions on the type of actions that can be so imitated or on the length of delay that young infants can tolerate before this behavior is disrupted. Such tests would, of course, need to be conducted using the controls outlined in the text.

In the control condition after the delay, only 7.5% of the younger infants produced the target behavior, whereas fully 25% of the older infants did so. Evidently, the younger infants simply had a lower probability of producing the target behavior after a delay than did the older infants, and this held true regardless of whether or not the infant saw the target behavior demonstrated.

From the point of view of *imitation*, the critical point is not that more of the older infants produced the target behavior in the imitation condition than did the younger infants, but that the older infants were about three times more likely to produce the target behavior in the imitation than in the control condition (70% vs. 25%), and the younger infants were six times more likely to do so (45% vs. 7.5%). Each age group thus demonstrated significant deferred imitation (more of the target behavior in the imitation than in the age-matched control condition, as shown in the bottom rows of Tables 1 and 2). Moreover, a chi-square test for homogeneity (Fleiss, 1981) reveals no significant difference between the deferred imitation results at 24 months (70% vs. 25%) and 14 months (45% vs. 7.5%).

The foregoing discussion shows that development may sometimes result in changes in infants' tendencies to produce the target behavior (in both the imitative or control conditions), but not necessarily in imitative capabilities per se. This point was confounded in many previous studies, which did not include controls to assess the rate of spontaneous production. The present results do not, of course, permit the inference that there is *no* developmental change in infants' imitative abilities. Rather, they underscore the need to separate changes in imitation per se from changes in the proclivity to perform the target action in the absence of exposure to the model.<sup>4</sup>

Given the current findings of both immediate and deferred imitation in both age groups, one might also ask why some previous laboratory studies reported weaker statistical effects at these and older ages than did the present study. In previous studies, infants have been given a long list of imitative tasks to perform in a repeated-measures design. For example, Abravanel et al. presented in-

fants with up to 22 items in a single test session, including bell ringing, hand clapping, and spoon stirring. On some trials the natural sounds associated with these actions (e.g., the ringing of the bell) were eliminated. Our pilot studies indicated that such procedures were poor elicitors of imitation. The infants often became engaged in other problems, such as why a noise-making bell was now being shaken without any resulting noise. They also tended to persist in imitating what they had just done. For these reasons, the present experiments required infants to imitate one action with an unfamiliar toy that they could have no preconceptions about. When the theoretical debate revolves around infants' underlying imitative capacities, such as whether infants of a certain age have the ability to delay their imitation until a later point in time, it may be judicious to design studies with a small number of carefully chosen test items.

#### *Implications for Infant Memory*

Developmental theorists have found it useful to retain some distinction between recognition and recall memory (Flavell, 1977). Much recent work in the infant cognition literature has focused on recognition memory. The present studies complement this literature by providing a useful technique for assessing infant recall memory.

Using habituation and paired-comparison test procedures, developmentalists have evaluated the impact of several factors on subsequent recognition memory: familiarization period (Fagan, 1974), delay interval (Cornell, 1979; Fagan, 1973; Pancratz & Cohen, 1970), interference (Cohen, DeLoache, & Pearl, 1977), stimulus characteristics (Caron & Caron, 1969; Fagan, 1972), and age (Fantz, 1964; Wetherford & Cohen, 1973). The picture that has emerged from these studies is that infant visual *recognition* memory is extremely robust, with the absence of recognition being more of the exception than the rule, even after significant delays (Cohen & Gelber, 1975; Fagan, 1977; Olson, 1976). The work on *recall* memory, however, has been much more meager. Interesting hypotheses about the late development of this capacity remain largely untested. Although recognition memory has been postulated to be a primitive capacity,

<sup>4</sup> There may be many reasons, aside from ones having to do with imitation per se, why the younger infants in the delay condition had an overall lower tendency to produce the target behavior (in both the imitation and control conditions). For example, these infants seemed particularly apt to reach out and offer the toy to the experimenter on day 2. This attempt at reestablishing social contact with the experimenter they had briefly seen the day before may have dampened their tendency to produce the target behavior. Again this underscores the need for the control conditions outlined in the text.



## 70 Child Development

the ability to recall objects or events in their absence has been postulated to be a sensitive index of developmental level (Flavell, 1977; Kagan, Kearsley, & Zelazo, 1978; Piaget, 1952, 1954; Sophian, 1980).

One way to demonstrate that infants recall something that is now absent is through object-permanence tasks. Some investigators have systematically varied the interval between the occlusion of the object and the beginning of search in an attempt to assess recall memory. Most of the results to date are compatible with the theoretically based notion that recall memory is a fragile and late-developing capacity in infants. For example, Gratch, Appel, Evans, LeCompte, and Wright (1974) reported that 9-month-olds successfully recovered a hidden object when allowed to search after no delay, but that search fell to chance when delays as short as 1–7 sec were introduced. Using a related object-hiding procedure, Webb, Massar, and Nadolny (1972) reported that 14-month-olds could not tolerate a delay of more than 10 sec. DeLoache (1980) recently suggested that more favorable estimates might be obtained from more naturalistic research with familiar objects being hidden in a home environment, and her observations suggest that by 18–30 months old, at least, infants can demonstrate some recall after an overnight delay.

The present studies provide a different and complementary test procedure that can be used to investigate aspects of infant recall memory. In the deferred imitation task, infants are shown a certain action and then a delay is interposed before the response is allowed. In order to reproduce the now-absent action, the infant must access an internal representation to guide his or her present behavior. If infants accurately reproduce the action, it indicates that they can do more than simply recognize that the current scene is related to the old one. It illustrates that they can recall or “reconstruct” what they have seen. Thus deferred imitation can be used to tap some form of recall memory in preverbal infants (Kagan, 1981; Meltzoff, 1981, 1985; Piaget, 1962; Watson, in press; Werner & Perlmutter, 1979).

The present studies demonstrated deferred imitation in 14-month-old infants after delays as long as 24 hours. The test object was not familiar to the infant, nor was the test environment designed to be naturalistic. Nonetheless, the retention interval, 24 hours, was the same as shown by DeLoache with far older children (18–30-month-olds), and like that work, provides a more favorable estimate

of long-term recall capacities than was originally suggested by Gratch et al. (1974) and Webb et al. (1972) using their particular object-search procedures.

Object-search tasks and deferred imitation are similar in that infants must govern their motor actions on the basis of a stored representation of a now-absent object or event, and not simply recognize two scenes as similar. The two tasks also have clear and obvious differences. For example, in the object permanence case, infants must represent a particular object in a spatial location, whereas in the deferred imitation task, it is not a particular object in space but an absent action that must be stored. As such, this new work on deferred imitation provides a converging technique for investigating non-recognition forms of memory in infants.

Future experiments using deferred imitation designs of the type developed here could investigate parameters such as delay, interference, stimulus characteristics, and perhaps, most interestingly, their interaction with age or developmental level as measured by other tasks. Converging tests of infant memory using paired-comparison, habituation, object permanence, and deferred imitation procedures would not only increase our knowledge about memory development, but may also help to clarify the differences between the types of representational processes involved in these different cases.

Regardless of this future research, the present studies show that infants as young as 14 months can profit from observation, and can use this visual experience to direct their behavior at a significantly later point in time. This suggests that imitation could, in principle, play a useful role in learning and socialization during infancy (Meltzoff, 1985).

## References

- Abravanel, E., Levan-Goldschmidt, E., & Stevenson, M. B. (1976). Action imitation: The early phase of infancy. *Child Development, 47*, 1032–1044.
- Caron, R. F., & Caron, A. J. (1969). Degree of stimulus complexity and habituation of visual fixation in infants. *Psychonomic Science, 14*, 78–79.
- Cohen, L. B., DeLoache, J. S., & Pearl, R. A. (1977). An examination of interference effects in infants' memory for faces. *Child Development, 48*, 88–96.
- Cohen, L. B., & Gelber, E. R. (1975). Infant visual memory. In L. B. Cohen & P. Salapatek (Eds.), *Infant perception: From sensation to cognition*

- (Vol. 1, pp. 347–403). New York: Academic Press.
- Cornell, E. H. (1979). Infants' recognition memory, forgetting and savings. *Journal of Experimental Child Psychology*, **28**, 359–374.
- DeLoache, J. S. (1980). Naturalistic studies of memory for object location in very young children. In M. Perlmutter (Ed.), *New directions for child development: No. 10. Children's memory* (pp. 17–32). San Francisco: Jossey-Bass.
- Fagan, J. F. III (1972). Infants' recognition memory for faces. *Journal of Experimental Child Psychology*, **14**, 453–476.
- Fagan, J. F. III (1973). Infants' delayed recognition memory and forgetting. *Journal of Experimental Child Psychology*, **16**, 424–450.
- Fagan, J. F. III (1974). Infant recognition memory: The effects of length of familiarization and type of discrimination task. *Child Development*, **45**, 351–356.
- Fagan, J. F. III (1977). Infant recognition memory: Studies in forgetting. *Child Development*, **48**, 68–78.
- Fantz, R. L. (1964). Visual experience in infants: Decreased attention to familiar patterns relative to novel ones. *Science*, **146**, 668–670.
- Field, T. M., Woodson, R., Greenberg, R., & Cohen, D. (1982). Discrimination and imitation of facial expressions by neonates. *Science*, **218**, 179–181.
- Flavell, J. (1977). *Cognitive development*. Englewood-Cliffs, NJ: Prentice-Hall.
- Fleiss, J. L. (1981). *Statistical methods for rates and proportions* (2d ed.). New York: Wiley.
- Gratch, G., Appel, K. J., Evans, W. F., LeCompte, G. K., & Wright, N. A. (1974). Piaget's stage IV object concept error: Evidence of forgetting or object conception? *Child Development*, **45**, 71–77.
- Jacobson, S. W. (1979). Matching behavior in the young infant. *Child Development*, **50**, 425–430.
- Kagan, J. (1981). *The second year*. Cambridge, MA: Harvard University Press.
- Kagan, J., Kearsley, R. B., & Zelazo, P. R. (1978). *Infancy: Its place in human development*. Cambridge, MA: Harvard University Press.
- Killen, M., & Uzgiris, I. C. (1981). Imitation of actions with objects: The role of social meaning. *Journal of Genetic Psychology*, **138**, 219–229.
- McCall, R. B., Parke, R. D., & Kavanaugh, R. D. (1977). Imitation of live and televised models by children one to three years of age. *Monographs of the Society for Research in Child Development*, **42**(5, Serial No. 173).
- Mehrabian, A., & Williams, M. (1971). Piagetian measures of cognitive development for children up to age two. *Journal of Psycholinguistic Research*, **1**, 113–126.
- Meltzoff, A. N. (1981). Imitation, intermodal coordination, and representation in early infancy. In G. Butterworth (Ed.), *Infancy and epistemology* (pp. 85–114). Brighton: Harvester.
- Meltzoff, A. N. (1985). The roots of social and cognitive development: Models of man's original nature. In T. M. Field & N. Fox (Eds.), *Social perception in infants* (pp. 1–30). Norwood, NJ: Ablex.
- Meltzoff, A. N., & Moore, M. K. (1977). Imitation of facial and manual gestures by human neonates. *Science*, **198**, 75–78.
- Meltzoff, A. N., & Moore, M. K. (1983a). Newborn infants imitate adult facial gestures. *Child Development*, **54**, 702–709.
- Meltzoff, A. N., & Moore, M. K. (1983b). The origins of imitation in infancy: Paradigm, phenomena, and theories. In L. P. Lipsitt (Ed.), *Advances in infancy research* (Vol. 2, pp. 265–301). Norwood, NJ: Ablex.
- Meltzoff, A. N., & Moore, M. K. (1985). Cognitive foundations and social functions of imitation and intermodal representation in infancy. In J. Mehler & R. Fox (Eds.), *Neonate cognition: Beyond the blooming, buzzing confusion* (pp. 139–156). Hillsdale, NJ: Erlbaum.
- Olson, G. M. (1976). An information-processing analysis of visual memory and habituation in infants. In T. J. Tighe & R. N. Leaton (Eds.), *Habituation: Perspectives from child development, animal behavior, and neuropsychology* (pp. 239–277). Hillsdale, NJ: Erlbaum.
- Pancratz, C. N., & Cohen, L. B. (1970). Recovery of habituation in infants. *Journal of Experimental Child Psychology*, **9**, 208–216.
- Paraskevopoulos, J., & Hunt, J. McV. (1971). Object construction and imitation under differing conditions of rearing. *Journal of Genetic Psychology*, **119**, 301–321.
- Piaget, J. (1952). *The origins of intelligence in children*. New York: International Universities Press.
- Piaget, J. (1954). *The construction of reality in the child*. New York: Basic.
- Piaget, J. (1962). *Play, dreams and imitation in childhood*. New York: Norton.
- Rodgon, M. M., & Kurdek, L. A. (1977). Vocal and gestural imitation in 8-, 14-, and 20-month-old children. *Journal of Genetic Psychology*, **131**, 115–123.
- Sophian, C. (1980). Habituation is not enough: Novelty preferences, search, and memory in infancy. *Merrill-Palmer Quarterly*, **26**(3), 239–257.
- Uzgiris, I. C. (1972). Patterns of vocal and gestural imitation in infants. In F. J. Mönks, W. W. Hartup, & J. deWit (Eds.), *Determinants of behavioral development* (pp. 467–471). New York: Academic Press.
- Uzgiris, I. C. (1979). Die Mannigfaltigkeit der Imitation in der frühen Kindheit. In L. Montada

## 72 Child Development

- (Ed.), *Brennpunkte der Entwicklungspsychologie* (pp. 173–193). Stuttgart: Kohlhammer.
- Uzgiris, I. C., & Hunt, J. McV. (1975). *Assessment in infancy*. Urbana: University of Illinois Press.
- Watson, J. S. (in press). Memory in infancy. In J. Piaget, J. P. Bronkard, & P. Mounoud (Eds.), *Encyclopedie de la pleidade: La psychologie*. Paris: Gallimard.
- Webb, R. A., Massar, B., & Nadolny, T. (1972). Information and strategy in the young child's search for hidden objects. *Child Development*, *43*, 91–104.
- Werner, J. S., & Perlmuter, M. (1979). Development of visual memory in infants. In H. W. Reese & L. P. Lipsitt (Eds.), *Advances in child development and behavior* (Vol. 14, pp. 1–56). New York: Academic Press.
- Wetherford, M. J., & Cohen, L. B. (1973). Developmental changes in infant visual preferences for novelty and familiarity. *Child Development*, *44*, 416–424.